DOCUMENT RESUME

ED 204 177 SE 035 375

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TITLE Investigations in Science Education, Vol. 7, No. 3. Expanded Abstracts and Critical Analyses of Recent Research.
INSTITUTION ERIC Clearinghouse for Science, Mathematics, and Environmental Education, Columbus, Ohio.; Ohio State Univ., Columbus. Center for Science and Mathematics Education.
PUB DATE 81
NOTE 68p.
AVAILABLE FROM Information Reference Center (ERIC/IRC), The Ohio State Univ., 1200 Chambers Rd., 3rd Floor, Columbus, OH 43212 (subscription $6.00, $1.75 single copy).

EDRS PRICE MF01/PC03 Plus Postage.
DESCRIPTORS *Abstracts; *Cognitive Development; College Science; Elementary School Science; Elementary Secondary Education; Higher Education; Inservice Teacher Education; Preservice Teacher Education; *Research; Research Methodology; *Science Course Improvement Projects; Science Curriculum; *Science Education; Science Instruction; *Science Teachers; Secondary School Science; Teacher Attitudes; Teacher Characteristics
IDENTIFIERS Biological Sciences Curriculum Study; Piaget (Jean); *Science Education Research

ABSTRACT

This issue of "Investigations in Science Education" (ISE) provides analytical abstracts, prepared by science educators, of research reports in the areas of preservice and in-service teacher education for elementary and secondary science teachers; and in cognitive development of elementary and secondary school children. Each abstract includes bibliographical data, research design and procedure, purpose, research rationale, and an abstractor's analysis of the research. (CS)

INVESTIGATIONS IN SCIENCE EDUCATION

National Association for Research in Science Teaching

ERIC Clearinghouse for Science, Mathematics
and Environmental Education

Published Quarterly by

The Center for Science and Mathematics Education
College of Education
The Ohio State University
1945 North High Street
Columbus, OH 43210

Subscription Price: $6.00 per year. Single Copy Price: $1.75
Add 50¢ for Canadian mailings and $1.00 for foreign mailings.

Volume 7, Number 3, 1981

NOTES FROM THE EDITOR

Analyses clustered in two areas are presented in this issue. They deal with teacher education (five papers) or with cognitive development (four papers and a response). Within the teacher education cluster, Campbell and Martinez-Perez reported on research involving elementary education majors relative to their self-concept, attitudes, and science process skills. Harvey looked at the influence of teacher background variables on the achievement of students. Kagan and Tamir presented information about Israeli teachers and their attitudes toward and participation in in-service education activities. Lawrenz's study involves that elusive concept of "teacher effectiveness." Yeany investigated the use of what is termed strategy analysis in a methods course with preservice teachers.

The cognitive cluster has, as may be expected, a rather predominant flavor of Piagetian theory. Brown et al worked with Mexican-American pupils studying science. Good and his collegues looked at student cognitive characteristics and classroom behavior. Lawson and Nordland investigated the achievement of nonconservers in BSCS biology. Smith and Padilla provided a description of strategies first grade children used in performing a seriation task.

This issue concludes with the response of Good et al to the critique of their article presented earlier in this same document. We welcome the opportunity to present a response to analysis in the same issue as the analysis which provoked the response. This situation is possible because we have a backlog of articles which enables us to wait for a response when we are notified that one is forthcoming. At the same time we realize that abstractors would like to see their remarks in print as soom as possible.

There does not seem to be a resolution to this problem that will satisfy all parties concerned so we have chosen to consider the reader. If ISE is used in college science education research courses (and we hope it is), it seems useful for the analysis and a response to the analysis to be contained within the same issue so that students may compare constructive criticism and an author's explanation of his/her reasons for presenting the information as it was found in the article critiqued.

Patricia E. Blosser
Editor

Victor J. Mayer
Associate Editor

TEACHER EDUCATION

Campbell, Richard L. and Luis Martinez-Perez. "Self-concept and Attitudes as Factors in the Achievement of Preservice Teachers." Journal of Research in Science Teaching 14(5): 455-459, 1977.

Descriptors--*Achievement; *Attitudes; College Students; Educational Research; *Higher Education; Methods Courses; *Preservice Education; Science Education; *Self-Concept; *Teacher Education

Expanded abstract and analysis prepared especially for I.S.E. by William G. Lamb, Frederica Academy, St. Simons Island, Georgia

Purpose

The purpose of the investigation was to determine the relationships among self-concept, attitudes toward science, and science process-skill achievement of preservice elementary education majors.

Rationale

The study's rationale was well-established by reference to the theory of self-concept as a behavioral determinant developed by Snigg and Combs (1950). Other studies cited linked self-concept to achievement and achievement to attitudes, yielding the hypothesis that attitudes and self-concept are related.

Research Design and Procedure

The research design was a correlational one. Subjects included elementary education majors who experienced instruction based on a modular package described by Campbell (1975a). Self-concept was measured by the Tennessee Self-Concept Scale (Fitts, 1965); reliability (type unspecified) = 0.88 for the total and "in the range of 0.88-0.90 for the Campbell and various profile segments." Basic and integrated science process skills were measured by tests developed by Campbell. Hoyt reliability coefficients were 0.92 for the basic process skills test and 0.96, for the integrated process skills test. No other information including references, item type or number, test format, reliability sample, etc., was provided. Attitude Inventory (Moore and Sutman, 1970); test-retest reliability = 0.93.

The collected data were analyzed by calculating correlation and regression coefficients.

Findings

The investigators reported statistically significant correlations among all three variables. Regression equations indicated a relationship only between self-concept and basic science process skills achievement.

Interpretations

The studies reporting links between self-concept and achievement, and achievement and attitudes were supported, and evidence linking attitudes to self-concept was discussed. The finding that only self-concept predicted achievement was rationalized using the argument that elementary education majors had established attitudes toward science that were unaffected by the "treatment." Self-concept and process skill achievement were hypothesized to have been affected.

ABSTRACTOR'S ANALYSIS

The study is straightforward, informative, useful and similar to many other studies in the area. There are a few nitpicking weaknesses however:

(1) Insufficient information about the science process skills test is provided. Science process skills are usually quite difficult to measure, and the reliabilities are unusually high for a process skills test. The authors should provide either references for the interested reader or should describe the test in more detail (Note 1).

(2) The necessity for a "treatment" is never clearly established. There were described neither a control, alternate treatment, treatment goals, nor pre and post tests. The authors obviously teach elementary science methods; the relationship between their academic duties and their research is implied but not discussed.

(3) Some of the authors' conclusions and implications are not only not supported by the data reported but are unrelated to the study as described in the written report. For example: "The concern of teacher trainers, then, should be to...allow prospective teachers to have some input into their training, and provide mechanisms whereby prospective teachers can discover and practice learned skills both in a simulated environment and in one which includes children."

This reviewer believes in these last two points almost as much as he believes in Mom's Apple Pie and the idea that good is to be preferred over evil. They are, however, absolutely unrelated to the study as reported and should have never escaped the watchful eyes of the panel of journal referees. The same can be said of their conclusion that self-concept and process-skill achievement were affected by the treatment.

As mentioned above, these points (with the possible exception of reporting strong unstudied beliefs as findings) are nitpicking. The study is basically a strong if simple one establishing the relationships among attitudes toward science, self-concept and science process skills achievement. These relationships should be explored more thoroughly.

A criticism not related to the study directly is one of journal policy. The authors presented a study very much like the one reviewed above at a NARST meeting a few years ago. It is unclear whether the published study is the same as the NARST-presented one or a replication. The Journal of Research in Science Teaching and other journals should adopt the policy of requiring submitters to footnote prior presentations of the reported research. This would save all of us who review the literature from time to time the trouble of attempting to determine what is multiply reported and what is replication. With meta-analysis as a research technique of increasing interest, such a policy might be an important one to adopt.

Note 1: This reviewer has made two attempts to obtain Campbell's tests--once at the NARST meeting mentioned above and once via a letter after the reviewed study appeared in JRST. Neither attempt resulted in a copy of the instruments. Similar instances have occurred with other authors and instruments--e.g., the Raven Test of Logical Operations.

For that reason, it is important that authors include, and editors demand, sufficient detail in research reports such that other researchers can not only get a general idea of what happened but can replicate the reported research. One possible mechanism for including such detail in a short report is to include an experimental section in small print such as that which appears in publications sponsored by the American Chemical Society such as the Journal of the American Chemical Society and the Journal of Organic Chemistry. In that way, those persons who are interested in only the general features of the study, the discussion and conclusions could read only the report itself; those interested in the experimental details could also read the fine print.

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Campbell, R. L. Special Teaching Laboratory: Science (Module) (Rev. Ed.). Miami: Florida International University, 1975.

Fitts, W. H. Tennessee Self-Concept Scale Manual. Nashville: Counselor Recordings and Tests, 1965.

Moore, R. and F. Sutman. "The Development, Field-Testing and Validation of an Inventory of Scientific Attitudes." Journal of Research in Science Teaching 7: 85-94, 1970.

Snigg, D. and A. W. Combs. "The Phenomenological Approach and the Problem of Unconscious Behavior: A Reply to Dr. Smith." Journal of Abnormal and Social Psychology 45: 523-528, 1950.

Harvey, T. J. "The Influence of Science Training on Student Achievement in the Age Range 8-10 Years Old." Journal of Research in Science Teaching, 14(1): 13-19, 1977.

Descriptors--*Academic Achievement: Age; *Educational Research; *Elementary Education; Elementary School Science; Instruction; School Role; *Science Education; *Teacher Education

Expanded abstract and analysis prepared especially for I.S.E. by Linda Jones, California State University, Northridge.

Purpose

This study was designed to determine whether the science background of teachers, age of the students, and type of school have relationships to the achievement of students taught a particular unit of study on electricity.

Rationale

Most science teaching units produced for children of ages 5-11 assume that the teacher's science background is not a factor in student achievement. This assumption was questioned on the basis that teacher-training institutions place emphasis on the student's major subject, which suggests that teaching effectiveness is related to academic ability in that subject.

Research Design and Procedure

The subjects were 259 students in five Bath, England, primary schools. Three age levels were involved for a total of six age-school groupings. The author's intention to compare groups taught by science-trained vs, nonscience-trained resident teachers was complicated by the fact that only two of the available teachers met the criterion of being science-trained (one year or more of science background). Since the author was a science-trained teacher, he undertook the instruction of the comparison groups. To equalize academic ability, students were assigned to treatments by a modified randomization with the stipulation that resident teachers taught children taken only from their own classes.

School	Age	Treatment Groups and Number of Subjects R NS-T	R S-T	A S-T
A	10	22	23	22
B	10	18		19
C	10	15		16
D	9	24	24	24
E	9	12		13
E	8	13		14

R NS-T: resident, nonscience-trained
R S-T: resident, science-trained
A S-T: author, science-trained

The instructional unit consisted of six topics in elementary electricity. It is described as being specifically structured for use by all teachers. The author implies that each topic was presented in a single one-hour lesson and that the unit was completed in six weeks.

The instrument used to measure student achievement is described as an objective-type written test. Instrument analyses performed on the posttest revealed a mean score of 15.90, a standard deviation of 5.87 and a Kuder-Richardson internal reliability of 0.78.

Findings

One week after the completion of the instructional unit, the achievement test was administered to all subjects, and comparisons were made using analysis of variance.

The two schools in which a science-trained resident teacher was involved were considered first. Comparisons were made only within schools. In both Schoola A and D, there were no significant differences between the three teachers in student achievement. On the basis of this finding of no difference, direct comparisons between the author's students and those of the resident nonscience-trained teachers were made in subsequent analyses.

The next series of analyses compared student achievement between teacher's science training and between schools with subject age being controlled. In each case there were no significant differences between teachers, between schools, or in interactions between teachers and schools.

In the last set of analyses, achievement between age groups was considered. One school (E) had two age groups involved, making comparison within a single school possible. In this case, the difference in achievement between ages was significant at the 0.05 level, while no differences were found between teachers or in interactions between ages and teachers.

Because previous analyses had shown no differences between schools or teachers, the age groups were combined for a final comparison, with the ten-, nine-, and eight-year-olds constituting the three comparison groups. Differences in achievement between age groups were found to be significant at the 0.01 level.

Interpretations

The findings of no difference in achievement attributable to science background of the teacher or to type of school may be related to the type of instructional unit used. This unit was designed for use by teachers whose science background may be limited. The implication is that elementary physical science may be taught successfully by nonscience-trained teachers when the instructional unit is carefully structured. These results strongly support the argument for producing such structured units because they seem to eliminate two variables which could affect student achievement. The third finding, that achievement is age-related, is consistent with Piagetian theory.

ABSTRACTOR'S ANALYSIS

The report would have been enhanced by setting the experimental question in a background of related research, and developing a rationale for the investigation on empirical grounds--if not theoretical. The only two references cited are methodological, leaving the reader to speculate as to the background and significance of the problem selected.

The instrument for measuring student achievement was described only by brief reference to its general format. The number of items, comments on item content, examples of items, details of administration, or reference to published instruments of a similar nature were not given. Acceptable figures for internal reliability are given, but no comment on validity is made. Neither, indeed, can any inference on validity be drawn from the available information. Item analysis is mentioned, but it must be assumed that this refers to internal reliability only. Since the analysis was made on the administration at the conclusion of instruction, the same administration on which the study as a whole is based, it is difficult to see how any refinement or modification of items could have occurred at that point.

Some of the design flaws of this study reflect problems inherent in research of this type. It is disappointing to note that the author fails to acknowledge such problems. A carefully developed discussion of the study's limitations would have been helpful.

One design problem that would have been quite easy to avoid was the omission of a pretest. Pretest results could have been useful in several ways, such as shedding light on initial equality of the various groupings. In addition, positive pre-post gains would have established some evidence of criterion validity for the instrument.

The author must be credited with the inclusion of a large number of subjects. Even though most of the comparisons are made between smaller subgroups, such comparisons may be thought of as replications which tend to strengthen the reliability of the findings.

Several of the author's conclusions require comment. While he does not directly state that nonscience-trained teachers were equally successful with science-trained teachers, he strongly suggests it by referring to the success of the material (called "instructional unit" here). In the absence of demonstrated gain scores, one might with equal logic conclude that the variously-trained teachers were equally unsuccessful.

The conclusion that the demonstrated differences in achievement between age groups is consistent with Piagetian theory is not overstated, and is eminently reasonable. Another possible interpretation not mentioned by the author is age-related difference in test facility.

The conclusion that the results strongly support further development of instructional units carefully structured for use by nonscience-trained teachers is disturbing to the abstractor on several counts. First, the superiority of the instructional unit in being immune to limitations in the teacher's science background is not established by comparison with appropriate control groups where such effects might occur.

Second, there is no evidence that learning took place. A pretest and/or comparison with a group not taught the unit would have greatly enhanced the study.

Third, neither the objectives of the unit nor the construct measured by the instrument is fully stated or explained, and neither is the relationship of the two established. One can easily imagine similar experimental results had the instruction dealt with topics quite unrelated to the test. A weakness common in studies of this type, that duration of treatment may not be sufficient to produce measurable effects, is not explored.

Finally, even if the three previous points had been thoroughly established, the question of the value and significance of such learning to the child remains to be considered. This point, while beyond the scope of rigorous testing in a study such as this, deserves some attention before assertions of support for the instructional unit can be justified.

Kagan, Martin H. and Pinchas Tamir. "Participation in and Views Concerning In-Service Training Among High School Science and Mathematics Teachers in Israel--A Survey." School of Science and Mathematics, 77(1): 31-46, 1977.

Descriptors--*Inservice Education; *Inservice Teacher Education; *Mathematics Teachers; Science Education; *Science Teachers; *Secondary Education; *Surveys; *Teacher Education

Expanded abstract and analysis prepared especially for I.S.E. by William C. Ritz, California State University - Long Beach.

Purpose

This study set out to determine to what extent Israeli high school science teachers differ in participation and attitude toward in-service education by assessing (1) the extent of their participation in various aspects of in-service training activities available in Israel, (2) the importance attributed by teachers to various types of in-service training activities -- both those available in Israel at the time of the study and suggested new activities, and (3) the relationship between declared priorities and actual participation in in-service training activities.

Rationale

The rationale for this study derives from the authors' view that "a positive attitude towards and active participation in in-service education" are basic to a healthy educational system. Concerned that traditional preservice courses are often not relevant until the teacher has gained classroom experience, they note the importance of in-service education for professional renewal, both from the standpoint of keeping informed about curricula and course content, and for preventing what they term teacher "atrophy." Their purpose was therefore to obtain information which could assist in developing more meaningful and helpful in-service training opportunities for teachers.

Research Design and Procedure

The data source for this study was a two-part questionnaire which was sent to a random sample of teachers from four types of high schools in Israel: Academic, Comprehensive, Settlement (Kibbutz and Moshav), and Agricultural. The total number is not specified, but the authors indicate that their sample included 10 percent of the total number of each type of high school except those of the "occupational" type. The questionnaire, developed by the authors, was submitted to "some senior researchers for a check of inclusiveness of the items chosen and to refine the wording." The authors viewed this procedure as a sufficient check of content validity.

The first section of the questionnaire dealt with the teachers' actual participation in various forms of in-service education already available to Israeli science teachers. The second section employed a five-point Likert scale format to obtain teacher ratings of both in-service activities already available in Israel and some suggested new ones. Reliability of the attitudes sections of the questionnaire was assessed using Cronbach's α-coefficient, and data analysis involved chi-square and t tests, correlation coefficients, as well as analysis of variance procedures.

Most of the replies came from teachers in Academic and Comprehensive high schools (total of 98). Teachers of physics, mathematics, chemistry, and biology are represented in the sample. The grade levels represented in the responding group ranged from grades 9-12, with a high proportion of respondents teaching at more than one level. The respondents include teachers of a broad range of years of experience, from one to more than 16 years. Roughly two-thirds of those responding were male teachers.

Findings

Due to the broad range of questions included in the questionnaire, and because the authors of the study elected to explore a large number of potential correlations, no attempt is made here to re-state all of the findings. Instead, what follows is a general summary of findings the authors viewed to be of greatest interest.

In general, the chief in-service activity of the teachers surveyed was that of reading scientific and educational books and journals (the percentages here being 93.3 and 63.9, respectively). While 73.9 percent reported having participated in at least one summer institute, the proportions of teachers who said they involved themselves in two other activities -- participating in at least three seminar days per year, and visiting another school at least once in the preceding year -- were considerably lower (52.1 and 31.9 percent, respectively). More than half of the teachers responding to the survey (55.5 percent) indicated having studied for at least one year since beginning teaching. A great deal of support for the establishment of teacher centers was expressed by the responding teachers. In rating the importance of a series of in-service activities, teachers ranked such activities as reading scientific literature and teachers' magazines in their subject, participation in during-the-year seminar days and being freed one day a week for preparation and private study much higher than they did visiting other schools, continuing formal university studies, reading educational literature, and using self-training materials such as tapes. Only minor differences in preference and activity were found between the sexes.

Interpretations

The survey results showing a high level of teacher interest in the establishment of teacher centers appear to parallel the upsurge of interest in such centers currently in the United States. The authors suggest that such centers might help to overcome many current barriers to year-round in-service activity. This finding, coupled with the apparent lack of teacher interest in "outside" in-service activities such as those provided by universities, may say much about the increasing desire of teachers to have a strong voice in determining what constitutes in-service education.

The authors suggest that their finding that biology teachers seem more aware than others of the importance of in-service education may be linked to the greater adoption of new curricula (such as BSCS), as well as to more in-service activities being available in biology. They see this finding to be supportive of the notion that the adoption of new curricula has an important impact on the professional renewal of teachers. They view linking specific curriculum projects to the activities of teacher centers as a significant way of enhancing teacher interest in in-service activities.

The finding that "new" teachers tend to shy away from in-service education is a significant concern. The authors suggest that this may be a failure in the preservice education of the teacher. They contend that preservice teacher education must somehow emphasize the importance of continuing training. It is their opinion that it may be necessary to legislate a certain amount of in-service education during the teacher's first few years of work in the schools.

ABSTRACTOR'S ANALYSIS

In an era of emphasis on controlled experimentation and increasingly sophisticated statistical analyses, one tends to lose sight of the strong potential which survey studies can still have for exploring certain areas of interest. It is important to learn all we are able about the attitudes and interest of teachers toward in-service education, and the present survey study addresses some important questions within this realm.

Although Kagan and Tamir provide us with a number of interesting findings, the published report of their research presents the reader with at least two problems which make interpretation of their findings difficult. For one, there are some key omissions of information which tend to leave the reader dangling. For example, we are not told how many questionnaires were actually sent out for completion -- only that 119 were received and processed. Was the response rate sufficiently high to make the reported data significantly representative? The demographic data which are provided indicate that 98 of 119 replies came from teachers in Academic and Comprehensive high schools; how does this proportion compare with that found in the Israeli schools? We are not told. Similar questions could be raised with respect to other aspects of the responding group, such as subject area taught and the sex of the teacher. The insertion of more complete baseline data would enable readers to better understand how the responding sample compares with the Israeli population of science teachers.

A second problem stems from the fact that many, if not most, non-Israeli readers will know but little about the categories of high schools which were sampled in this study. We are told that the survey was performed on four types of high schools -- Academic, Comprehensive, Settlement, and Agricultural. Brief descriptions of each of these would assist us to better understand the findings and to more readily infer what these findings may mean in terms of the schools and teachers of other nations. It is important that we share information across international boundaries. However, careful attention must be given to the form which this communication takes if the sharing is indeed to be as helpful as one would hope.

These reservations aside, the Kagan and Tamir study does raise some interesting and important questions. The current general state of in-service education is of considerable concern. The recently-completed studies of the state and needs of science, social studies, and mathematics education in the United States, conducted with the assistance of grants by the National Science Foundation, indicate that many science teachers leave college "with so little command of the substantive content of the NSF-initiated curricula that they are in need of remediation the instant they graduate" (DeRose, et al., 1979). Although this finding says much about the apparent deficiencies in the preservice education of teachers in science, it also reminds us how important in-service education for teachers remains. If we are going to attract science teachers to the kinds of in-service programs which will alleviate these deficiencies, we will need to design these offerings with great care, and data obtained from the teachers themselves must play a central role in the process.

The call made by Kagan and Tamir at the conclusion of their paper for similar studies to be conducted in other countries is one which should not be taken lightly. While we are generally aware of the need to view and deal with preservice and in-service science education as a continuous program -- a need stressed both by Kagan and Tamir and by the NSF studies -- we seem to know too little about how to successfully bring about this state of affairs. Data obtained through studies of this type can assist us to effectively address this great challenge.

REFERENCE

DeRose, James V., J. David Lockard, and Lester G. Paldy. "The Teacher is the Key: A Report on Three NSF Studies." The Science Teacher, pp. 31-37, April 1979.

Lawrenz, F. "The Relationship Between Science Teacher Characteristics and Student Achievement and Attitude." Journal of Research in Science Teaching, 12(4): 433-437, 1975.

Descriptors--*Academic Achievement; Educational Research; Science Education; Secondary Education; *Secondary School Science; Science Teachers; *Student Attitudes; *Teacher Characteristics

Expanded abstract and analysis prepared especially for I.S.E. by Russell H. Yeany, University of Georgia.

Purpose

The study was conducted to determine the relationship of teachers' knowledge of subject matter and teaching methods, experience, attitudes toward science, self-improvement, and learning environment with student achievement and attitude. A second purpose was to provide a ranking of selected teacher characteristics so that teacher trainers could effectively concentrate their development efforts.

Rationale

The author states that "the art and science of teaching must be critically examined and effective teacher characteristics carefully identified." This information could then be used to guide competency and performance-based instruction on how to teach. The teacher variables of knowledge of subject matter and teaching methods were chosen for examination because they are two of the main requirements in teacher education programs. The author based the selection of the teachers' experience, attitude toward science, self-improvement, and learning environment created on previous research (Anderson, 1971; Hummel, 1972; Rothman et al., 1969; Taylor, 1957; Wynn and Bledsoe, 1967) which suggested possible relationships with student outcomes.

Research Design and Procedures

Data were collected from a stratified random sample of 236 secondary science teachers from 14 states. The response rate was 60 percent and a non-respondent follow-up showed no difference between respondents and non-respondents. Each teacher completed:

1. a questionnaire;
2. the National Teachers Exam in Science (NTE);
3. the Science Process Inventory (SPI); and,
4. the Science Attitude Inventory (SAI).

Each teacher randomly selected a class to complete:

1. the Learning Environment Inventory (LEI);
2. the Test on Achievement in Science (TAS);
3. the Science Process Inventory (SPI); and.
4. the Science Attitude Inventory (SAI).

Within each class, randomized data collection procedures were used and the class mean on each instrument was identified as the unit of analysis.

Canonical correlation analysis procedures were used to assess the overall relationship between all student outcomes and all teacher characteristics.

Findings

A significant canonical correlation of 0.61 was found between the set of student outcomes and teacher characteristics ($p < 0.01$). The coefficients for the individual canonical variables were as follows:

Student Variable		Teacher Variable	
TAS	0.77	Formality	-0.61
SPI	0.42	Self-Improvement	0.43
SAI	-0.14	SPI	0.41
		Goal Direction	0.40
		Years Experience	0.25
		SAI	0.19
		NTE	0.17
		Teaching Methods Credits	0.08
		Democratic	0.07

Interpretations

The author concluded that there is a relationship between selected teacher characteristics and science student outcomes. She also recognized that there are other student and teacher characteristics which are probably related to outcomes. Three tentative goals for science teacher trainers were suggested. They are:

1. consider the type of organizational pattern the new teachers will impose on their classes;
2. determine how to instill a desire for self-improvement in student teachers; and
3. insure that the trainees have a basic understanding of the underlying processes of science.

ABSTRACTOR'S ANALYSIS

The author admits that the study is exploratory rather than definitive, but may be a source of ideas for more research. She also cautions that one should not imply a causal direction from the correlation among the variables in the study.

With the above cautions in mind, one has to agree that the data collection, analyses, and interpretation in the study were very adequate to provide incentive and direction for further activity in two areas: first, better controlled process-product research in the area of teacher behaviors and characteristics, and pupil outcomes; and second, a rational decision-making process related to the selection of science teacher training activities.

In relation to the process-product dimension, more research needs to include classroom observation of the teacher and pupil behaviors in order to "flesh out" the set of variables of interest. The author is congratulated for her careful attention to nationwide sample stratification, a non-respondent follow-up, and randomization to the classroom level. But, the data on teachers provide very few hints about how and what they are actually teaching. These are the teacher variables which are influencing the pupil behaviors and outcomes and need to be included in the further research suggested.

The use of canonical correlation analysis is somewhat unique for science education research and it is refreshing to see research employing a multivariate analysis as well as univariate analysis. The canonical analysis was appropriate for the broad question on the existence of a relationship between teacher variables and pupil outcomes. But, specific questions and decisions relate also to singular variables. Information from analyses at this level was also supplied in the article.

The author's interpretations of the results were certainly based on the results and logical reasoning. But they should be considered no more than as tenable hypotheses until more controlled studies involving less of a reliance on self-response survey procedures are conducted.

Yeany, Russell, Jr. "The Effects of Model Viewing with Systematic Strategy Analysis on the Science Teaching Styles of Preservice Teachers." Journal of Research in Science Teaching, 14(3): 209-222, 1977.

Descriptors--*Educational Research; *Instruction; *Performance Based Teacher Education; Preservice Education; Role Models; Science Education; *Science Teachers; *Teacher Education; Teaching Models

Expanded Abstract and Analysis Prepared Especially for I.S.E. by Charles L. Price, Indiana State University-Evansville.

Purpose

The study was designed to assess the effects of model viewing in conjunction with systematic teaching strategy analyses on preservice teachers' selection of science teaching strategies and their attitudes toward the role of the pupil in science class.

By using an experimental design employing treatments of varying amounts of exposure to indirect teaching strategies, the following questions were studied:

1. Are there differences in science teaching strategies among groups which experienced the four treatments associated with strategy analysis and planning for science classes?
2. Are there differences in the science teaching strategies employed by elementary preservice teachers due to the effects of grade level taught?
3. Is there an interaction between the type of training in the strategy analysis received and the grade level taught as expressed in the dependent variable, science teaching strategy?
4. Are there differences in the science teaching strategies, as perceived by elementary pupils, among the treatment groups?
5. Is there a difference in science teaching strategy, as perceived by elementary pupils, due to the effects of grade level taught by the elementary preservice teachers?
6. Is there an interaction between the type of training received in strategy analysis and the grade level taught?

7. Is there a difference in the attitude toward the role of the pupil among the treatment groups?

Rationale

Previous research in interaction and strategy analysis systems supported the viewpoint that indirect teaching strategies were related to favorable attitudes and achievement.

The treatments used in the study included the viewing and systematic analyses of model tapes which presented a variety of student centered science teaching strategies. The rationale for the selection of the treatments was based on two precepts. First, the stimulus-contiguity theory offered by Bandura (1965) suggested that individuals tended to accept models of behavior patterns; and second, the thought that systematic analysis of the teaching act allowed teachers to better plan and bring their teaching behavior under control.

Research Design and Procedure

From a group of undergraduate preservice teachers, Ss were stratified according to grade level selected for student teaching. Sixteen preservice teachers in each of the grade levels 3, 4, 5, and 6 were randomly selected and assigned to treatments (the 64 Ss represented approximately one-third of the experimentally available population).

The four treatments were:

1. Strategy Analysis (S). Lecture, discussion, and lesson planning activities introduced subjects to strategy levels defined by the Teaching Strategies Observation Differential (TSOD) (Anderson, et al., 1974). An attempt was made to persuade subjects to accept an inductive/indirect strategy toward science instruction.

2. Modeling (M). Four video tapes and one 16 mm film of elementary science teaching which represented inductive/indirect strategy were shown to the subjects. No organized discussion followed the presentation of the media, but time was allowed for informal discussion and questions.

3. Combination (MS). All activities from the previous treatments (M and S) were experienced by the subjects. In addition, subjects rated films as to the extent of inductive/indirect strategy use.

4. Control (C). Subjects in this treatment viewed science content films. No discussion or emphasis was placed upon teaching methodologies used in the films.

Data Collection

Three types of data were collected.

Teaching Strategy Analysis was performed via videotapes. Trained raters viewed 30-minute tapes of each subject teaching in an elementary school classroom. The resultant TSOD scores represented the extent of inductive/indirect strategies used.

Elementary Pupils' Perceptions of their student teachers' science teaching strategies were evaluated through the use of the Elementary Science Activities Checklist (ESAC) (Kochendorfer and Lee, 1967).

Preservice Teachers' Attitudes toward the role of the pupil in science class were measured at the last treatment session through the utilization of the Science Activities Attitude Sort (SAAS) (Yeany, 1974).

Data Analysis

A Campbell and Stanley random assignment post-test only design was utilized. ANCOVA was employed for analyses of TSOD and ESAC scores, with class size and average class ability as covariates. Differences in SAAS scores were analyzed by ANOVA. Alpha level was established a priori at 0.10. Appropriate post-hoc tests were employed to detect specific differences between treatment groups.

Findings

Subjects in the MS (combination of Modeling and Strategy) treatment differed significantly from the C (Control) group on all three criterion measures. Significant differences in criterion measures did not exist in comparisons of S (Strategy), M (Modeling) and C treatments.

Interpretations

The findings of the study indicated that a combination of training in science teaching strategy analysis (TSOD training) with the use of videotaped model lessons could significantly affect the teaching styles and attitudes of preservice teachers. The need for similar studies (1) with inservice teachers, (2) in other subject areas, (3) in a longitudinal dimension, and (4) with individualized, self-paced administration of the program was cited.

ABSTRACTOR'S ANALYSIS

The study is an example of paradigm-based research. A theoretical base is established and group equivalence guaranteed through the use of randomization. Data analysis consists of appropriate and sensitive tests. However, the findings of the study must be evaluated in light of unanswered issues concerning the treatments utilized.

The four treatments have been described previously--(1) Strategy Analysis, (2) Modeling, (3) Modeling-Strategy Analysis, and (4) Control.

In respect to the MS treatment the investigation states, "Subjects in this group were involved in all the activities from the two levels above, i.e., training in strategy analysis and planning, discussion of the research and viewing models of elementary science teaching." In regard to the Control group, the researcher states, "Subjects assigned to this group were scheduled to spend their time in an activity considered to have a neutral relationship to the treatment levels described above, i.e., viewing science content films which did not present model lessons or teaching strategies."

This information leads one to conclude that (1) the instructional pace in the MS treatment greatly exceeded that of either M or S treatments, or (2) additional undescribed activities were used in M and S treatments. Furthermore, the assumption that viewing science content films projects a neutral relationship to directness or indirectness of teaching strategy must be questioned. Can any presentation be value-free concerning an endorsement of teaching methodology? Do not films (I am assuming the films were narrated) because of their expository nature, condone "lecture" at the expense of indirectness?

Additional information concerning the treatments is needed to assess the significance of the findings of the study. The investigator established an a priori alpha level of 0.10; twice the conventional. Still, this level of significance was met only in criterion measure comparisons between the C and MS treatments.

The study, though in need of greater control in treatment levels, should serve as foundation for additional research into teaching strategy analysis. In rationale for the study, the investigator states that "research can be summarized by saying that differences in achievement and attitude seem to be in favor of or related to indirect teaching strategies." Given the ephemeral nature of attitudes, the investigator suggests longitudinal measure of attitudes as related to training in inductive/indirect teaching strategies. Another logical extension of this study could be to examine pupils' science achievement as related to the indirectiveness of their teacher.

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COGNITIVE DEVELOPMENT

Brown, R. Lloyd; James F. Fournier; and Richard H. Moyer. "A Cross-Cultural Study of Piagetian Concrete Reasoning and Science Concepts Among Rural Fifth-Grade Mexican and Anglo-American Students." Journal of Research in Science Teaching, 14(4): 329-334, 1977.

Descriptors--*Achievement; Biculturalism; Cultural Differences; *Cross Cultural Studies; Educational Research; Elementary Education; *Elementary School Science; *Elementary School Students; *Learning Theories; Science Education; *Spanish Americans

Expanded Abstract and Analysis Prepared Especially for I.S.E. by Anton E. Lawson, Arizona State University.

Purpose

The purpose of the study was to answer the following questions: Does the time required to develop facility in a new language (English) and a new cultural environment cause a lag in logical thought development in Mexican-American children? If so, does this effect their "view" (understanding?) of science concepts?

Rationale

The authors hypothesize that Mexican-American children will lag somewhat behind their Anglo-American counterparts in terms of intellectual development and understanding of science concepts due to "culture shock" and difficulties in becoming proficient in English. The Whorfian hypothesis that the structure of language determines a person's concepts was cited as was Piaget's theory in which the development of intelligence is seen as linked to the development of language and concepts. A 1971 study by Wasik and Wasik was also cited in which culturally-deprived children were found to lag behind group norms for acquisition of conservation skills.

Research Design and Procedure

The sample consisted of 75 Mexican-American fifth-grade students (Spanish surname and/or Spanish spoken in home) and 75 Anglo-American fifth-grade students randomly selected from 249 students so classified. The population sampled was characterized as rural Colorado.

Variables measured were understanding of science concepts (Fournier, 1975) and concrete reasoning ability (Ankney and Joyce, 1974). The Fournier Test measures understanding of 16 science concepts using multiple-choice items with a KR-20 reliability of 0.83 and an appropriate reading level. The Ankney-Joyce Test measures understanding of 10 Piagetian concrete concepts also using multiple-choice items with a KR-20 reliability of 0.83 and an appropriate reading level. The Ankney-Joyce multiple-choice items correlate moderately ($r = 0.63$) with five interview tasks involving the same Piagetian concepts. Both tests were read orally to the subjects in attempt to eliminate reading ability as a factor influencing success. The tests were administered within a two-week interval in April, 1975.

Data were analyzed using multiple linear regression where score on the Piagetian test was assumed to be the independent variable and the assumed dependent variables were: (1) subject's surname (Spanish vs. nonSpanish), (2) language spoken at home (Spanish or English), (3) letter grade in science, and (4) score on science concepts test. Restricted models were used for each of the significant full models to determine the unique contributions of each of the 10 Piagetian concepts.

Findings

The Piagetian concepts test was found to be a significant predictor of surname, language, science letter grade, and science test score; R^2's = .34 ($p = .01$), .39 ($p < .01$), .31 ($p = .02$), .45 ($p < .01$) respectively. Anglo-children scored higher than the Mexican-American children on the Piagetian concept test ($\bar{X}$'s = 17.39 vs. 15.23 respectively) and on the science concept test ($\bar{X}$'s = 10.36 vs. 8.31 respectively)*. Both differences were statistically significant $p < .01$. The difference in cognitive development between the two groups appears to be about 2+ years.

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*This assumes that the author's textual remarks are accurate and Table III is in error (i.e., the mean scores for the Anglo- and Mexican-American subjects have been reversed).

Interpretations

Culture (surname) and language do seem to be useful indicators of cognitive development. The relationship between surname and language and performance on Piagetian and science concept tests may be due in part to a language change from Spanish to English.

Some students may lack the level of cognitive development required for understanding the science concepts being taught. Science concepts could be analyzed for the reasoning required for understanding and readiness for concepts might be assessed by reasoning tests.

ABSTRACTOR'S ANALYSIS

Purpose and design. The authors ask two related questions: Does the time required to develop facility in a new language and a new cultural environment cause a lag in logical thought development? And if so, does this effect understanding of science concepts? Unfortunately the study's design precludes gathering any data to answer these questions. No attempt was made to measure "time required to develop facility in a new language" nor was any attempt made to determine whether or not the new cultural environment caused the "apparent" delay in logical thought development. A number of studies, including the Wasik and Wasik (1971) study cited by the authors, have shown that socioeconomic level is significantly correlated with performance on Piagetian tasks with, as expected, lower socioeconomic classes performing at a lower level than upper socioeconomic classes. Without controlling for this variable the authors really have no way of determining whether or not "cultural environment" is correlated with logical thought development, much less whether it is somehow a cause of it.

The phrase "cultural environment" is much too ambiguous to allow one to seriously consider the hypothesis that it might be related to logical thought development without going on to specify what within the cultural environment might speed up or slow down development. Once one answers this question, then it becomes possible to ask the next question:

Does one culture have more or less of this factor(s) than another culture? Do the authors believe that concrete operators are the sole possession of the Anglo-American culture? Do not people in all cultures experience liquid amounts, masses, volumes, areas? Do they not attempt to seriate and classify objects, events and situations that are experienced?

To determine whether or not cultural differences do in fact influence the rate of development of concrete reasoning, it would of course be necessary to control socioeconomic level and it would also be necessary to use a design in which the Spanish-speaking children were administered the reasoning tasks in Spanish while the English-speaking children were administered the tasks in English. This procedure would avoid the problem of poor performance due to inability to deal with a foreign language. Better yet, half of the Spanish-speaking subjects could be tested in Spanish and the other half in English. This procedure would allow a determination of the effect of language on test performance and would still allow the comparison of Spanish-speaking and English-speaking subjects when both are administered the tasks in English.

The authors estimated that the Spanish-speaking subjects lagged in intellectual development approximately two-plus years behind their English-speaking peers. But this estimate should not be taken seriously in light of the fact that the Piagetian tests were administered only in English. They were also administered in a standardized format which may have further biased the result in favor of the Anglo-American subjects. A standardized format eliminates the possibility of clarification of ambiguities that may arise due to language-related problems. Nyiti (1976), for example, conducted a cross-cultural study of conservation reasoning of Meru children in Tanzania using the classical interview technique conducted in the children's native language. Nyiti found that both schooled and unschooled Meru children demonstrated conservation of substance, weight and volume at ages reported for European children. Previous studies of such groups using standardized formats and non-native languages reported significant "lags" in the development of conservation reasoning.

Rationale. What about the authors' claim that their research is somehow related to the Whorfian hypothesis concerning the relationship between language and conceptual development? The connection seems tenuous at best. What in the English language (that is not found in Spanish) would help a child develop concrete operations and/or scientific concepts more readily? My question is not to imply that there may not be something, although this seems unlikely. My question is raised to call for an identification of that something in the English language, if it indeed exists. Without at least a guess at what this might be, Whorf's hypothesis seems quite unrelated to the present study.

The relationship to Piaget's theory concerning language and thought development also seems tenuous. First of all, it is not at all clear that Whorf's hypothesis is consistent with Piaget's position concerning language development and mental development as the authors claim. Interestingly the quotation that appears on page 330 to support this claim is without a citation.

Piaget's position would seem to be at odds with Whorf's in that Piaget has made it quite clear that concrete and formal operations do not come from language. Rather they come from sensorimotor actions. In putting forth Piaget's position, Sinclair (1976) stated: "The sources of intellectual operations are not to be found in language, but in the preverbal sensorimotor period where a system of schemes is elaborated that prefigures certain aspects of the structures of classes and relations, and elementary forms of conservation and operatory reversibility" (p. 190). On the other hand, the authors may believe that concrete operations result primarily from schooling. If this were the case then schooling in a foreign language could be expected to result in a delay in cognitive development. However, what little evidence that is available on this issue suggests that schooling is not significantly related to the acquisition of concrete operations (e.g., Mermelstein and Shulman 1967; Nyiti, 1976).

Findings. The study, in effect, found only low to moderate correlations between surname/language and concrete reasoning/science concepts. These low correlations in and of themselves are not enough to conclude that the change of language from Spanish to English has anything to do with the lower performance of the Spanish-speaking subjects on the reasoning test. Given the finding that they performed worse on the reasoning test, the result that they also performed worse on the science concepts test is not surprising, and is consistent with non-cross-cultural studies (e.g., Lawson and Renner, 1975; Lawson, Nordland and DeVito, 1975). But again the change of language is not at all implicated as the cause of the lower performance on a science concepts test. Other variables such as socioeconomic standing, "intelligence," and indeed Piagetian level itself must be ruled out first.

In point of fact, the data are available to check to see if Spanish- and English-speaking children matched for intellectual level perform at the same level on the science concept test. A significant partial correlation coefficient between spoken language and science concept score with concrete reasoning ability partialled out (held constant) would indicate that spoken language is related to performance on the science concept test. The computed partial correlation coefficient of 0.26 indicates that a statistically significant, but low, relationship exists. In other words, Spanish-speaking students evenly matched for intellectual level with English-speaking students performed at a somewhat lower level on the science concepts test than did their English-speaking counterparts. But does this mean that their understanding of the science concepts is less? Not necessarily. Perhaps it is simply the language that the test is written in that caused the poorer performance. To resolve this question, the science test should have been given in both languages. Again only in this way would we be able to determine that the English used in the fifth-grade classes represents a barrier to learning for the Spanish-speaking children.

Another point must be raised. Were the 16 science concepts actually introduced to these fifth-grade students? The authors do not tell us. Rather they simply state that the 16 science concepts are commonly taught in fifth grade. Until it is established that the concepts were actually introduced to these fifth graders, we must continue to entertain the hypothesis that the differences in performance may be due to general knowledge and not specific school learning.

Interpretations. Finally, the authors' stated implications for education may be valid yet they seem to go beyond what is called for based upon their research design and results. No causal relationship between cognitive level and science concept understanding has been established. Indeed cognitive development may result from an accumulation of understandings of scientific concepts not vice versa. The present results do not bear on the issue.

To the point: the authors provide an example item from the science concept test to support the idea that "development" is required for understanding of the science concepts being taught. The example item states "before a storm it becomes very dark. You cannot see the sun because...". The authors state that "spatiality" (a Piagetian concept) is required to understand that the sun is behind the clouds and thus it is dark. But what is this thing called "spatiality"? Does one need some mysterious thing called "spatiality" to answer the question or does one simply need to know that you cannot see the sun during a storm because clouds get in the way? Common sense seems to argue against the evocation of hypothetical entities when a direct observation will do.

Perhaps one should not be overly critical of the authors' drawing of implications unwarranted by the research results in that authors, in general, are often encouraged to do so by the editorial policy of the Journal of Research in Science Teaching.

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Descriptors--Class Management; *Cognitive Development; *Conservation (Concept); *Educational Research; Elementary Education; *Elementary School Science; Instruction; Science Education; *Teaching Methods

Expanded abstract and analysis prepared especially for I.S.E. by Dennis W. Sunal, West Virginia University.

Purpose

The study attempted to determine the relationship between a student's cognitive characteristics and his/her classroom behavior under two quantitatively defined instructional strategies. These strategies are defined as Student-Structured Learning in Science (SSLS) and Teacher Structured Learning in Science (TSLS). The specific research question addressed was. "Are cognitive characteristics a significant determinant to children's lesson-related classroom behaviors under TSLS and SSLS conditions?"

Rationale

Although a great deal of research has concerned some facet of cognitive development, this study grew out of an assessed lack of research in the area relating differential cognitive characteristics to actual student classroom behaviors in quantitatively defined settings.

Research Design and Procedure

The basic research involved a randomized two treatment post-test only design. All children (250 from grades 1-5) from Florida State University's Developmental Research School were involved in the study. School admission selection criteria (not included) were reported to provide for a representative sample of the population at large. All students were randomly assigned to either TSLS or SSLS science treatments before the school year. Behavioral patterns in both the TSLS and the SSLS groups were stated to be well-established with high stability after the first few weeks from the beginning of the study. The study lasted for 30 weeks.

Two variables were measured during the final weeks of the study. Cognitive indicators for each child were seven Piaget-type conservation interview tasks. These tasks involved number, area, weight, displacement volume, perimeter, perimeter area and internal volume. Student classroom behavioral data were collected using a classroom observation instrument, Student Behavior Categories (Matthews et al., 1971). The instrument consists of nine categories of student behavior including 1) observing teacher; 2) following directions; 3) student invents own behavior, does not follow teacher directions (left out in article due to printer's error); 4) responding to teacher; 5) initiates interaction with teacher; 6) imitates interaction with another student; 7) receives ideas from another student; 8) copies another student; 9) gives ideas to another student. The TSLS Strategy differs from SSLS mainly in amount of directive and evaluative behaviors (Categories 9, 4 and 5) exhibited by the TSLS teacher.

A one-way analysis of variance was used to analyze variable effects. Conservation ability on each conservation task was thus compared on each of the nine behavior instrument categories in each class structure TSLS and SSLS. Fourteen (2 x 7) comparisons were made on each of the nine student behaviors.

Findings

Patterns of differences were found between conservers and nonconservers on only the first three expressed student behaviors. Nonconservers exhibited more observing teacher behavior (1) in 12 of 14 cases. Statistically significant differences appeared most often (five cases to one case for SSLS) in TSLS classes. Conservers exhibited more following directions (2) and student invents own behavior (3) than nonconservers. Statistically significant differences appeared most often in TSLS classes (four cases) for behavior 2 and SSLS classes (three cases to one for TSLS) for behavior 3.

Interpretations

The investigators concluded that cognitive characteristics do relate differentially to certain student behaviors in SSLS or TSLS environments. Specifically:

1. Nonconservers tend to observe the teacher more than conservers in a TSLS classroom in elementary science.
2. Conservers tend to follow a teacher's directions more than nonconservers in a TSLS classroom.
3. Conservers tend to make up their own activities with sets of manipulative materials more than nonconservers in SSLS classrooms.
4. Student's cognitive characteristics do not seem to affect the amount of interaction they have with one another in either SSLS or TSLS settings.

The authors state that implications, for a science curriculum which offers manipulative materials, from this data are that:

1. less cognitively advanced children are more susceptible to the influence of certain teacher behaviors than are more cognitively advanced children.
2. teacher's directions, evaluations, etc., seem to divert the nonconservers' attention away from more productive activities.
3. TSLS strategies could work to the disadvantage of the "slower" student.

ABSTRACTOR'S ANALYSIS

The authors are addressing a very real issue in science teaching: the relationship of cognitive development and expressed student behavior in classrooms. However, the length of the article and chosen procedures severely limits other teachers and researchers from evaluating interpretations of the educational significance of the study. The non-flexible and nonevaluative restrictions placed on authors by the journal have led to a lowering of the educational significance of this study. These restrictions coupled with certain procedures used by the authors lead to further study being necessary before usable information is secured.

Specifically, most areas of the report need to be expanded. The rationale for this study needs to be more fully developed. Other than only citing a lack of research, related research involving cognitive development and student and teacher classroom behavior could have developed the need and direction for this line of research. Additional thought in this area could have developed the possibility of parameters on the level of expected results. Since neither cognitive development or expressed behavior lie as isolated centers for human action, one might indicate possible personality, social nor physical environment interactive effects. Thus, attitudes and interests, first year in school, birth order in family and achievement in science relationships reported in literature should be important for interpretation of results as well as structuring controls for the research design.

More information and additional work could have been added to the research design and procedure. Validity, reliability and reasons for selection of the chosen instruments are not addressed. The reader is given only one reference (1971) as to the nature of the instruments, while other easily accessible journal articles describing the behavior instrument could have been cited. Descriptions of the instruments in addition to tables, offering only instrument categories, are needed. The cutoff levels of grouping children's responses as 1) conserver, 2) transitional and 3) nonconservers are needed. Evaluation criteria for task responses are needed. Procedures for collecting data on the Piaget tasks, behavior instrument and classroom strategy (TSLS or SSLS) are not included. Were observers and/or interviewers used? How many? Interrater reliability? How often were student behaviors observed? Did the observer interact with the setting? Precautions? What about other variables--teacher attitudes, teacher science interests, science activities at each grade level, etc.?

The research design did not involve pre-test measurements. Since students are undoubtedly changing in behavior and developmentally, a post-test-only design is not obvious or desirable. Were the students' behavior patterns determined by cognitive characteristics and not influenced by classroom strategy? Study design and data analysis sought an answer to this only by a random (criteria not stated) classroom assignment procedure.

TSLS and SSLS classroom description and measurement need to be added. Since the students were grouped by classroom, measurement data on level of TSLS or SSLS teacher behavior in the classroom should have been included. Were all TSLS classrooms at the same level or spread into a spectrum leading to SSLS? What was the cutoff level? What were the number of classrooms involved? The interactive effects of varying TSLS classrooms should have been investigated.

The analysis of data appears to be very restrictive. Multiple analysis of variance with post-hoc analysis is an effective strategy for this situation. Why was one-way analysis of variance chosen? Since means and standard deviations were not given, even cursory judgments on these results cannot be performed. The analysis chosen precludes comparison of interactive effects.

Due to the lack of information in the study report, the conclusions and implications are difficult to evaluate or use. "Observing teacher" or "make up own activities" are too limiting to put to use in a classroom or use as guides to further research. The authors do not mention the significance in finding no relationship in behavior categories 4, 5 and 9 even though the TSLS and SSLS classrooms differ most in these categories. The implications, while pointing to a more clear direction, cannot be interpreted as following from the results of the reported study.

The issue is important and the research timely. The educational significance of the reported study however, is somewhat limited. The reasons stem from questionably conceived (or reported) procedures on the part of the authors, but more so as a result of the briefness of the article as published in the research journal.

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Descriptors--Biology; *Cognitive Measurement; *Conservation (Concept); *Educational Research; *Science Education; *Secondary Education; Secondary School Science

Expanded Abstract and Analysis Prepared Especially for I.S.E. by David L. Dunlop, University of Pittsburgh at Johnstown.

Purpose

The purpose of this study, as stated by the authors, is to examine, in a sample of high school biology students, the relationship between ability to conserve first- and second-order quantitative invariants and ability to respond correctly to questions on published Biological Sciences Curriculum Study Blue Version examinations (BSCS, 1971).

Although no explicit, null hypotheses were stated, two predictions were made by the authors. First, it was predicted that students who demonstrated conservation reasoning would perform significantly better on the biology examinations than nonconserving students. Second, it was predicted that nonconservers would not demonstrate success above the level of chance on examination questions previously classified as "formal-operational."

Rationale

The rationale for this study is based upon Piagetian theory, and the authors state that Piaget's view of conservation reasoning as a prerequisite for rational thought suggests that a strong relationship should exist between a student's ability to demonstrate conservation reasoning and his performance on subject-matter examinations. This relationship is predicted because the same cognitive abilities appear to be required for success in both situations. If this ability does not manifest itself in fundamental conceptual understandings, such as conservation reasoning, then it would not be expected to manifest itself in specific subject matter such as BSCS biology.

Research Design and Procedure

The 23 subjects (20 males and 3 females), ranging in age from 14.9 to 17.0 years, were enrolled in an elective biology course which used the BSCS Blue Version as a textbook. Since the course was an elective and was considered by the students to be difficult, the authors assumed that the students would be "above average" with respect to academic ability.

The subjects were administered three conservation tasks in individual interviews. The tasks were the conservation of weight (Elkind, 1961), conservation of volume using clay (Elkind, 1961), and conservation of volume using metal cylinders (Karplus and Lavatelli, 1969). The conservation of volume tasks were used as indicators of early formal reasoning while the conservation of weight task was used to indicate concrete reasoning.

Based upon the results of these tasks, two of the 23 students demonstrated no conservation reasoning and were placed in Group I. Four students conserved only weight and were placed in Group II. Ten students were placed in Group III, and seven students demonstrated correct reasoning on all three tasks and were placed in Group IV.

Subsequent to administration of the three tasks, the subjects were taught the regular course of study for approximately one semester. During the semester, six chapter examinations were given by the classroom teacher. Each examination consisted of 20-30 questions selected from the BSCS examination item book. Prior to selection all of the items were judged to require either concrete or formal thought for successful completion. Approximately 50 percent of each examination was composed of questions judged to be formal. The combined reliability coefficient, calculated using the Spearman-Brown split-half method (Guilford, 1965), was 0.76. The total number of test items was 149.

Several specific criteria were used to categorize the questions into a formal or concrete category. Concrete questions, for example, were considered to be questions in which the student was required to recall facts, understand concepts defined in terms of familiar objects and events, apply a memorized algorithm, establish one-to-one correspondences between two sets of data, and draw conclusions from direct observation or from graphed data.

Formal questions required the student to reason hypothetically, use theories or idealized models to interpret data, evaluate results of experiments and recognize ambiguous and unambiguous conditions, use proportional or probabilistic reasoning, and to understand concepts defined in terms of other concepts or through abstract relationships.

Statistical analysis included the calculation of Pearson product-moment correlation coefficients and a one-way analysis of variance.

Findings

An examination of the combined chapter tests shows that for both concrete and formal examination items, the percentage of successful responses is greater for the group of students who demonstrated more conservation responses on the three Piagetian tasks.

A one-way analysis of variance was used to examine group differences, and it was found that group differences for the concrete questions reached significance at the 0.10 level ($F_{3,22} = 2.77$; $p = 0.07$). However, group differences for the formal questions failed to reach significance at the 0.10 level ($F_{3,22} = 2.23$; $p = 0.12$).

The authors also studied the percentages of correct responses on the concrete and formal examination items for each group of students after the percentages had been corrected for chance success (Guilford, 1936). Group differences for the concrete items failed to reach significance at the 0.10 level ($F_{3,22} = 1.59$; $p = 0.23$); however, group differences for the formal items did reach the 0.10 level of significance ($F_{3,22} = 2.95$; $p = 0.06$). The authors emphasize the finding that the nonconserving students (Group I) did not demonstrate success above the level of chance on the formal examination items.

To further analyze the relationship among the conservation tasks and the subject matter examination scores, the authors calculated Pearson product-moment correlation coefficients. All correlations were positive and ranged from 0.23 to 0.48. The conservation of weight task correlated significantly with both the concrete and formal examination questions ($p < 0.10$), while the "volume using metal cylinders" task correlated significantly with the formal examination questions ($p < 0.05$).

Interpretations

The prediction that success on the conservation tasks is positively related to success on the content examinations was partially confirmed as was the prediction that students who were nonconservers of weight would not demonstrate success above the level of chance on examination questions previously classified as "formal operational." A student who exhibits a lack of conservation reasoning ability is likely to encounter a great deal of difficulty in science courses which deal with abstract subject matter such as the BSCS Blue Version materials. The fact that a student does demonstrate conservation reasoning, however, in no way seems to insure his success in such a course.

It is obvious that the students who demonstrated conservation responses on all three conservation tasks encountered extreme difficulty on the BSCS examinations (only 46.0 percent success on the concrete questions, and only 22.4 percent succese on the formal questione). In relation to this situation, the authors state that if one can make the assumption that the BSCS examinations accurately assess student mastery of the course material, then it is clear that this course material is probably not appropriate for the kind of students in this sample. It is then recommended that these types of studente should take a course that involves more familiar and more concrete subject matter.

It was also stated that the teacher and the students were uncomfortable with the BSCS examination items. These higher-level questions (application, analysis and synthesis levels) were unlike the types of questions with which they were familiar. Although recognizing that these questions create difficulties, the authors encourage teachers to incorporate them into classroom activities as well as chapter examinations.

Unlike placing an emphasis on the recall of factual information, this strategy would place a premium on critical thought.

ABSTRACTOR'S ANALYSIS

The relationship between ability to conserve first- and second-order quantitative invariants and ability to respond correctly to questions on published BSCS Blue Version examinations is certainly a relationship worth examining. In this particular article the implications which were emphasized related to appropriate classroom and curriculum activities and materials. However, in a more general context the discovery of a close relationship between an ability to conserve and an ability to respond correctly to questions on a group-administered test would be useful as a supplement to the time-consuming, Piagetian-type interviews. See Lawson (1978) for an excellent discussion of this topic.

An interesting aspect of this study was the manner in which the teacher allowed the students to redefine the level and type of test questions to be used for grading purposes. Initially the students were given the BSCS examinations and these examinations determined the student's grade on the chapter. However, the students were uncomfortable with these examinations. The teacher's solution to the problem was to add some of his own questions to subsequent examinations. At first, both his questions and the BSCS questions counted toward student grades; however, near the end of the semester the teacher added more and more of his questions as a factor in grading. Of significance was the fact that the teacher's questions were all, or almost all, at the knowledge or recall level while the BSCS questions were all at the comprehension, application, analysis, or synthesis levels. Clearly, the students and teachers alike were more comfortable with the recall type questions. To what extent did this "shift" effect the student's attitudes toward the BSCS type of questions? Could this have affected the outcome of the study?

In general the results of this study are consistent with related studies. For example, the finding that the majority of students in this sample performed below the formal-operational level is, as stated by the authors, similar to the results of a number of previous studies (Lawson and Renner, 1974; Wollman and Karplus, 1974; McKinnon and Renner, 1971).

However, in the interest of academic discussion a few questions could be asked and briefly discussed. First, why did the students who were conservers (Group IV) perform so poorly on the examination? One possible answer would dictate a closer examination of the cognitive level of the seven students in Group IV. These students were placed into Group IV because they responded correctly to all three Piagetian-type tasks; however, the two conservation tasks used in this study to identify formal operational students are useful in identifying students who demonstrate early formal reasoning. Therefore, it is possible that some (maybe all) of the students in Group IV are not fully formal operational. Additional Piagetian tasks such as "colorless chemical liquids" (Inhelder and Piaget, 1958) or "flexibility of rods" (Inhelder and Piaget, 1958) could have been included as part of the research to assist in the discrimination of the various levels of formal operational thought.

It was stated in the study that group differences for the concrete questions reached significance; however, group differences for the formal questions failed to do so. Did this result hold true for each of the six examinations? Since the data for all six examinations appear to have been "lumped" together, there is no way for the reader to answer this question. Additional information and/or discussion concerning this question would have been useful to the reader.

Is it possible that some of the test items were incorrectly classified? This is possible; however, there is another related question which is, I believe, more basic and more probable as a potential source of error. For example, does a specific question demand the same degree of cognitive processing from every person? In other words, is it possible for a question to be a "formal" question for one student but a "concrete" question for another student? It seems to me that this is clearly possible. Further, in cases where the two students have had different experiences (read a related newspaper article, talked individually with the teacher about the concept, and etc.) it appears that it would even be probable that a given question could require different processing by different students. This type of "data contamination" would be difficult to control; however, it should be considered in future research of this type.

Although this study addresses several concepts and does provide teachers with useful "cautions," I feel that one of the main messages to classroom teachers comes near the end of the article as an "aside." It is here that the authors emphasized the need for teachers to include higher-level questions as part of their routine classroom activities. Failure to do so leads to an undue emphasis upon factual recall and is counterproductive to sound science instruction.

Suggestions for future research in this specific area would include the following:

a. Another Piagetian test should be added which could assist in the identification of <u>full</u> formal operational students.

b. The study could be replicated with a larger sample and with a more even distribution of males and females.

c. Consideration should be given to the possibility that two different students will use different mental processes to correctly answer a specific question.

d. Future studies could be conducted with subjects and teachers who are "comfortable" with BSCS-type test items.

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Descriptors--*Concept Formation; Educational Research; Elementary Education; *Elementary School Science; *Learning Processes; *Science Education; *Serial Ordering; Weight

Expanded abstract and analysis prepared especially for I.S.E. by Chester E. Raun, Temple University.

Purpose

The investigators of this study did not present the problem to be investigated in terms of either questions to be answered or hypotheses to be tested. The purpose of the study is stated in a narrative form as an examination "of the strategies used by first-grade children to perform a seriation task with materials varying in length or weight. Also examined were the effects on performance of two seriation task characteristics, the seriation variable and the number of objects to be ordered."

Rationale

Referring to prior work by Bessemer and Smith (1972) and Smith (1974) the investigators use a concept-task strategy (CTS) model for the study presented here. This model is based upon an assumption that the goals of science education imply an expectation of a transfer of learning. It is proposed within this model that to facilitate transfer of learning it is necessary to take into account the nature of concepts involved, the tasks to be performed, and the strategies by which the tasks might be carried out. The CTS model is presented as an eclectic position directed towards the potential mechanisms of transfer and providing a descriptive framework within which systematic research may be conducted.

One potential mechanism of transfer is based on strategies for performing tasks. The assumption is made that a learner can acquire a strategy for performing tasks. If such a strategy could facilitate performance of the task with new but related concepts, and if the strategy is a relevant part of a new strategy for a more complex task, then there might be facilitation of the performance of the more complex task.

Addressing other dimensions of the study the investigators refer to Piagetian research concerning the development of cognitive structures for seriation. Major statements drawn from such research are that the ability to order on the basis of length develops in most children by the age of 5-7 (Inhelder and Piaget, 1964) while the ability to order on the basis of weight usually follows one or two years later (Piaget and Inhelder, 1941). The number of objects used in the ordering tasks led to an assumption by Piaget and Inhelder and by Elkind (1964) that the seriation task would be facilitated if a lesser number of objects were used. Prentice (1963) found that five and fifteen elements were easier to order than ten elements.

Concern for "how" the child performs the task was a focus of this study as well as one by Baylor and Gascon (1974) where it was reported that children aged 6 to 12 tend to use one of two base strategies and infrequently a third for ordering objects by weight using a balance for comparison. The investigators make a reference to their "pilot work" for the present study which identified basic strategies essentially identical to those of Baylor and Gascon. These are presented as:

1. The Extreme Value Selection (EVS) Strategy which involves repeated selection of the unordered object with the greatest value and placement of that object next in the row.

2. The Insertion (INS) Strategy which involves repeated random selection of an unordered object and insertion into the ordered row wherever it belongs.

3. The Rearrangement (RAR) Strategy which involves the construction of an approximately ordered row followed by rearrangements to produce a correct order. This is indicated as observed mainly with adults.

There is, unfortunately, no clear reference to the "pilot work" nor whether the basic strategies, as identified, are those of the investigators or those described by Baylor and Gascon.

Research Design and Procedure

The basic design used by the investigators appears to fit best the equivalent materials paradigm as suggested in Campbell and Stanley (1966). Thus, MaXoO MbX.0 McXoO MdX.0, etc. where: M's indicate specific materials, and MaMc, etc., being, in sampling terms, equal to Mb, Md, etc.; and Xo being the Seriation task of length and X, the seriation task with weight. A set of ten 3/8-inch wooded dowels which varied from 9 to 16.2 cm was used for the seriation variable of length. A set of ten weights that varied from 10 to 2100 g was made from 12 oz. styrofoam cups filled with differing amounts of paraffin and leadshot. These were used for the seriation variable of weight and judged by hefting. The investigators state that every object in a particular set appeared to be the same as the others except in the variable of interest.

A sample of 96 children was drawn from four randomly selected elementary schools of Lansing, Michigan. Twenty-four children, with an average age of 80.5 months, were then randomly selected from the pooled first-grade classes within each of the four schools. Each child was required to order only one set of objects. The sets of objects presented to the children differed on the seriation variable (length or weight) and the variable of the number of objects in a set (4,6,8, and 10). There were 8 possible sets of objects and 12 children (3 from each school) performing the ordering task with each set.

The investigators provided instructions to the sample of children by presenting an ordered row of five objects which the child was asked to physically examine by looking or hefting. The order of the row and the task instructions were then explained by the investigator, making certain each child understood. The assigned seriation task was then presented to each child. After a child ordered all objects of the assigned set, the actual ranking was recorded. A Kendall's Tau correlation was calculated between actual rank and true order. This score was referred to as the Task Score (TS) and reflected the accuracy of task performance.

The investigator recorded the sequence and position of object placement as a row of numbers. This information, along with the TS, was used to create several new scores which in combination were used to infer strategy use. What the "new scores" were and how they might be used was not indicated. What is stated is a general summation which suggested that those children showing a sequential placement sequence and a TS > 0.70 were considered to be using an EVS Strategy. Those showing a lack of sequential placement and a TS > 0.70 were thought to be using an INS Strategy. Those who ordered the objects and then rearranged them were considered to exhibit the RAR Strategy if a TS > 0.70 was also satisfied. The investigators' decision to use a TS > 0.70 was based on results of pilot work. A TS > 0.90 was thought to indicate a high degree of task accuracy and, where the TS was < 0.70, no inference of Strategy use was attempted.

A 4x2x4 factorial design was employed. The four different values of number of objects were completely crossed with the two seriation variables and the four schools. A three-way analysis of variance (ANOVA) was used to test for differences among the number of objects and between variables of length and weight. Strategy analysis was used to provide frequencies of use of each strategy for each seriation variable.

Findings

The accuracy of task performance is tabled and reported as the mean and standard deviation task score (TS) for each cell, i.e., each group of three children from each school performing an assigned task. However, in the narrative discussion the investigators present information about individual childrens' TS which are not found in the tabled correlations.

Thus, the investigators report 42 children, 30 in length and 12 in weight, who performed the seriation tasks at a high level of accuracy (TS > 0.90) with 8 additional children scoring between 0.70 and 0.90. It is stated that all TS values are distinctly bimodal for both length and weight data.

A significant effect due to the seriation variable was reported from the ANOVA analysis, but no significant difference was evident due to the number of objects. There were no significant main effects for school or interaction effects. None of the ANOVA analysis was tabled.

The results of strategy analysis were presented in a second table with the investigators reporting that of the 50 children who performed with a TS > 0.70, 39 used a highly systematic and identifiable strategy and only 11 used an unknown method. The EVS strategy was used more frequently for weight seriation (11 used EVS and 3 used INS) while EVS and INS were about equally employed with length (10 used EVS and 12 used INS). Using a Chi square analyses with a Yates correction for low cell frequencies, the investigators found no significant differences regarding strategy used.

Interpretations

The investigators conclude that the bimodal distribution of task scores coupled with the relatively high proportion of successful children who used the recognized strategies reveals a high degree of systematic behavior by many first-grade children. The results also indicated that the investigators' strategy models are quite useful in characterizing the successful approaches first-grade children use in perceptually ordering objects on the basis of length and weight. Hence, the investigators felt that their results confirmed and extended the findings of Baylor and Gascom (1974). Also, that within the ranges examined, the basic strategies appear relatively stable across both the seriation variable and the number of objects.

It is acknowledged that the results confirm the Piagetian time line for acquisition of linear ordering and weight ordering abilities and the child's need to acquire an underlying cognitive structure in order to comprehend a task. The investigators did not find evidence to support the statement of Inhelder and Piaget (1964) that "we might have found a marked improvement in the seriation of length had we used fewer elementa."

The investigators present the most important implication as the viability of the strategy to be used as a construct in educational theory. That strategy instruction may be practical is based on the fact that even young children quite systematically approach some tasks.

ABSTRACTOR'S ANALYSIS

There have been many studies which attempted to investigate the transfer of learning. The study reviewed here is not attempting to investigate a psychological theory of transfer of learning but is a descriptive framework utilizing the three dimensions of instruction, concept-task-strategy (CTS), as the means of facilitating transfer of learning. This conception of transfer of learning is a newer approach and the investigators provide a succinct rationale for their study. In so doing they have submerged the statement of their problem in this rationale. The purpose of the study does not clearly stand out as this abstractor believes it should.

There is reference made to a pilot study which preceded the present study. There is no clear reference to this pilot study nor is it clear as to which study produced the strategy mechanisms identified as EVS, INS, and RAR: the ~~pilot~~ study by the investigators or a study by Baylor and Gascon. Although these strategies are described, it would be helpful to most readers if an example of each was included.

The research design developed and used by the investigators appears to set the stage for excellent internal validity. However, in the opinion of this abstractor, a major flaw arises with what amounts to pre-instruction of the tasks. Such pre-instruction would implant a strategy in the child's mind when the investigator presents a seriation and explains the ordering. If this was the procedure, as interpreted from the report, then the question arises as to how the investigator arrived at the specific strategy utilized by the child. One may also ask, to what extent was the study biased by such instruction?

The impact of the above on the Task Score and on the strategy analysis is also subject to question. How "several new scores" were derived and what these were is not clear from the report. As a result it is difficult for the reader to ascertain how these were used in the strategy analysis. It is also unclear as to whether one or more investigators carried out all of the tasks with all of the children. If more than one investigator was involved then correlation between observers becomes a necessity. As the report stands the reader is left to assume only one investigator was involved with the children.

The investigators report Task Score results by school for the entire sample in Table I. In the narrative discussion the number of children receiving a Task Score greater than 0.70 is based on individual children, not on school results. There is therefore no agreement between the data in the table and the narrative data. This weakness of reporting results would be easily corrected by using one set of data. Table II presented "frequency of strategy use" yet the development of the reported frequencies is unclear.

In discussing the results of the study the investigators refer to the bimodal distribution of the Task Scores. In order that clear communication occurs, further discussion of this bimodal distribution is warranted. The investigators couple this bimodal distribution of Task Scores with the "relatively high proportion of successful children who used the recognized seriation strategies" and conclude that there is "a high degree of systematic behavior by many of the first-grade children." If one uses the investigators' individual Task Scores, as presented in the narrative, it is observed that 52 percent of the sample exceeded a Task Score of greater than 0.70. This is a simple majority but hardly a high proportion. If the school Task Scores are used, as presented in Table I, one finds that 48 percent of the sample exceeded a Task Score of 0.70. This figure produces something less than a simple majority. The investigators then conclude that "our strategy models are quite useful in characterizing the successful approaches first-grade children use in perceptually ordering objects on the basis of length and weight." This is a dangerous generalization projected beyond the sample tested. It is acknowledged that the seriation results are compatible with Piaget's findings and the Piagetian view of cognitive structure. This is the extent to which the study could safety be generalized.

For the investigators to hold that the "most important implication of the results is the viability of the strategy as a construct in educational theory" is seriously clouded by the design procedure of pre-instruction of tasks and by the Lack of clarification of the strategy analysis procedures.

This study, corrected for flaws as seen by this abstractor, could provide an empirical basis to substantiate the investigators' concept-task-strategy framework for transfer of learning. The CTS framework is not only an interesting approach but appears to provide a sound rationale for instructional research.

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RESPONSE TO ANALYSIS

IN RESPONSE TO THE ANALYSIS OF

Good, Ronald, et al. "Relationships Between Classroom Behavior and Cognitive Development Characteristics in Elementary School Children," by Dennis Sunal. Investigations in Science Education, 7(3):39-44, 1981.

by
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The "expanded abstract and analysis prepared especially for I.S.E. by Dennis W. Sunal" seems a bit misguided. Nearly all of the points raised in the analysis centered around the brevity of our 1976 paper in JRST. Rather than deal with the validity of various points one at a time, we prefer to deal with the general question of how much detail is needed in a research report.

The purpose of a research report is to communicate the results of findings to colleagues in one's field. Adequate interpretation of these results requires some knowledge of (and ability to understand) research design. If a research report is of particular interest to a reader, and further information on research design, etc. is desired, it is a relatively simple matter to contact the author(s) and request the desired information. To reprint tests and give detailed information about all aspects of a study such as ours would, quite obviously, require a great many pages in a journal. The proper balance between too little and too much detail is largely governed by the editorial board of a given journal and we believe that, in this case, the JRST Board has shown reasonable judgment in maintaining that balance.

A few points raised by Sunal are rather curious, but we will respond to them on the assumption that his intentions were good:

1. The research design did not involve pretest measurements because such measurements were not needed to answer the main question of the study, namely "Are cognitive characteristics a significant

determinant to children's lesson-related classroom behaviors under TSLS and SSLS conditions?"

2. The "interactive effects" of "varying TSLS classrooms" were not investigated because:

   a) there were no varying TSLS classrooms, and

   b) if there had been it is rather difficult to conceive of "interactive effects" of separate classes.

3. One-way analysis of variance was chosen for data analysis because there was only one principle of classification, namely the degree of teacher structure exhibited in the classroom. Multiple analysis of variance assumes two or more distinct bases of classification.

If Sunal or others are interested in learning more about the SSLS-TSLS studies conducted as a part of Project LEO at Florida State University, we will be happy to supply the specific information requested.