DOCUMENT RESUME

ED 265 081 SE 046 382

AUTHOR Blosser, Patricia E., Ed.; Helgeson, Stanley L., Ed.
TITLE Investigations in Science Education. Volume 12, Number 1.
INSTITUTION Ohio State Univ., Columbus. Center for Science and Mathematics Education.
PUB DATE 86
NOTE 80p.
AVAILABLE FROM SMEAC Information Reference Center (SMEAC/IRC), The Ohio State Univ., 1200 Chambers Rd., 3rd Floor, Columbus, OH 43212 (U.S. subscription $8.00; $2.75 single copy).
PUB TYPE Collected Works - Serials (022) -- Reports - Research/Technical (143) -- Information Analyses (070)
JOURNAL CIT Investigations in Science Education; v12 n1 1986

EDRS PRICE MF01/PC04 Plus Postage.
DESCRIPTORS *Academic Achievement; Blacks; Concept Formation; Elementary School Teachers; Elementary Secondary Education; Higher Education; Nonmajors; *Preservice Teacher Education; Questioning Techniques; *Science Education; *Science Instruction; Scientific Enterprise; *Sex Stereotypes; *Student Attitudes; Teacher Attitudes
IDENTIFIERS *Science Education Research

ABSTRACT

Abstracts and abstractors' critiques of 10 science education research studies are presented. The first section contains four studies related to science teacher education. These studies focus on: preservice elementary science teachers' science content backgrounds, perceptions of purposes for teaching science in elementary schools, and their concerns about teaching children science; effects of field-based versus campus-based science methods courses on preservice elementary teachers' attitudes toward science teaching and pupil control; the feasibility of training teachers in using a questioning technique; and the influence of the type of practice in acquiring process skills by preservice elementary teachers. The second section contains three studies dealing with student achievement: relationships of sex, mathematics and science achievement, and science self-concept on science career preferences of black students; effects of different kinds of museum tours on children's attitudes and learning; and the relationship of students' attitudes and achievement on external examinations. The last section contains studies dealing with nonscience majors' expectation of the scientific enterprise, perceptions of high school students as to whether certain science fields are masculine or feminine, and the level of detail and degree of abstraction appropriate for different age groups who are learning about the earth in space. (JN)

ED265081

INVESTIGATIONS IN SCIENCE EDUCATION

National Association for Research in Science Teaching

ERIC® Clearinghouse for Science, Mathematics, and
Environmental Education

INVESTIGATIONS IN
SCIENCE EDUCATION

Volume 12, Numoer 1, 1986

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: $8.00 per year. Single Copy Price: $2.75.
Add $1.00 for Canadian mailings and $3.00 for foreign mailings.

SE 046 382

Volume 12, Number 1, 1986

NOTES FROM THE EDITOR:

This first issue of Volume 12 of Investigations in Science Education contains critiques of articles dealing with two perennial problems in science education: science teacher education and student achievement. In the teacher education section are critiques of articles dealing with preservice elementary science teachers' science content backgrounds, perceptions of purposes for teaching science in elementary schools, as well as their concerns about teaching children science (Zeitler); the effects of field-based vs. campus-based science methods courses on preservice elementary teachers' attitudes toward science teaching and pupil control (Harty and others); the feasability of training teachers in the use of a questioning technique (Otto and Schuck); and the influence of the type of practice in acquiring process skills by preservice elementary teachers (Zeitler).

In the achievement section the ISE reader will find critiques of articles dealing with studying the relationships of sex, mathematics and science achievement, and science self-concept on science career preferences of black students (Jacobowitz); an investigation of the effects of different kinds of museum tours on children's attitudes and learning (Stronck); and an examination of the relationship of students' attitudes and achievement on external examinations (Hamilton). Hamilton's response to the critique of her article is also included in this section.

The third section of this issue contains critiques of three miscellaneous studies. One deals with a study of nonscience majors' expectations of the scientific enterprise (Helms and Montague). The second deals with an examination of perceptions of high school students as to whether certain science fields are masculine or feminine (Vockell and Lebonc). The third relates to the issue of the level of detail and degree of abstraction appropriate for different age groups of children who are learning about the Earth in space (Sneider and Pulos).

Patricia E. Blosser
Editor

Stanley L. Helgeson
Associate Editor

TEACHER EDUCATION

Zeitler, W. R. "Science Backgrounds, Conceptions of Purposes, and Concerns of Preservice Teachers about Teaching Children Science." Science Education, 68 (4): 505-520, 1984.

Descriptors--*Educational Background; *Elementary School Science; Higher Education; *Preservice Teacher Education; Science Education; *Science Instruction; Teacher Attitudes; *Teacher Background; *Teacher Characteristics

Expanded abstract and analysis prepared especially for I.S.E. by Harold H. Jaus, Purdue University.

Purpose

The purpose of this study was to obtain and interpret information from preservice elementary teachers regarding their (1) science backgrounds, (2) perceived purposes for teaching science in the elementary school, and (3) their concerns about teaching children science.

Rationale

The investigator of this study suggests three factors which may influence the quality and quantity of science teaching in the elementary school. The first factor concerns the science preparation of prospective elementary teachers. The author points out that although science requirements for the preparation of elementary teachers have been identified, the specific science courses taken at the high school and college level have not been reported. This information could be valuable in revising the science requirements of preservice elementary teachers in weak preparatory programs.

The second component suggested by the investigator that may influence science teaching is the purposes for teaching science at the elementary school level as these purposes are perceived by preservice teachers. Elementary teachers' conceptions of science as having little or no purpose may result in "very superficial science instruction."

On the other hand, "conceiving of science as a vital aspect of the elementary school curriculum may result in dynamic, in-depth science instruction." How and how often science is taught at the elementary school level may depend largely upon the teacher's conception of why it should be taught.

The third factor outlined by the investigator which may influence science teacning is the anxieties of preservice elementary teachers toward teaching the subject. Once the specific concerns about teaching children science are identified, it may be possible to "alleviate many of them through science content and methodology courses."

Research Design and Procedure

A nine item survey/questionnaire was designed to obtain certain information from preservice elementary teachers. The first four items requested demographic data from the respondents, e.g., gender, and year in college. These data were not used in the study. Items five and six consisted of lists of high school and college science courses. The preservice elementary teachers were to check each course they had taken at the high school and college level. Items seven and eight were of the free response type. Item seven requested the respondents to write three purposes for teaching children science in the elementary school and to identify the purpose they thought most important. Item eight requested the preservice teachers to list three concerns about teaching science if they were to teach children the subject "tomorrow." These concerns were to be ranked by the preservice teachers from greatest concern, second greatest, and third greatest concern. Item nine asked for any comments the respondents might like to add.

Item validity was ascertained by a panel of five judges. There was 90 percent agreement among panel members that the items on the survey met the established criteria of the survey/questionnaire.

Copies of the survey/questionnaire were sent to science methods instructors at five participating institutions of higher learning.

These institutions were selected from five different geographical regions in the United States. The survey/questionnaires were administered to preservice elementary teachers during the term prior to their student teaching experience.

A total of 229 surveys were returned and analyzed. Since free responses were requested for item seven (purposes) and eight (concerns), two science educators reviewed the responses and placed the responses into appropriate categories. Nine "categories of purposes" and five "categories of concerns" were identified. Percentages for each category were calculated. Because item nine had few responses ($< 1\%$), it was eliminated from the analysis.

Findings

At the high school level, the greatest number of science courses taken by the respondents was in the physical sciences. The second greatest was in the biological sciences, earth science was third, and the miscellaneous category was last.

At the college level the highest frequency of courses was in the earth sciences (mean = 1.16), and biological sciences was second (mean = 0.95). Although the greatest total number of courses taken was in the earth science category, the single course taken most frequently was biology (71%). Advanced courses in any of the sciences were taken infrequently ($< 4\%$).

Of the nine categories of purposes for teaching elementary school science, "teaching science information, developing an awareness of the world and teaching problem solving" were listed the most often. Teaching science processes was listed only 10 percent of the time.

The five categories of concerns which emerged from item eight were science content, teaching, teacher, student, and miscellaneous. The two categories containing the most concerns were science content and teaching. In the science content category the two concerns listed most frequently were lack of science background and selecting interesting topics. The two concerns listed most often in the teaching category were "teaching science content" and "student participation." The concern listed most frequently at all levels (greatest to least greatest concern) was lack of science background.

Interpretations

Although science courses taken at the high school level are most likely those in the physical and biological sciences, at the college level courses taken in the physical and earth sciences diminish greatly. Overall, the mean number of college science courses taken was 3.37. In short, the science background of preservice teachers appears to be inadequate. Improved advising, alterations in the preparatory program, and providing science courses and science methods courses that are consistent with the needs of elementary teachers are suggested as partial solutions to this problem. It is also suggested that (1) more emphasis be placed on teaching science process skills as a legitimate goal of elementary school science rather than teaching the "informational aspects of science"; and (2) teachers of science courses should be brought into closer association with the needs of preservice teachers. Based on the results of this study and other studies, the author also recommends that the societal implications of science should be addressed in both science courses and science methodology courses.

ABSTRACTOR'S ANALYSIS

This study adds additional support to the contention that preservice elementary teachers have an inadequate background in science and that this inadequacy is perceived by preservice teachers as a handicap to their teaching of science. On the other hand, few investigations have been reported that deal specifically with preservice teachers' perceptions of the purposes of teaching science to children. This investigation has pointed out rather clearly that, as perceived by preservice teachers, teaching both science process skills and problem solving are low on the list of purposes for teaching science in the elementary school.

There are several facets of the study that were not made clear or were not explained. For example, why was only one higher institution selected from each of the five geographical areas? This procedure limited the sample size to 229. Were the preservice teachers provided with an explanation regarding the purpose of the survey/questionnaire? Were they provided assistance in answering the questionnaire? How much time was provided for the completion of the questionnaire? Were the teachers given a day or two beforehand to think of their responses to the pertinent questions? (This seems of paramount importance since responses may differ when a person has time to sort out answers as opposed to responding with no time permitted to think about such answers.)

Since free responses were requested for the "purposes" and "concerns" items, the investigator was obliged to classify responses into appropriate categories. One of the "purpose" categories, as the investigator points out, leads to a wide variety of interpretations. This category was "developing an awareness of the world." In fact, the author found that 20 judges provided 20 different interpretations of the category. To alleviate such problems, it may be more objective to provide checklists of possible purposes and concerns. A space could also be provided, after the checklists, for the respondent to add "other" purposes or concerns not mentioned in the chekclists.

The change in format suggested above might clarify one of the investigator's interpretations of the data. The investigator found that teaching science information was the most frequently listed purpose (58%) of teaching science in the elementary school, and teaching process skills was listed only 10 percent of the time. It is possible that the preservice teachers view the science process skills as science information. For example, they do not differentiate between teaching observing, inferring, graphing, etc., from teaching facts or concepts.

The preservice teachers may not be isolating process from content but lump both into one large category called "teaching science information." A checklist of very specific purposes might clarify the interpretation.

Another explanation of the "teaching science information" versus the "teaching science processes" interpretation may concern the honesty of the respondents. They may honestly feel that teaching science process skills is really THE major purpose of elementary school science but know that because of a lack of equipment, supplies, and time that teaching the processes will be difficult. Therefore, their answer to the question was realistic, i.e., teaching science information requires fewer supplies, less time, and thus will be easier and more practical to accomplish. In other words, their answers were formulated in a "what I probably will do" as opposed to a "what I should do" framework.

Future investigations on this topic might consider the following questions. Are there correlations between preservice teachers' perceived inadequacies in teaching science and their ideas of the purposes of teaching sicence in the elementary school? Is there a correlation between the number of high school and college science courses of preservice teachers? Is there a difference in the perceived purposes and concerns of teaching science between preservice and inservice teachers? The suggested checklist questionnaire format would readily permit such analyses.

Harty, Harold; Hans O. Andersen and Larry G. Enochs. "Science Teaching Attitudes and Class Control Ideologies of Preservice Elementary Teachers with and Without Early Field Experiences." Science Education, 68 (1): 53-59, 1984.

Descriptors--Elementary Education; *Elementary School Science; *Field Experience Programs; Higher Education; *Methods Courses; *Preservice Teacher Education; Science Education; *Science Instruction; *Teacher Attitudes; Teacher Education Programs

E.panded abstract and analysis prepared espec ally for I.S.E. by Jerry G. Horn, Kansas State University.

Purpose

The focus (purpose) of this study was to explore whether differences in attitudes toward science teaching and pupil control exist between preservice elementary teachers engaged in field-based science methods courses and those enrolled in a campus-based science methods course.

Rationale

The assertion is made that attitudes, values, idealogies and perceptions play an important role in off-campus teaching situations. Additionally, methods courses have responded to this belief by greater utilization of field experiences, either prior to and/or in conjunction with instruction in methodology. Presently, little conclusive evidence exists as to any desirable influence field experiences are having on science teaching attitudes and ideologies.

Earlier studies indicate that preservice teachers' campus preparation does influence how they will perceive and even behave in field-based teaching assignments. Guba, Jackson and Bidwell (1959) found that prospective teachers exhibit personality patterns more characteristic of the undergraduate attending the institution than those associated with the profession being pursued; Cumins (1961) found that the orientation of preservice teachers toward teaching and educational practices becomes similar to those of their professors; and Sunal (1980a) observed the tendency to model recent contacts with college/university professors. Yet there is, according to Hoy (1967), a double socialization process where prospective teachers initially argue professional attitudes, values and ideologies in formal college course work, and the second phase occurs when they enter the "real world" of teaching where they become confronted with conflicting sets of attitudes, values and ideologies embedded in the schools' subculture, role definitions, and behavior expectations.

Several studies (Thompson and Thompson, 1975; Gabel, Rubba and Franz, 1977; Weaver, Hounshell, and Coble, 1979; Story and Brown, 1979) have reported on the modifications of or the development of new preservice science and/or science education courses or course sequences geared toward changing would-be teachers' attitudes and perceptions.

Research Design and Procedure

The design of this exploratory effort focused on two preservice elementary science teacher preparation programs where the would-be teachers had undergone different treatments and socialization for the teaching of science in the elementary school. More specifically, the research design could best be described as a "Posttest-only Control Group Design," with the control group receiving the usual instruction in a single three-hour methods course.

The subjects consisted of two groups of preservice elementary school teachers who had completed three semester hours of science methods instruction before the data were collected. One group, termed "field-based" received three one-credit-hour methods courses that were completed concurrently with corequisite science courses in biology, physical science, and earth science/astronomy. These one-hour science methods courses utilized the science content learned in companion science courses to plan for and teach small groups of students during their field experiences on a biweekly basis over three weeks. The other group, named "campus-based" received instruction in a three semester-hour single methods course with a lecture and two-hour lab per week. There were 39 subjects (96 percent female) in the Field-Based Group and 43 (98 percent female) in the Campus-Based Group. Both groups were 93 percent white-Anglo, had completed their course work, and were to student teach the following semester.

The dependent variables were attitudes toward science teaching and the would-be teachers' ideologies, which were measured by the Shrigley-Johnson Science Attitude Scale and the Pupil Control Ideology Form. Both instruments were administered during the last week of the semester to the Campus-Based Group and during the same period to the Field-Based Group who were completing the third of the three, one-semester-hour courses. After testing for normality using the Kolmogorov-Smirnov "goodness of fit" test, the t-test was used to determine significant differences at the 0.05 level between the Field-Based and Campus-Based preservice teachers' attitudes toward science teaching and pupil control ideology.

Findings

Preservice teachers in the Field-Based Program were significantly more custodial in their pupil ideology than were the prospective teachers in the Campus-Based Program. However, both groups tended to be custodial, with means being below the instrument's neutral point (60).

When considering attitudes toward science teaching, no significant differences were found between preservice teachers in the Campus-Based Program and the would-be teachers in the Field-Based Program. Both groups did, however, reveal positive attitudes by exceeding the instrument's neutral point (78). Also, six significant differences surfaced between the two groups on individual items. The Field-Based Group exhibited significantly more positive attitudes toward the dimension of "responsibility for teaching all science," and the Campus-Based Group possessed significantly more desirable attitudes with respect to "difficulty in learning science," "confused about science classes," and "fear about anything associated with science."

Interpretations

The Field-Based teachers, who had early and continuous exposure to the elementary school classroom over three semesters, were significantly more custodial than their Campus-Based counterparts. This seems to be consistent with the findings of earlier research (Willower and Jones, 1963; Hoy, 1967). When preservice teachers move into the teaching profession, they adopt the more custodial ideologies of the school subculture and forego some of the idealism in the campus-based science education curriculum. Also, the results could be attributed to the so-called "second phase of the double socialization process" (Hoy, 1967), as well as to other explanations related to the lack of skills to implement inquiry oriented teaching strategies.

No significant differences were found between Campus and Field-Based Groups with respect to attitudes toward science teaching, which is consistent with earlier research by Gabel, Rubba and Franz (1977), Weaver, Hounshell, and Cable (1979), and Sunal (1980a). The available evidence now indicates that field experiences have little or no measurable impact on attitudes toward science teaching.

The findings of this exploratory effort lead to the following hypothesis: If the development of more humanistic teachers who possess more positive attitudes toward the teaching of science is a goal, then a second training and/or preparation intervention inserted after preservice teachers have gained confidence in their classroom management repertoires and have experienced the socialization to the "real world" of schools may be appropriate.

ABSTRACTOR'S ANALYSIS

The authors of this article did an unusually good job of reviewing relevant literature and setting the stage for the reader. In addition, they reviewed throughout the article, related their findings to earlier research, and proposed a hypothesis for program development and further investigations. This process was done so thoroughly that the discussion/interpretations of the findings were almost automatic.

With regard to the design of the study, there are several instances where improvements were possible. One must infer that the subjects were not randomly assigned to treatment groups and no attempt was made to equalize the two groups. Only the sex and cultural composition of the subjects within the treatment groups were described, which seems to be an inadequate description for consumers of the results of this study. No mention was made about the presumed effect of sex or cultural background on the dependent variables. In addition, it was stated that "the would-be teachers (subjects) had undergone somehwat different treatments and socialization for the teaching of science in the elementary school." Was the treatment different or not? If the treatments were different, were they planned to be strong enough to cause an effect, or were the treatments designed for convenience rather than for true experimental purposes?

The psychometric instruments were adequately described, and appropriate validity and reliability tests were performed. The quantitative results of the study were presented in a very concise and readable form.

In total, this study provides useful and additional information and builds on an existing knowledge base. True, the design of the research and the treatments could be stronger, but the authors did describe this study as exploratory, and a hypothesis for further study was presented. We look forward to future research in this area, one of considerable importance to campus-based teacher educators. Do we really make a difference, and is the difference sustained in the presence of the extreme socialization process and the realities found in the classrooms of local educational agency classrooms?

REFERENCES

Blosser, P. E. and R. W. Howe. "An Analysis of Research on Elementary Teacher Education Related to the Teaching of Science." Science and Children, 6: 51-52, 1969.

Butzow, J. W. and A. Davis. "The Development of a Semantic Differential of Teachers' Attitudes Toward Teaching Elementary School Science." Science Education, 59: 215-216, 1975.

Collea, F. P. "A Model for Pre-service Training of Science Teachers Based on the Intentions, Perceptions, and Verbal Behaviors of First Year Science Teachers." Science Education, 58: 363-367, 1974.

Cumins, R. E. "Role Study in Teacher Training: A Sequel." Journal of Educational Sociology, 35: 119-120, 1961.

Frankel, E. "Teacher Training in Elementary Science Education." Science Education, 56: 57-63, 1972.

Gabel, D. L.; P. A. Rubba, and J. R. Franz. "The Effect of Early Teaching and Training Experience on Physics Achievement, Attitude Toward Science and Science Teaching, and Process Skill Proficiency." Science Education, 61: 503-511, 1977.

Guba, E. G.; P. Jackson, and C. Bidwell. "Occupational Choice and the Teaching Career." Educational Research Bulletin, 38: 1-12, 1959.

Hoy, W. K. "Organizational Socialization: The Student Teacher and Pupil Control Ideology." Journal of Educational Research, 61: 153-155, 1967.

Jones, P and J. W. Blankenship. "A Correlation of Biology Teachers' Pupil Control Ideology and Their Classroom Teaching Practices." Science Education, 54: 263-265, 1970.

Schwirian, P. "Characteristics of Elementary Teachers Related to Attitudes Toward Science." Journal of Research in Science Teaching, 6: 203-213, 1968.

Shrigley, R. L. and T. .. Johnson. "The Attitudes of Inservice Elementary Teachers Toward Science." School Science and Mathematics, 74: 437-446, 1974.

Story, L. E. and I. D. Brown. "Investigation of Children's Attitudes Toward Science Fostered by a Field-based Science Methods Course." Science Education, 63: 649-654, 1979.

Sunal, D. W. "Effect of Field Experience During Elementary Methods Courses on Preservice Teacher Behavior." Journal of Research in Science Teaching, 17: 17-23, 1980a.

Sunal, D. W. "Relationship of Affective Measures and Preservice Teaching Behavior." Science Education, 64: 337-347, 1980b.

Thompson, R. G. and A. G. Thompson. "Building Attitudes Toward Science for Preservice Teachers: An Experiment." School Science and Mathematics, 75: 213-216, 1975.

Weaver, H. M.; P. B. Hounshell, and C. B. Coble. "Effects of Science Methods Courses With and Without Field Experience on Attitudes of Preservice Elementary Teachers." Science Education, 63: 655-664, 1979.

Willower, D. J. and R. G. Jones. "When Pupil Control Becomes an Institutional Theme." Phi Delta Kappan, 45: 107-109, 1963.

Willower, D. J.; T. L. Eidell, and W. K. Hoy. The School and Pupil Control Ideology. University Park, PA: Pennsylvania State University Studies (No. 24 revised), Pennsylvania State University, 1973.

Otto, Paul B. and Robert F. Schuck. "The Effect of Teacher Questioning Strategy Training Program on Teaching Behavior, Student Achievement, and Retention." Journal of Research in Science Teaching, 20 (6): 521-528, 1983.

Descriptors--*Academic Achievement; Biology; Grade 8; Program Effectiveness; *Questioning Techniques; *Retention Psychology; Science Education; *Science Instruction; *Secondary School Science; *Teacher Behavior; Training Methods

Expanded abstract and analysis prepared especially for I.S.E. by Gerald H. Krockover, Purdure University.

Purpose

The purpose of this study was to investigate the feasibility of training teachers in the use of a questioning technique and the resultant effect upon student learning.

Rationale

The research literature is replete with conflicting conclusions as to student benefits derived from a teacher questioning strategy. It has also been difficult to make comparisons between studies because a variety of strategies and observational systems have been used. Recently, researchers have attempted to solve this problem by applying analysis strategies to existing research. Using a three-category sorting method across 18 studies, one researcher found that the predominant teacher use of higher level cognitive questions had minimal effect on student achievement. Another researcher found that there was no clear linear relationship between the frequency with which the teacher used certain types of questions and pupil achievement and that the experimentally increased use of specified procedures or types of questions had not resulted in increased achievement.

This study investigated the following questions:

1. Will teachers trained in a specific questioning technique employ the technique to a greater degree in a classroom situation than will a control group?
2. Will students taught by teachers trained in a specific questioning technique demonstrate significantly higher achievement in two sequentially taught biology units compared to students taught by control group teachers?
3. Will students taught by teachers trained in a specific questioning technique demonstrate significantly greater knowledge retention in two sequentially taught biology units compared to students taught by control group teachers?

Research Design and Procedure

The questioning technique utilized in this study was the model developed by Kenneth George and Associates (1974). The George question categories parallel the Bloom taxonomy of cognitive objectives utilizing the condensed format of: Recall, Data Collecting, Data Processing, and Verification. The post-test-only control group design was utilized.

Five hundred twenty-one eighth grade student volunteers from science classes in three selected rural junior high schools participated in the study sample pool. Since 30 students from each school were the desired sample size (90 total), the first 30 volunteers were accepted. The sample of 90 students was randomly assigned to six groups of 15 each. Three of the pupil groups were randomly assigned to an experimental group and three to a control group.

Six volunteer biology teachers, with a range of two to six years of teaching experience, were randomly assigned to the experimental or control groups, respectively. The experimental group teachers received no training. Two hours of in-service credit was earned by each teacher participant.

An observer group, consisting of six elementary school teachers, categorized the questioning strategies employed by the experimental and control group teachers. The observer group went through a 13-hour training program that was designed to develop an observational competence level demonstrated by (1) an acceptable correlation with the judgements of an expert panel and (2) an acceptable inter-rater reliability among the observer trainees. Inter-rater reliability was determined using the weighted Kappa procedure. Even though the observer group reached a satisfactory level of reliability after six hours of training, the decision was made to continue the training of an additional seven hours.

All of the student groups were instructed in two units of biology (Circulation for two weeks and Respiration for two weeks) for a total of four weeks. Achievement tests were administered at the completion of each unit with scambled versions of the achievement tests used as indicators of retention during weeks eight and ten.

Findings

The control group of teachers implemented a higher use of managerial and rhetorical type questions than did the experimental group. The experimental group asked more questions which dealt with recall, data gathering, data processing, and verification. More higher order questions than lower order questions were asked by the experimental group. The reverse was true of the control group. Mean scores and standard deviations were computed from the posttest and retention score data. In all cases, the differences favored the experimental groups at the 0.02 level of confidence. The analysis of variance of the raw score achievement test data was significant at the 0.01 level for both the unit on Circulation and the unit on Respiration. The analysis of variance of the retention test data showed significant retention when compared to the control group.

Interpretations

The following interpretations were made as a result of this study:

1. Teachers can be trained to use the systematic questioning technique.
2. Teachers trained in this technique are able to employ it in a classroom setting.
3. Students taught by teachers trained in and employing the questioning technique will achieve significantly higher than those taught by a control group.
4. Students taught by teachers trained in and employing this technique will retain their knowledge for a period of time (six weeks) to a significantly greater degree than those taught by a control group or teachers.

This study supports the concept that teachers can be trained in the systematic use of questions as an instructional strategy and that once so trained are able to use this teaching method. It also indicates that students taught by teachers employing this strategy will achieve more and retain their acquired knowledge to a higher degree than those taught by a control group of teachers.

ABSTRACTOR'S ANALYSIS

This study made an attempt to ascertain the effect of a teacher questioning strategy training program on teacher behavior, student achievement, and retention. While the results will be endorsed in the science education community, several key questions related to this study are left unanswered. For example: What effect does using volunteer students have upon the study? Are volunteers more interested in science, more responsive to teachers? We are not provided with any background information about either the students or the teachers. We are also left in the dark with respect to the type of biology curriculum used; was it BSCS, traditional?

There is also an error published in this study when it states, "The experimental group teachers received no training." Shouldn't this statement refer to the control group of teachers?

The volunteer teachers and the observers received in-service credit for their work. What effect did this credit have upon the participants? Maybe certain performance expectations were assured by virtue of in-service credit expectations.

The observer group consisted of elementary school teachers. Do they really have the necessary expertise to observe in a junior high biology classroom?

The use of an "expert" panel to correlate with the observer group is indicated. However, no attempt was made to indicate the characteristics of this "expert" group.

Furthermore, no indication was given in this study for the rationale in the selection and use of the two biology units selected. Why were these units used? How were they taught?

Achievement tests were administered as indicators of retention. What was the reliability and validity for these tests? Were these tests teacher developed or standardized? What levels of cognitive questions were asked?

Three of the four conclusions for this study are inferential in nature. They were not adequately addressed or investigated to their fullest. As a result, this study can be grouped with the question asked by the famous commercial: "Where's the beef?"

REFERENCES

George, K. S., M. A. Dietz, E. C. Abraham and M. A. Nelson. Elementary School Science Why and How. Lexington, MA: D. C. Heath and Company, 48-174, 1974.

Gage, N. L., Editor. Handbook of Research on Teaching. Rand McNally and Company, Chicago, IL: 1963.

Zeitler, W. R. "The Influence of the Type of Practice in Acquiring Process Skills." Journal of Research in Science Teaching, 18 (3): 189-197, 1981.

Descriptors--Elementary Education; Elementary School Science; Higher Education; Instructional Design; *Instructional Improvement; *Preservice Teacher Education; *Process Education; Science Education; *Science Instruction; Teacher Improvement

Expanded abstract and analysis prepared especially for I.S.E. by Donald E. Riechard, Emory University.

Purpose

The study was designed to answer the following questions: Does the type of practice in which preservice elementary teachers engage during acquisition of communicating skills--

1. enhance their acquisition of those skills?
2. influence their instructional planning?
3. influence the effectiveness of their teaching the skills in the elementary classroom?

Rationale

The author builds a rationale for his study by citing such proponents of process teaching as Gagne and Herron. He ties the inclusion of science processes in teacher education to several researchers including Butts and Raun, Ashley and Butts, and Jaus. A number of investigations, including the one by Allen and Fortune, are cited to provide a rationale for microteaching while Claus is identified to support the modeling technique.

Research Design and Procedure

The subjects were 29 female senior undergraduates in two different elementary science methods sections. One section (Group I) had 13 subjects; the other (Group II) had 16. Subjects were randomly placed for field experience in elementary school classrooms in grades one through five. The average number of children assigned to be taught by each subject was 14.

The design of the study was a pre- posttest two treatment design with no control group. The procedure followed was:

1. Subjects from Group I and Group II were pretested on a process skills test (PST).
2. Both groups received instruction and practiced communication skills. Instruction for the two groups was the same.

   The microteaching-practice subjects (Group I) designed mini-lessons consisting of objectives, learning activities, and a summation or assessment. The group was broken into small subgroups and the lessons were taught to peers. Each member of a subgroup served in one of three roles--teacher, evaluator, or learner. Following a subject's teaching, members of the subgroup, under leadership of the evaluator, analyzed lessons using the following criteria: 1) objectives being evident; 2) clarity of instruction; 3) use of equipment; and 4) effectiveness of instruction.

   The modeling-practice subjects (Group II) designed learning activities. The activities were modeled after, or were imitations of, those used by the instructor to teach the skills to the subjects. For the purpose of analyzing the learning activities, two subgroups were formed. Members of each subgroup analyzed the learning activities with the same criteria used to analyze the microteaching lessons above.
3. Group I and Group II were posttested on the PST.
4. Subjects from both groups designed lesson plans for teaching communication skills to elementary school children.

5. Subjects administered a pretest on a student process skill (SPST) to the children with whom they were assigned to work.
6. Subjects taught the lessons they had developed in step 4, above, to the children.
7. Subjects administered the SPST posttest to the children.
8. Subjects submitted teaching plans along with scores on SPST pre- and posttests to the investigator.

Statistical analyses on the mean scores of pre- and posttests were done using t tests of independent means. The 0.05 probability level was the criterion for significance in each comparison. The frequency with which each skill was found in a group's teaching plans was converted to percentage form; comparisons between groups were determined by use of the critical ratio.

Findings

Three questions were stated in the purpose above. Related to those questions, results were:

1. No significant differences in skill acquisition were found between the two groups (I and II).
2. All communication skills were represented in the teaching plans of subjects in both groups.
3. Comparison of children's pre- and posttest accuracy scores on the SPST revealed that those children taught by Group I subjects had significantly higher scores.

Interpretations

It was concluded that type of practice did not affect subjects' acquisition of process skills. The findings, however, do support the conclusion that subjects who practiced microteaching were more effective instructors than those who practiced modeling.

The author states that the additional instructional experience obtained in microteaching might have had an influence. Thus, he suggests that, prior to classroom teaching, preservice teachers should have an opportunity to prepare plans and do microteaching.

ABSTRACTOR'S ANALYSIS

The results obtained in this study are predictable from perusal of previous research or one's own teaching/learning experiences. Of course, it is always satisfying to see one's predictions verified by a research study.

Conceptual Contributions. I think more significant than the results themselves are the conceptual contributions of the study. Most importantly, there is a direct effort to assess the effect of teacher preparation strategies on pupil outcomes in the classroom. Pupil learning is our ultimate goal. Attaining that goal in the climate of teacher evaluation controversies, merit pay proposals, and dismal commission reports on education (Tanner, 1984) make it absolutely necessary to examine teacher education practices as they relate to pupil outcomes. The reader is referred to a recent issue of *Phi Delta Kappan* which examines a number of conceptual issues related to teacher preparation (Cole, 1984).

Design and Procedure

I have some problem with the author's identification of modeling as an independent variable and, specifically, to modeling as a form of practice. It is quite obvious that microteaching is a type of practice but it seems to me that modeling is merely a technique the subjects could use in designing lessons.

Further, while the microteaching group was "encouraged to design or adapt learning activities," (p. 192) I would guess they were influenced by the instructor's modeling also. Thus, I prefer to identify the design as a pretest-posttest control-group design where the treatment was microteaching and the control group was the one that did not microteach.

Perhaps another term, such as instructional strategy, should have been used to identify the independent variable. Regardless, when one looks beyond semantic preferences, the terminology used does not detract greatly from the study.

It would have been desirable, as recognized by the author, had the subject sample size been larger. However, considering the small sample size and sampling method, the statistical procedures were appropriate, straightforward, and uncomplicated. The author should be commended on his efforts to establish validity and reliability of the various instruments and procedures used.

Written Report. The report is well organized and clearly written. The purpose and research questions are laid out at the beginning so the reader knows the nature of the study immediately. Tables are used effectively to present data and the discussion flows logically and smoothly. The author is somewhat cautious with his interpretations and generalizations but as in most behavioral research, caution is a virtue.

There are a few technical errors in the report. These appear to be primarily typographical and/or editorial in nature. For example, there are several instances where the spelling or presentation of authors' names in the text are different from that in the list of references. Such errors can occur easily but should be corrected in the final review of the typeset proofs.

Research Relationship. The author is very effective in tying his study into the body of past research on teaching/learning of science processes, microteaching, and modeling. A sampling of the research is identified in the Rationale, above. I presume the author thinks the research is important. (I believe it is.) It is interesting, therefore, that the major thrust of related research took place some ten to twenty years ago.

The current dearth of research is due, in part at least, to the more recent back-to-basics movement in which sciencing has not been given a high priority in the schools. In fact, concerned representatives of NSTA state, "The significance of the laboratory is being questioned at every level of science teaching" (Yager, Klein, & McCurdy, 1981, p. 42). What, then, are the implications for future research related to the present study?

Implications for future research can be viewed from the specific or from the general point of view. The author identifies some specific directions which appear to be based on the assumption that science process skills are "good." For example, he recommends similar research at secondary grade levels, the study of process skills other than communication (particularly those requiring multisensory observations), and the study of several methods for teaching the process skills simultaneously in the classroom.

Accepting his assumption, I would suggest that a variety of pupil variables such as socioeconomic status, age, and gender be examined as they relate to process learning. Cognitive development, learning styles, and previous preparation could also be fruitful areas of study.

From a more general point of view, this study suggests two highly important research directions. First, there is need for study to clarify the role of science process skills in the school curriculum. Are process skills really "good"? Do the public and school officials want science curricula to focus on process skills? If not, promising studies like the one under analysis here, will be mainly academic in nature and will have little impact in the current climate of educational reform. There is tremendous need for educational policy research (Brandt, 1984).

As a second extension of this investigation, I suggest more research on teacher preparation strategies as the strategies relate to pupil performance in the classroom. Much of what is done now in teacher education is a mixture of folklore and consensus of the profession.

A number of problems could be investigated. Does the teacher's background preparation in science affect pupil performance? What science information and methodology should be taught and how should they be taught? Is pupil performance, for example, really affected by the teacher's lesson planning ability? Do the length and nature of a preservice teacher's field experience (e.g., student teaching) affect pupil performance? And, very timely, how can the growing computer technology be used in teacher preparation to enhance pupil learning in science?

The present investigation suggests that one strategy in teacher preparation, namely microteaching, can increase pupil learning of science processes. It seems to me that this should be adequate incentive to test other strategies and approaches against the yard stick of pupil performance.

REFERENCES

Brandt, R. S. (Ed.). "Education Policy" (Total Issue). Educational Leadership, 42 (2): October, 1984.

Cole, R. W., Jr., (Ed.). "Teacher Effectiveness and Teacher Education" (Total Issue). Phi Delta Kappan, 66 (2): October, 1984.

Tanner, D. "The American High School at the Crossroads." Educational Leadership, 41 (6): 4-13, 1984.

Yager, R. E., S. E. Klein, and D. W. McCurdy. "Science Activities are Central to Science Education in Elementary School." Science and Children, 19 (2): 42, 1981.

ACHIEVEMENT

Jacobowitz, T. "Relationship of Sex, Achievement, and Science Self-Concept to the Science Career Preferences of Black Students." Journal of Research in Science Teaching, 20: 621-628, 1985.
Descriptors--*Academic Achievement; *Blacks; Grade 8; Junior High Schools; Junior High School Students; Mathematics Achievement; *Science Careers; Science Education; Science Interests; *Secondary School Science; *Self Concept; *Sex; Sex Role

Expanded abstract and analysis prepared especially for I.S.E. by Marsha Lakes Matyas, Office of Opportunities, American Association for the Advancement of Science.

Purpose

This study was designed to determine the relationships of sex, mathematics and science achievement, and science self-concept to science career preferences among black junior high school students. Specifically, the relationship between science self-concept and science career preference was examined after accounting for sex and achievement differences.

Rationale

The author notes the lack of blacks studying and working in scientific fields. The literature review suggests that students who later work in scientific fields often expressed science career interests early, usually in their junior high school years. The author suggests that, for high school and college students, the lack of mathematics and science skills and knowledge is the major factor preventing Black students from entering science-related majors and careers. According to the author, however, this finding is not necessarily generalizable to junior high school students. In addition to math/science skills, self-concept is cited as important to career preferences among junior high school students. Citing the vocational preference theories of Super, the author suggests that self-concept influences vocational preference and that science self-concept might be closely related to science career preferences. Finally, sex is listed as an important variable in science career choice among both minority and majority groups.

Research Design and Procedure

The study utilized non-experimental, survey techniques. Subjects in the study were eighth grade black students attending an inner city school in New York City (N=261). It was not noted whether these students were in the class of one or several teachers, nor whether they were all taking similar mathematics and science courses. Three scales were administered to the subjects by the author (female) and two graduate students (sex not given).

The Science Career Preference Scale was developed by the author. Five science occupations (biochemist, science professor, optometrist, meteorologist, and aerospace engineer) and five non-science occupations (lawyer, social worker, city planner, librarian, and English professor) are presented to the student in 45 pairings. Students indicated their preference in each pair. Alpha reliability for the scale was 0.78; concurrent validity estimates of correlations with other science career preference scales were not given.

The Self-Concept of Ability Scale, Form B, was used to assess science self-concept. A citation for the scale was given, but no estimates of reliability or validity for the current or similar populations were indicated. Mathematics and science achievement were measured by using third quarter grades for students. Again, the author did not indicate whether all students received grades from the same teacher and/or were enrolled in the same science and mathematics courses. No reliability or validity estimates for these measures were given.

Data were subjected to t-tests for gender differences and to multiple regression analyses using science career preference as the criterion variable. The order of entry of variables into the equation was predetermined by the author: 1) sex; 2) achievement variables; 3) science self-concept.

Findings

Student t-tests indicated that there were no significant mathematics or science achievement differences between males and females in this sample. Male students had significantly more positive science self-concepts and stronger science career preferences than did female students.

Correlational data indicated that mathematics and science achievement were strongly related ($r = .67$). Science self-concept was strongly related to science achievement ($r = .45$) and to math achievement ($r = .32$), and was also related to sex ($r = .15$). Science career preference was most strongly related to sex ($r = .51$), but also related to science achievement ($r = .21$) and to science self-concept ($r = .37$). Math achievement was not significantly related to science career preference.

Multiple regression analyses indicated that student sex accounted for 25 percent of the variance in science career preference. Adding mathematics and science achievement to the equation accounted for an additional 3 percent of variance (28% of total variance). The addition of science self-concept to this equation increased the accountable variance by 6 percent, therefore, using all variables in the equation accounted for 34 percent of the total variance in science career preference scores. There were no significant interaction effects between sex and the other independent variables.

Interpretations

The author states that the study's findings agree with an earlier study's assertions that "sex is the single most powerful influence on direction of science career path" (p. 626). She also states that the data from this study indicate that "the conflict between choosing science as a career goal and the desire to appear feminine is evident" (p.626) among junior high school level, black females.

The lack of a significant relationship between mathematics achievement and science career preference leads the author to conclude that the students in the study were unaware of the relationship of math and science achievement to science careers and "for this reason did not realistically assess these factors when indicating preferences for science careers" (p. 626). Finally, the finding that science self-concept accounts for variance in science career preference in addition to that accounted for by sex and achievement variables is in agreement with Super's theories. The author rationalizes the sex difference in science self-concept by attributing it to differing socialization processes which reward science achievement behaviors more for boys than for girls and provides male but not female science role models.

Suggestions for action based on the study include the following: 1) Black science intervention programs should attempt to eliminate the perception of science as a masculine field. Black females should be advised to enroll in high school math and science courses and be exposed to female science role models. 2) Sex-role restructuring should be encouraged among male and female adolescents. 3) Teachers should enhance science self-concept by reinforcing "specific science behaviors" (p. 627), encourage girls to participate in lab activities, and teach that success does not "detract from the feminine self-image" (p. 627). 5) Black students should be made more aware of the link between school achievement and science careers.

Finally, the author states that the study results suggest that "the relationship between science self-concept and sex-role self-concept of black students may be stronger than the relationship between science self-concept and mathematics and science achievement" (p. 627). She indicates that further investigation of these relationships could improve science self-concept enhancement programs which could channel more blacks into science careers.

ABSTRACTOR'S ANALYSIS

This study serves to confirm and expand the findings on gender differences in science career choice to a new population, that is, black junior high school students. The author constructs the study around Super's theories of vocational choice, emphasizing the importance of self-concept in developing career preferences. However, Super's theories were primarily concerned with vocational preferences among white males, therefore, caution must be used when expanding these theories to include women and minorities.

Jacobowitz points out the difficulty in obtaining information on gender differences in science among blacks and, unfortunately, much of the information provided in the literature review is dated. Studies by Hall (1981), Treiman and Hartmann (1981), the National Board on Graduate Education (1[illegible]), and the 1980 U. S. Census could provide up-to-date information concerning minority women and men in science during the data collection period of the study.

The purpose of the study was to "gain further understanding of factors that may be related to the scarcity of blacks in science occupations" (p. 622). It might be more appropriate to modify this to "the relative scarcity of black females in science compared to black males" since the study did not compare black students with white students, but examined only gender differences among a black student population.

Some questions might also be asked about the instruments and methodology. First, what is the reliability and validity of the science self-concept scale for use with this population? Is the scale actually a measure of self-confidence? If this is the case, female students usually express less confidence on such scales in many academic areas, not only traditionally masculine fields (Barusch, 1973). Questions can also be raised concerning the use of course grades as measures of achievement. Were all the students enrolled in the same mathematics and science courses? Did one teacher assign all grades? If not, were the grade distributions similar for all teachers and were there gender differences in grades assigned by specific teachers? Were the classroom environments similar for all students? If not, this may affect career preferences and/or science/math achievement.

The description of the Science Career Preference Scale also raises some questions concerning its development and use. Are "science careers" and "masculine careers" interchangeable terms? According to the 1980 U. S. Census (see following table), three of the science occupations are extremely "masculine" careers, but two of the science careers (biochemist and science professor) overlap two of the non-science careers (lawyer and city planner) in the degree to which women are employed in them. Therefore, in some pairings, students are choosing between a science versus a non-science career while, in other pairings, they are also choosing between a masculine versus a feminine career. This may create some confusion in determining which aspect of career preference the scale actually measures. An additonal confusion may arise due to misunderstanding of the occupations and what they entail. What proportion of this student population really understood what a city planner, optometrist, meteorologist, or aerospace engineer does?

Percentages of Workers in Each Field Who Are Female:
1980 U. S. Census Data

Field	% Female
Biochemist	28%
Science Professor	27%
Optometrist	8%
Meteorologist	6%
Aerospace Engineer	1%
Lawyer	14%
Social Worker	65%
City Planner	24%
Librarian	82%
English Professor	55%

(Note: Data drawn from Vetter & Babco, 1984).

Finally, since the sex and race of two of the researchers was not indicated, some concern about researcher/role model effect is appropriate. Were all three researchers present at each testing situation? Were all three researchers female? Were all three researchers black? Science career preferences could be influenced by the sex and race of the researchers, especially if only one researcher administered the scales in each class or if the test administrator was introduced as a "scientist" or a "researcher."

Data analyses were straightforward and well-done. The author justified the order of entry of variables into the multiple regression equation by review of the previous literature. It would have been useful to know, however, the maximum and minimum possible scores and/or skewness of the distribution for the four variables.

In her conclusions, Jacobowitz provides excellent recommendations on strategies for increasing the participation of black females in science. While the study data do not specifically support all of these recommendations, the suggestions are firmly grounded in previous research. She also suggests that black students must be made more aware of the importance of science and mathematics achievement to later science careers. However, this problem is not unique to black students (Kahle, 1983), and this recommendation could be expanded to include all junior high level students. Currently, little is known about the vocational choice process among women and minorities. Caution must be used, therefore, when making assumptions concerning black males' and females' use of achievement information in making career decisions.

In her conclusions, Jacobowitz uses the term "sex-role self-concept" in analyzing girls' reasons for not preferring science careers. Her implications that the results of the study suggest a stronger relationship between science career preference and sex-role self-concept than between science career preference and mathematics/science achievement must be questioned. Sex and sex-role self-concept are not necessarily equivalent for all students. Since sex-role self-concept was not specifically measured, can valid conclusions concerning it be made?

Finally, correlational data do not imply causality. From the data in this study, it cannot be determined whether science self-concept causes science career preference or visa versa, or whether there are additional factors mediating this relationship. Certainly, for black students in inner city schools, the problems of access and aspiration to higher education degrees is a complex problem encompassing more factors than achievement and self-concept.

REFERENCES

Barusch, G. K. "Feminine Self-Esteem, Self-Ratings of Competence, and Maternal Career Commitment." Journal of Counseling Psychology, 20: 487-488, 1973.

Hall, P. Q. "Problems and Solutions in the Education, Employment and Personal Choices of Minority Women in Science." Washington, DC: American Association for the Advancement of Science, 1981.

Kahle, J. B. Girls in School: Women in Science. Washington, DC: National Science Foundation Commission on Precollege Education in Mathematics, Science and Technology, 1983. (Summary report available from J. B. Kahle, Departments of Biological Sciences and Education, Purdue University, W. Lafayette, IN 47907).

National Board on Graduate Education. Minority Group Participation in Graduate Education. Washington, DC: National Board on Graduate Education, National Academy of Sciences, 1976.

Treiman, D. J. and H. I. Hartmann. Women, Work, and Wages: Equal Pay for Jobs of Equal Value. Washington, DC: National Academy Press, 1981.

Vetter, B. M. and E. L. Babco. Professional Women and Minorities. Washington, DC: Scientific Manpower Commission, 1984.

Stronck, David R. "The Comparative Effects of Different Museum Tours on Children's Attitudes and Learning." Journal of Research in Science Teaching, 20 (4): 283-290, 1983.

Descriptors--*Academic Achievement; Elementary Education; *Elementary School Science; Foreign Countries; *Museums; Science Education; *Science Instruction; *Student Attitudes; *Teaching Methods

Expanded abstract and analysis prepared especially for I.S.E. by Peter A. Rubba, Pennsylvania State University.

Purpose

The purpose of the study was to compare the effects of a highly structured tour of the National History Gallery of the British Columbia Provincial Museum in Victoria, with a less structured tour on 5th, 6th, and 7th grade children's attitudes toward the museum and learning about the museum. In particular two research questions were studied:

1) Does a more structured tour produce greater cognitive learning about the museum among students of grades 5, 6, and 7?
2) Does a more structured tour produce more positive attitudes toward the museum among students of grades 5, 6, and 7? (p.283)

Rationale

The study was justified based upon contradictory conclusions from a half a dozen studies which compared the effects of classroom instruction and field trip excursions on the attitudes and/or the learning of facts and concepts by students.

Research Design and Procedure

The subjects included 816 5th, 6th, and 7th grade students (n = 306, 216, and 262, respectively) who visited the museum in classroom groups to tour a new exhibit entitled "Living Land-Living Sea." A random sample of eight classroom groups (n = 194) received "unguided tours," defined as, "...one which was not guided by any staff or docents of the museum but was organized by the regular classroom teachers of the students." (p. 284). Twenty-three groups (n = 622) had "guided tours," "...one that was guided by a docent following the goals and procedures clearly defined in the six-page booklet, Coast and Sea: Teacher's Guide, produced by the Education and Extension Division of the British Columbia Provincial Museum." (p.284). The children were placed in groups of nine for the guided tours. The staff of the museum observed that classroom teachers leading unguided tours tended to allow the exhibits' media to do most of the teaching. The docents who lead the guided tours followed highly organized lesson plans which focused students' attention on concepts and details.

A posttest-only control group design was used to collect data on research question 1. Data were collected on research question 2 using a pretest-posttest control group design. The museum staff composed and validated a 10-item multiple choice exam based upon the cognitive goals of the exhibit. A KR-20 reliability of 0.581 was calculated with the data collected from the 816 students. A 10-item questionnaire which employed a "semantic differential" (SD) format with a five point smiling/frowning face scale, was constructed and validated by the same staff members. A pretour-to-posttour (test-retest) comparison yielded "...a Pearson Moment correlation of 99.6 (sic)." (p. 288). The questionnaire also contained three items on the students' preference for tour organization.

Findings

In t-test comparisons made for research question 1, the students on the structured tour were found to be superior in achievement, on total exam score ($p < 0.001$) and on eight of its ten items (one at $p < 0.005$, seven at $p < 0.001$). The mean total exam score for the guided tour groups was 5.18, while that for the unguided groups was 3.65 (maximum possible score = 10).

The t-test analyses completed for research question 2 showed the students in the unguided tours had more positive attitudes toward the museum on three of the 10 SD items ($p < 0.05$) prior to the tours. After the tour, the differences on these three items increased ($p < 0.001$), plus five additional items showed differences ($p < 0.05$) in favor of the unguided tour group.

On the three additional questionnaire items a high percentage of the students signified: 1) the Natural History Gallery reminded them of the outdoors (69.1%), 2) they preferred to teach themselves in the museum (23.6%), second to receiving a guided tour from a docent (50.4%), and 3) they wanted to see more of the museum (55.2%), or touch and feel more things (27.8%). The majority of the students in the respective guided and unguided tour groups signified that they would select that type of tour again.

Interpretations

"This study provides evidence that more structured tours at the British Columbia Provincial Museum produce greater cognitive learning while less structured tours produce more positive attitudes." It was concluded, "...that the more structured tour at the British Columbia Provincial Museum did not increase the students' positive attitudes toward the museum." (p. 289). This conclusion was used 1) to explain why at least one prior study did not find differences in attitudes between students on a field trip and those in a classroom, 2) to suggest further study of the effects of field trip and museum visits take into consideration the degree of structure of the activities, and 3) to support an assumption held by many teachers that field trip and museum visits can improve motivation.

ABSTRACTOR'S ANALYSIS

Non-formal educational settings, for example, museums, outdoor centers, and zoos, have the potential to make significant contribution to the science education of students and adults. Experiences gained through non-formal settings can supplement science instruction students receive in school, and can provide continuing education in science and technology for individuals once they are out of school. A number of non-formal educational settings offer teacher development activities. As the influence of science and technology upon our society grows, non-formal settings will become increasingly important sources of science education. Thus, research on the effectiveness of non-formal science education experiences, such as the study by Stronck (1983), is most timely.

While the subject of Stronck's research lends significance to the study, there are a number of questions which arise in the mind of a reader (the abstractor for one) which distract from the quality of the article and therefore cast suspicion upon the validity of the study, irrespective of the findings. The most prominent of these questions are:

1. Was it meaningful to compare guided tour groups containing nine children to unguided classroom size tour groups which probably contained 25 or more students?
2. What was the exact nature of the treatments--the guided and unguided tours--beyond the definitions presented in the text?
3. Should the museum staff have presumed that the prescribed goals of the guided tour could be achieved because the docent instructed a maximum of nine children?

4. Was it appropriate to include the three additional items on the three posttour questionnaires which assessed student's preferences for museum tour organizations when the children did not experience both organizations?
5. Were the 10 posttour questionnaire items of semantic differential or Likert type, and were they construct valid?
6. What level of cognitive understanding did the children have on the display-related concept prior to the tours?
7. Was the unit of statistical analysis individual students or groups of students, and were one or two-tailed t-tests used?
8. What degree of variance existed in the way the teachers operated the unguided tours?
9. Is it appropriate to compare the degrees of change which occurred in the children's attitudes toward the museum and their motivation for learning science, as is apparently done in the second sentence of the last paragraph of the article?

Some of these questions are related to the design of the research. It may or may not have been within the researcher's (Stronck's) control to make the design modifications which would eliminate them. Other questions appear to the abstractor to arise as a result of a lack of clarity in the writing. The abstractor is sympathetic to the problems associated with lucidly communicating an account of an involved study with the few pages allotted by journals. Still, researchers need to anticipate readers' perspectives as manuscripts are prepared.

Hamilton, Marlene A. "Jamaican Students' Attitude to Science as it Relates to Achievement in External Examinations." Science Education, 66 (2): 155-169, 1982.

Descriptors--*Achievement; Affective Objectives; Attitudes; Developing Nations; *Educational Research; *Evaluation; Science Curriculum; Science Education; Secondary Education; *Secondary School Science; *Student Attitudes

Expanded abstract and analysis prepared especially for I.S.E. by Ronald D. Simpson, The University of Georgia.

Purpose

There is concern in Jamaica over the paucity of personnel required for technological development and advancement. There also is concern over the number of failures in science as measured by scores on the British-based external examinations. A compounding problem is that significantly fewer girls than boys pass the external examinations in science. This research study was designed to examine attitudes of fifth form (grade 11) and upper sixth form (grade 13) students toward science and to investigate the relationship between these attitudes and student achievement on science examinations.

Rationale

The investigator cites the fact that most of the contemporary science curricula in Jamaica place emphasis on selected affective outcomes. The measurement of attitudes has assumed a prominent role in the newly introduced external examination in integrated sciences of the Caribbean Examinations Council. It is agreed that positive attitudes toward the sciences are an accepted educational objective in this country.

As background information the author cites the following literature as being relevant to her study:

"Arvidson (1956), for example, is of the opinion that a better attitude toward school is associated with higher marks because the attitude conditions other factors (home environment, teacher influence, and the like) which determine the student's achievement level. Cronbach (1977) points out that interest patterns have as much to do with persistence and success in a line of studies as abilities do, suggesting that teachers ought therefore to monitor attitudes directly related to the school subjects they teach. Aiken (1970), surveying attitudes to mathematics, found that a high proportion of teachers held negative attitudes toward this subject, and that this situation was likely to be reflected both in the attitudes and achievement of their students. Lindgren (1976) also supports this view by stressing the importance of students' holding favorable attitudes toward teachers, toward school, toward other students, and toward themselves, if learning experiences are to be successful."

"Bruner (1960) has pointed to the importance of students' learning certain general attitudes toward science and literature which can serve as bases for developing an understanding of concepts; while Carey's (1958) research on problem-solving skills of female college students allowed her to conclude that the difficulties women experience in this area are probably due to culturally determined attitudes, and not to any lack of ability."

The rationale behind this study, then, is one of investigating in an exploratory manner broad relationships between student attitudes toward and achievement in science.

Research Design and Procedures

Within the research procedures section of this report the investigator discusses the two major variables and describes the sample. The Science Attitude Inventory by Sutman and Moore (1970) was used to determine students' attitudes. This 60 item Likert-type scale possesses both intellectual and emotional dimensions.

The General Certificate of Education "Ordinary" and "Advanced" level science examinations were used to ascertain science achievement. The quality of a student's performance on the "Ordinary" examination determines whether the individual leaves school (and the type of job likely obtained) or advances to the sixth form. The "Advanced" level examination is given two years after the "Ordinary." The author acknowledges that there are shortcomings in employing external examinations as the major criterion for measuring academic success. Validity and reliability measures for the external examinations have, however, been high.

Data were initially collected from 576 students in the fifth form of seven high schools in Jamaica. An effort was made to include students in different types of schools--single sex, coeducational, rural, urban, small and large. The author states that "...The sample of 248 boys and 328 girls represents approximately one-third of the fifth form students taking the 'Ordinary' level examinations for the first time in 1975. These students were asked to complete the science attitude scale, and the 'Ordinary' level achievement index in the sciences was determined when these results became available. In the second instance, all those who entered sixth form to study sciences were identified, and their achievement in the 'Advanced' level science examinations, 1977, recorded. These 82 students (56 boys and 26 girls) represent 14.2 percent of the fifth form sample, and 58.6 percent of the 140 students who did proceed to sixth form after the "Ordinary" level examinations of 1975."

Findings

The results section of this research report presented data in three sections: Ordinary Level Data, Advanced Level Data, and Across-Group Comparisons. A summary of these data are presented by the author as follows:

1. At fifth form, girls entered for, and passed, significantly fewer science subjects than boys, and, in addition, their index of "Ordinary" level science achievement was significantly lower. However, in terms of science attitude, there was no significant difference between the sexes.

2. For both sexes, there was a significant relationship between "Ordinary" level science achievement and science attitude. ($p < 0.01$).

3. For those fifth formers classified as high science achievers (this group being composed of a higher percentage of boys than girls), there was no significant difference between the sexes on either the science attitude or achievement measures. Attitude and achievement correlated significantly for high achieving girls, but not for their male counterparts.

4. At sixth form, fewer girls opted for the sciences, but, unexpectedly, of those who did, there were more selecting the physical sciences, although their performance was better in the biological sciences. Overall performance of the boys was stronger than that of the girls, and a larger percent gained two or more "Advanced" level passes, thus securing university entrance.

5. Looking at the two sixth form groups, it is observed that the "university" science students (both boys and girls) gained higher scores in attitude and achievement measures than their "nonuniversity" counterparts. These differences were not significant in the case of science attitude.

6. Across-group comparisons pointed to better "Ordinary" level performance and science attitude for both boys of Group 4 ("university" science students) over the other three groups. There were several instances of significant differences in favor of this group based on their "Ordinary" level data; and, of particular importance was the significantly higher attitude score gained by Group 4 girls over their counterparts in Group 1.

Interpretations

Findings from this study add strength to previous notions that gender differences are closely related to performance in science. The author has inferred that girls holding more favorable attitudes toward science are more likely to achieve at a higher level. Given this, the author goes on to suggest that attitude may play a more vital role in science achievement where girls are concerned. The author also cites other studies that support this conslusion, in^luding the fact that British studies have linked favorable science attitudes with intellect. Another recurring theme throughout much of the literature is the importance of societal expectations with common "male" and "female" images that operate to discourage girls from pursuing "masculine" fields such as the sciences. The author refers to conclusions by Hamilton and Leo-Rhynie (1980, p 55) by citing:

"It is not sufficient to make equal educational provisions for students of different sexes: a change is needed in the attitudes and prejudices which have persisted through many generations, and which many people hold without being fully aware of them... Girls must be encouraged at home and school to develop a sense of responsibility and independence, to think analytically, and to question issues rather than to accept passively: in this way they can develop the interest, competence, and confidence to be successful in careers which have traditionally been closed to them."

The author concludes her paper by suggesting the following:

"Elimination of these prejudices, coupled with the inculcation of favorable attitudes--including favorable attitudes toward the sciences--cannot be left to chance, especially in view of the fact that Jamaica urgently needs skilled scientific and technical personnel of both sexes. I .s important that role models for science achievement be made available to girls, and for them, like boys, to be encouraged to participate in the analytic, scientific domain. Schools, through their teachers and guidance counsellors, should promote careers in science and technology as desirable fields for both sexes, and so attempt to broaden their students' interests, while building favorable attitudes.

The home environment is also of great importance in the global sphere of socialization, as well as in the more specific task of fostering favorable attitudes toward science. Laughton and Wilkinson's (op.cit.) research findings underscore the contribution of home environment variables to the development of favorable science attitudes, especially so for girls, who require much greater encouragement and support than boys. Research mounted by Leo-Rhynie (1978) on a sample of Jamaican sixth formers, has provided results allowing for similar conclusions to be drawn--namely, that girls (especially high achievers) need the support of their parents and the encouragement of teachers; whereas boys do not require this bolstering.

"The advancement of science and technology has also been put forward as an important goal of national development: This in itself, presents a strong case for stringent measures to be taken in an effort to improve high school students' grasp of the sciences. Also, although, as Ormerod (1973) points out, relation does not necessarily imply causation, the link between attitude to and achievement in the sciences is sufficiently clear, especially for girls, to merit the attention and action of local educators."

ABSTRACTOR'S ANALYSIS

This investigation addresses one of the most important topics in science education: the fact that differential attitudes toward and achievement in science exist between boys and girls in most cultures, and that much of this may be due to differences in societal expectations. What this study has illuminated in a unique way is the fact that attitude and achievement may be more intricately interwoven in girls. If this is true, then a significant insight has been advanced: fostering positive attitudes toward science among girls is extremely important. In my opinion this study advances the importance of attitude and achievement within the matrix of other studies. The most novel contribution, however, appears to be the notion that the attitude-achievement connection with respect to science education is more developed and probably more important in females. For girls in the Ordinary level a coefficient of correlation between attitude toward science and achievement in science was found to be .38. For boys it was .20. Upon squaring the correlation to ascertain the sense of shared variance, one can quickly see that this estimate is nearly four times greater for girls. Again, I see this as a major contribution of this study.

I found this study easy to read and the data reported to be complete. While the description of the sample and the selection procedure was terse, the results cited were adequate. The author also did an excellent job in relating the findings of this study to the findings of other international reports. The author provides a clear focus on intervention strategies that need to be considered both in school and in the home. For me, the report was a good blend of theory, data analysis, and implications for practice

The only query I would interject in my analysis is the idea of what constitutes "attitude toward science" and "science attitude." The two terms were used interchangeably in this report and this variable was measured by the well-known and widely used Science Attitude Inventory by Sutman and Moore. Many items in this instrument address "science attitudes" which I take to represent, at least in part, values and beliefs embodying the nature of the scientific enterprise. In essence, part of what this construct is comprised of is cognitive in nature. Conventionally, "science attitude" or "scientific attitude" has come to mean an acceptance and understanding of how science operates and its relationship in a more abstract way to society. In contrast, "attitude toward science" represents how people <u>feel</u> toward science, how much they like it, their interest in doing science-related activities, and to some extent their motivation to achieve in science. Another facet of "attitude toward science," one borne out by my own research, pertains to self-concept. Students who view themselves as "good" science students and as being capable of being successful in science are often those who are most positive toward this school subject and are those who do the best. My concern, therefore, is one of needing to be more specific in defining important terms that relate to the affective domain. If one is focusing on important <u>feelings</u>, in this case how girls feel about science and themselves as science students, the Sutman and Moore instrument may not represent the most appropriate manner in which to measure attitude. Attitude research is still an emerging area in science education and as more investigators work in this field the more clarity we will develop with respect to our vocabulary and definitions.

This study brings to our body of knowledge additional support for the fact that attitudes do relate to achievement and that these relationships may be mediated in a significant fashion by gender. The author also discusses important interventions and strategies that need to be used in schools and homes to optimize the potential of girls' opportunities in science. It is hoped that other valuable studies of this kind will ensue as science education commuinity seeks to fuse more coherently the enterprise of science with modern society.

REFERENCES

Aiken, L. R. "Attitudes Toward Mathematics." Review of Educational Research, 40: 551-596, 1970.

Arvidson, G. L. "Some Factors Influencing the Achievement of First Year Secondary Modern School Children." Unpublished doctoral dissertation, University of London, 1956.

Bruner, J. S. The Process of Education. Cambridge: Harvard University Press, 1960.

Carey, G. L. "Sex Differences in Problem-Solving Performance as a Function of Attitude Differences." Journal of Abnormal Social Psychology, 56: 250-256, 1985.

Cronbach, L. J. Educational Psychology (3rd ed.). New York: Harcourt Brace Jovanovich, 1977.

Laughton, W. H. and W. J. Wilkinson. "A Study of Some Pupil, Home and School Variables Associated with Attitudes to Science." The Durham Review, VI(3): Spring, 748-751, 1973.

Leo-Rhynie, E. A. "An Investigation into the Relationship of Certain Cognitive, Environmental, Experiential and Motivational Variables to the Academic Achievement of Selected Sixth Form Students." Unpublished Ph.D. thesis, University of the West Indies, 1978.

Lindgren, H. C. Educational Psychology in the Classroom (5th ed.). New York: Wiley, 1976.

Ormerod, M. B. "The Social Implications Factor in Attitudes to Science." British Journal of Educational Psychology, 41: Part 3, 335-338, November, 1971.

Ormerod, M. B. "Social and Subject Factors in Attitudes to Science." School Science Review, 54 (5): 645-660, 1973.

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

IN RESPONSE TO THE ANALYSIS OF

Hamilton, Marlene A. "Jamaican Students' Attitude to Science as it Relates to Achievement in External Examinations." by Ronald D. Simpson. Investigations in Science Education 12 (1): 44-57, 1986.

Marlene A. Hamilton
The University of the West Indies

The main thrust of Simpson's insightful critique addresses the distinction between "science attitudes," which he defines as "an acceptance and understanding of how science operates and its relationship in a more abstract way to society" and "attitude to science" - how people feel toward science. There are others, such as Hughes (1971)[1] however, who employ the label "scientific/science attitudes" as an all-embracing term encompassing both sides of the coin. Klopfer's (1971) scheme similarly addresses both the cognitive and affective domains, while Ormerod (1971, 1973), through his social (SOCATT) and subject (SUBATT) attitudinal sub-scales, has likewise recognized the importance of the two. It is not surprising, however, that Gauld and Hukins, in their highly acclaimed review of scientific attitudes, have pointed out that: "One of the problems which faces a reviewer in such an area as this is the lack of agreement about the meanings to be attributed to the various terms that are used" (1980: 129).

At the time when the present author was conceptualizing her research, she took the arbitrary decision to adopt the broader definition, such as proposed by Hughes. To this end, the Moore and Sutman (1970) scale, probing both intellectual and emotional dimensions, was employed, and the terms, "science attitude" and "attitude to science" were thus used interchangeably throughout the paper.

Simpson's point concerning the need to focus more sharply on students' (especially girls') "feelings" about science is well taken; and it is also recognized that the Moore and Sutman scale is not the most appropriate measure of this aspect. In fact, the present author's

[1]Hughes' stand is reflected in Gauld and Hukins' (1980) review of science attitudes appearing in Studies in Science Education, 7, 129-161.

subsequent work in this area has been concerned with the development of a science attitude scale for Jamaican adolescents, specifically encompassing six dimensions (including a strong "feelings" component), namely:

- Enjoyment of, and interest in science learning experiences in class
- Enjoyment of, and interest in science learning experiences outside of lessons
- Interest in pursuing a career in science
- Adoption of a critical attitude to science, rather than one of passive acceptance
- The social implications of science (its importance in everyday life)
- The social prestige of science (views regarding the prestige value attached to scientific work, especially as a masculine-oriented field). (Hamilton, 1983)

Factor analysis, coupled with internal consistency methods of item-analysis, pointed to the existence of a strong general factor, composed of 36 items ($r = .907$), representative of the first five dimensions listed above. (The sixth is currently being studied on its own, and has so far indicated marked differences between boys' and girls' opinions of the social prestige attached to scientific work). The unidimensional scale has likewise discriminated sharply between boys' and girls' attitude to science/science attitudes ($t = 4.094$; $p = .001$), and is being used in a replication of he original study reviewed by Simpson.

REFERENCES

Gauld, C. F. and A. A. Hukins. "Scientific Attitudes: A Review." Studies in Science Education, 7: 129-161, 1980.

Hamilton, M. A. "Preliminary Work on the Development of a Science Attitude Scale for Jamaican High School Students." Caribbean Journal of Education, 10 (1): 18-32, 1983.

Klopfer, L. E. "Evaluation of Learning in Science." In B. S. Bloom, J. T. Hastings and G. F. Madaus (eds.) Handbook on Formative and Summative Evaluation of Student Learning. New York: McGraw-Hill, 1971.

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

Ormerod, M. B. "The 'Social Implications' Factor in Attitude to Science." British Journal of Educational Psychology, 41 (3): 335-338, 1971.

Ormerod, M. B. "School and Subject Factors in Attitudes to Science." School Science Review, 54: 645-659, 1973.

MISCELLANEOUS STUDIES

Helms, Susan J. S. and Earl J. Montague. "A Study of College Nonscience Majors' Expectations of the Scientific Enterprise." Journal of Research in Science Teaching, 17 (6): 553-558, 1980.
Descriptors--Chemistry; *College Science; Higher Education; Science Education; *Scientific Enterprise; *Student Attitudes

Expanded abstract and analysis prepared especially for I.S.E. by Patricia H. Suter, Del Mar College.

Purpose

The purpose of the study (which involved some 1,014 students in 24 chemistry courses) was to ascertain factors which contributed to nonscience majors' expectations of scientific enterprise.

Rationale

Realistic expectations of the scientific enterprise can be seen to have importance in three contexts. First, the educated citizen is required to make decisions that involve an understanding of what to expect from the scientific enterprise. Second, the support of the scientific enterprise depends, in a democrati society, on what society expects from it. In this context, excessive expectations might seem to be beneficial to the scientific community, but research on the effects of disconfirmed expectations indicates that negative attitudes and much lowered evaluations may result from inflated expectations. Finally, in a rapidly changing society, the citizenry need to develop skills for coping with change.

The development of realistic expectations of the scientific enterprise was viewed in this study as an application or transfer of various components of scientific literacy to a consideration of future events.

Research Design and Procedures

The authors used four principles of learning transfer fundamentals as a basis for the identification of possible nonacademic background factors which might relate to the students' expectation of the scientific enterprise. The principles used were:

1) A concept must be understood to be available for transfer.
2) Analogies, concrete referents, or cognitive structures are helpful in the understanding of abstract concepts.
3) Practice in the transfer must be recognized by the learner.
4) Opportunities for transfer must be recognized by the learner.

These principles were then used as a basis for the identification of possible nonacademic background factors, academic background factors, and components of courses which might relate to the students' expectation of the scientific enterprise. The following factors were identified:

1) Nonacademic factors
   a) Students' gender
   b) Frequency of nonscientific reading, nonfiction TV viewing, science fiction reading.
2) Academic background factors.
   a) Students' academic classifications
   b) Percent of students' previous science course time spent learning facts, principles, history, methods, techniques, practical problems.
   c) Cumulative grade-points in both high school and college science courses.
3) Current chemistry course factors.
   a) Percent class time spent on developing basic principles, studying scientific methodology, performing numerical calculations, historical development.

A 30-item, Likert-type, multiple response instrument was developed to assess the realistic-unrealistic dimension of college nonscience majors' expectations of the scientific enterprise. The response choices were from "strongly agree" to "strongly disagree." The respondent was asked to indicate his relative agreement to such statements as the following:

In the future I expect that:

> Conservation of scarce materials will not be necessary because scientists will discover good substitutes before existing supplies run out.
>
> Scientific research will lead to the solution of social problems such as poverty and race relations.

The sample was 1,014 students enrolled in 24 chemistry classes for nonscience majors in 19 colleges and universities, mostly within the state of Texas. The students were given the Expectations of Scientific Enterprise (ESE) and a 19-item questionnaire dealing with the factors listed above. The instructors were asked to complete a survey form covering the nature of content emphases, teaching methodologies, and laboratory work involved.

Findings

Correlation coefficients were calculated between student-reported background factors and students' scores on the Expectations of Scientific Enterprise (ESE) instrument. There are statistically positive correlations between the ESE scores of individuals and the frequency of viewing nonfiction, science related TV programming, as well as ESE scores and the frequency of reading nonfiction, science-related material. There is a statistically significant negative correlation between the frequency of reading science fiction and the ESE scores of individuals.

Interpretations

The conclusions from this study are based on a correlational study, so no cause-and-effect relationships have been established. The authors suggest that perhaps the first component for transfer of learning may be lacking in nonscience majors, an understanding of concepts, and that courses designed for these students might emphasize basic scientific concepts and principles if realistic expectations of the scientific enterprise are to be promoted.

ABSTRACTOR'S ANALYSIS

The authors of this paper reported on an extensive study of 1,014 students and their prior exposure to science as this experience related to their expectations of the scientific enterprise. They conclude from their study that there were positive correlations with realistic expectations and the frequency of viewing nonfiction, science-related TV programming and similar reading material. There was a statistically negative correlation between the frequency of reading science fiction and realistic expectations. They also found negative correlations with the exposure to prior courses in the history of science, scientific methodology, and practical applications of science in society.

We are all in the business of improving science instruction. Most of us believe that improvement is most likely to come when we carefully scrutinize what we are doing and modify our procedures when there is sufficient evidence to warrant change. This study indicates that courses designed for nonscience majors would better serve the cause of producing adults who have a more realistic view of what is possible in scientific endeavors if these courses emphasized facts and principles rather than societal or practical aspects.

It is not clear to me exactly how the authors conducted their study. The 30-item, Likert, multiple response instrument which was used was not described in sufficient detail for this reviewer to comment on. In fact, I had to consult the reference librarians to learn just what this type of test consisted of. The authors also state that "the content validity of the Expectations of the Scientific Enterprise (ESE) instrument was established by panel review of the items." It would have been helpful if examples of this instrument were included in the article so that the reader would be able to judge this content validity.

The authors conclude that courses for nonscience majors may need to place emphasis on basic scientific concepts and principles if realistic expectations of the scientific enterprise are to be promoted. Their data certainly indicate this.

Vockell, Edward L. and Susan Lobonc. "Sex Role Stereotyping by High School Females in Science." Journal of Research in Science Teaching, 18 (3): 209-219, 1981

Descriptors--*Biological Sciences; *Coeducation; *Females; High School Students; *Physical Sciences; Questionnaires; Science Education; Secondary Education; *Secondary School Science; Sex Differences; *Sex Stereotypes

Expanded abstract and analysis prepared especially for I.S.E. by Claire A. Baker, Debra Swing and Zexia K. Barnes, Purdue University.

Purpose

According to Vockell and Lobonc, "the American labor force is still divided into many fields considered primarily 'male' and others considered 'female'. One of the career fields in which women have been largely underrepresented is the scientific profession" (p. 209). The purpose of this study was to examine the perceptions that high school science students have of certain science fields as either masculine or feminine. Specifically, the study addressed two questions:

1. Is physical science perceived as more masculine than biological science by high school juniors and seniors?
2. Does coeducation influence this perception?

Rationale

Vockell and Lobonc stated that science was considered a masculine career field by students, and that this perception was perpetuated in the school system. The authors cited studies (Looft, Siegel, Slocum and Bowles) which showed that sex-stereotyping of careers and occupations begins at an early age; however, there were no apparent differences in achievement in school subjects related to scientific fields in the early grades (Hilton and Berlung). The study analyzed any differences in the sex-stereotyping of physical and biological sciences. The authors suggested that girls did not reject science as a whole, but rather that they rejected physical science in particular because of its perception as more masculine (Fox and Denham, Hanson and Neujahr, Koelsche).

According to Janda, O'Grady and Capps (1978), male dominance of a profession contributed to the "fear of success" image developed among women. Vockell and Lobonc concluded that male domination in secondary science lassrooms leads to a similar effect. With this premise in mind, the authors examined the effects of coeducation on sex-stereotyping of career fields by the girls in coed and non-coed schools.

Research Design and Procedures

The study used a form of survey research. The subjects in the study consisted of 280 girls and 329 boys from coeducational public high schools and 476 girls from single-sex Catholic schools in the Chicago area. All students were juniors or seniors. A modified version of a questionnarie given to college students in a Carnegie Commission (1974) study was administered to the high school students. The survey contained 45 career fields which students were asked to rank as masculine or feminine. The ranking was done on a seven point scale with one as most masculine and seven as most feminine. Only eight of the career fields on the earlier survey were analyzed in this study. Four of the fields, chemistry, biochemistry, geology and physics were considered physical sciences; and four, zoology, botany, bacteriology and physiology were considered biological sciences.

The design of the study was a 2x2 factorial. The independent variable was type of school with two levels, coeducational and non-coeducational. The dependent variable was sex-role in career fields in biological and physical sciences. In the process of analyzing the data, three covariates were included. They were level of parental education, level of educational aspiration of the students, and sex of the physical science teacher.

The Chi-square test was used to compare the level of parental education with student aspirations for subjects attending both coed and non-coed schools. Analysis of variance was used to examine the interaction of education levels with types of school, for analysis of ratings of the career fields by girls in both types of schools, and the interaction of type of school and career field. The last analysis was done using the split-plot, repeated measures approach with type of science as the repeated measure.

Findings

The Chi-square results indicated that girls attending coed and non-coed schools held similar educational aspirations, but the two samples were significantly different with respect to level of parental education. This finding was attributed to demographic differences between families who send children to private schools and those who use public education. A factorial analysis of variance, however, failed to reveal any significant interaction between the educational variables and the ratings of the career fields at the .01 level.

The t-test was used to test the means of the ratings for physical science and biological science by coed and non-coed girls and by coed boys. The total rating for the two types of science by the entire group of subjects was also given. In all cases there was a significant difference at the .001 level, showing that physical science was perceived as more masculine than biological science. This is the only analysis of data which included the sample of boys.

The rating of the two types of science by girls in coed and single-sex schools was subjected to an analysis of variance. The results showed that girls in coeducational schools viewed physical science as more masculine than did girls in single-sex schools ($p = .02$). However, there were no differences in the perceptions of biological sciences by both samples. The split-plot, repeated measures analysis of variance showed significance for the interaction of type of school with type of science at the .07 level.

The effect of the physical science teacher as a role model was analyzed by comparing the survey ratings of physical science careers by female students in the two types of schools. Two of the non-coed schools had only female physical science teachers, while three of the coed schools had only male teachers. Three schools in the study had both male and female physical science teachers. If the teacher as a role model affected students' views of physical sciences, it was expected that students in classes with female teachers would demonstrate less sex-role stereotyping of physical sciences compared to those with male teachers. However, that pattern was not revealed.

Interpretations

The analysis of the data supported the following findings:

1. Physical sciences were viewed as more masculine than were biological sciences by all subjects in the study;
2. Girls attending coed and non-coed schools ranked biological science as a more feminine discipline;
3. Girls in single-sex schools viewed physical sciences as less masculine than did girls in coed schools.

None of the covariates or interactions included in the analysis was significant. The authors concluded that since the sex of the teacher and the educational level of the parents had no effect on the perception of the sex orientation of the sciences by girls, the presence or absence of boys in their school was the variable which was responsible for the difference in ranking physical sciences and biological sciences along a feminine/masculine scale.

ABSTRACTOR'S ANALYSIS

The rationale for parts of the study is well defined in the introduction. The fact that sex-stereotyping of careers and occupations is a real phenomenon that appears at an early age and that it is reinforced by schools is supported by several studies. The differences in performance by male students and female students in secondary math and science classes is documented. The authors use the literature to develop a case for the role of competition between male and female students as a major contributor to the rejection of physical science as a career by girls. Other studies place some doubt on this conclusion. Kahle and Lakes (1983) and Kahle, Matyas and Cho (1985) report that the source of girls' lack of interest in science lies in the difference in experience with science in early grades. Boys have greater exposure to science-related activities than girls have in elementary school. There is an implication that the competition variable is the same as the coeducation variable. This equivalence was not justified, since no measures of the competition variable were made. There is no mention in the review of the literature of the teacher as a role model and the effect that this has on students' perceptions of the teacher's subject area.

There were several problems with the research design. The sample consisted of high school juniors and seniors in coed and non-coed schools. All of the coed students came from public schools, while all of the non-coed students were girls from Catholic schools. The authors assessed any differences in the two types of schools by comparing educational level of parents. However, other demographic factors which might have been important were not mentioned. The authors seemed to assume that, since all of the schools in the study were in the same geographical area, demographics such as socio-economic status and ethnicity were equalized among groups of students.

All subjects in the study had taken biology, but physical science was an elective. It is not clear in the paper which, if any, of the students had taken physical science and what courses they had taken.

Exposure to the content of a science may have a bearing on the students' understanding of the day-to-day activities of a chemist or physiologist. No evidence is given in the paper that the authors measured the students' understanding of any of the 45 terms used to represent the career fields.

The source of the survey was the Carnegie Commission. This study used only part of the questionnaire and administered it to a different sample than the one used in the Carnegie study. The sample in the Carnegie study was made up of college students. These factors may account for the failure to report reliability or validity for the instrument.

The statistical analysis of the data appears to be complete. Careful study of the presentation of the analyses reveals lack of clarity in several instances. The format of presentation of ANOVA tables is inconsistent. The tables of interaction of educational level with coeducation, and sex of the teacher and ratings of girls from both types of school present only F ratios and probabilities. The tables of ratings of types of science by both groups of girls and the split-plot, repeated measures present a complete ANOVA table. The form of presentation seems to be related to the relative importance of the analysis to the research questions. The concern is not the lack of information, although complete information is convenient to have; rather, it is over the derivation of the results presented in the tables. In the split-plot repeated measures table, the information given contains an error which is probably a typographical error. The number 315.48 should be 351.77. Identification of this error made us examine more closely the other tables. In the table of the career field ratings by girls from coed and single-sex schools, the F ratios have different denominators, indicating they were derived from different analyses. This table is critical to the conclusions of the study so the inconsistency raises serious questions in the minds of these reviewers as to the quality of the other statistics presented.

The reviewed research indicates a need for further study into the source of sex-stereotyping in science. It would be interesting to repeat this study with an instrument designed to assess the competition variable directly, as well as the sex-role perception, and with an improved design in which both coed and non-coed samples were private school students. A sample of this type would limit generalizability but would lessen demographic contamination. This approach could shed light on the role of competition by comparing groups of more homogeneous students.

REFERENCES

Carnegie Commission on Higher Education. Escape from the Doll's House: Women in Graduate and Professional School. New York: McGraw-Hill, 1974.

Fox, L. H. and S. A. Denham. "Value and Career Interest of Mathematically and Scientifically Inclined Youth." J. C. Stanley, D. P. Keating and L. H. Fox (eds), Mathematical Talent: Discovery, Description, and Development. Baltimore: The John Hopkins University Press, 1974.

Hanson, R. and J. Neujahr. "Career Development of Males and Females Gifted in Science." Journal of Educational Research, 68: 43-45, 1974.

Hilton, T. L. and G. W. Berlung. "Sex Differences in Mathematics Achievement-A Longitudinal Study." Journal of Educational Research, 67: 231-237, 1974.

Janda, L. H., K. E. O'Grady, and C. F. Capps. "Fear of Success in Males and Females in Sex-linked Occupations." Sex Roles, 4: 43-50, 1975.

Kahle, J. B. and M. K. Lakes. "The Myth of Equality in Science Classrooms." Journal of Research in Science Teaching, 20: 131-140, 1983.

Kahle, J. B., M. L. Matyas, and H. Cho. "An Assessment of the Impact of Science Experiences on the Career Choices of Male and Female Biology Students." Journal of Research in Science Teaching, 22: 385-394, 1985.

Koelsche, C. L. "Characteristics of Potential Scientists." Science Education, 49: 72-79, 1965.

Looft, W R. "Vocational Aspirations of Second Graders." Psychological Reports, 23: 241-242, 1971.

Siegel, C. L. "Sex Differences in the Occupational Choices of Second Graders." Journal of Vocational Behavior, 3: 15-19, 1973.

Slocum, W. L. and R. T. Bowles. "Attractiveness of Occupations to High School Students." Personnel and Guidance Journal, 46: 754-761, 1968.

Sneider, Cary and Steven Pulos. "Children's Cosmographies: Understanding the Earth's Shape and Gravity." Science Education, 67 (2): 205-221, 1983.

Descriptors--Comprehension; *Concept Formation; *Earth Science; Elementary Secondary Education; *Elementary School Science; *Gravity Physics; *Individual Differences; Learning Theories; Science Education; *Scientific Concepts; Secondary School Science; Student Characteristics

Expanded abstract and analysis prepared especially for I.S.E. by Charles R. Ault, Jr., Indiana University.

Purpose

Sneider and Pulos approached a fundamental issue in elementary science teaching with four questions. The issue is the level of detail and degree of abstraction appropriate for different age groups of children who are learning about the Earth in space. The four questions addressed in this study were:

1. Does Nussbaum's (1979) five stage developmental model of the "Earth Concept" adequately describe concepts held by California schoolchildren in grades 3 through 8?
2. What is the distribution of the notions held by these children?
3. How do the distributions of Earth Concept notions compare across several studies using the Nussbaum model?
4. What role do individual differences play in grasping spherical Earth and center-directed Gravity concepts?

In addition, the authors sought to refine the predictive validity of the Nussbaum scheme. Their study also included comment on the Mali and Howe (1979) claim that cultural differences account for significant amounts of the variation in Earth Concept understanding.

Rationale

The Earth Concept -- up and down on a sphere -- is elementary in the sense of being a fundamental notion in modern science. Understanding day and night, location on Earth, falling objects and satellite motion all require a mental model of the Earth as a sphere, inhabited in nearly all parts, with gravitational force directed against the surface and towards the center everywhere. An extension of this idea is that space has no absolute up and down, only the relative directions of away and toward.

The rationale for the study of the Earth Concept is strong. Its teaching raises very basic questions about science learning by children. The cross-cultural and cross-age replications of interview studies utilizing the Nussbaum scheme make this a very fruitful domain of inquiry. The application of the Earth Concept to children's experiences also reveals aspects of development explained by Piagetian theory (1956/48) interacting with culturally transmitted information.

Research Design and Procedure

Sneider and Pulos split the Earth Concept into two parts, the spherical shape of the Earth and the center-directed force of Gravity. They modified the Nussbaum interview into a "structured interview" with six questions, some of which utilized props and drawings. Three questions focused on the shape of the Earth; three others, on Gravity. Shape questions included asking children to draw themselves on the ground and then the Earth, sun, moon, and stars in space. Children commented on the differences between the two drawings.

The Gravity questions utilized an Earth globe and styrofoam balls. Children drew the paths of falling objects dropped from different locations on the globe. The foam ball had tunnels drilled through them. In the "dropthrough" question children could indicate what would happen to a ball falling into the Earth unimpeded. In the "tunnels" question, responses indicated whether an object dropped at the equator would fall to the center of the Earth or angle towards the south pole at the bottom of the drawing. In all three Gravity questions children had to free their thinking from the distracting cue of the bottom of the paper or down as towards the floor in the room. In effect, they had to understand that the props and drawings modeled the Earth and hence required them to reason about falling objects using the center of the model or drawing as a reference object. The implicit assumption is that this ability to decenter and reason correctly using representations equals understanding of the Earth Concept.

The study sample was composed of 30 third graders, 25 fourth graders, 25 fifth graders, 25 sixth graders, 26 seventh graders and 28 eighth graders. Usable data came from 144 subjects. Test and interview data were gathered one time only. No test of instruction was intended.

In addition to interview data (obtained and scored by different individuals), Sneider and Pulos administered several tests to explore the contribution of individual differences to Earth Concept attainment (research question number 4). They depended heavily upon the work of Hildebrand, Laing and Rosenthal (1977) in their analysis of the predictive validity of the Nussbaum scheme and its refinement to include an additional, middle level notion. A Chi-square test applied to a frequency table formed the basis of verifying the relationship between the Earth's Shape Scale and the Gravity Scale. Trends on a frequency profile for the California study and five other studies revealed strong age dependency yet great spread in concept attainment for 741 subjects.

Findings

1. With one refinement -- the addition of a level between Nussbaum's III and IV (for children who understand that objects fall towards the surface everywhere on Earth but do not grasp that people live "under our feet") -- the Nussbaum scheme was highly successful in predicting the relationship between the Earth's Shape and Gravity Scales.

2. Understanding the Earth's shape precedes understanding the direction in which Gravity acts. Progress through the notions is discrete.
3. Distribution of Earth Notions is highly age and grade level dependent ($p < 0.0001$, chi square test with df=25). However, "a wide distribution of notions was found at each age/grade level" (p. 214).
4. This same trend was apparent across studies, with variation at any age level even greater.
5. Differences in Earth Concept development by culture were less substantial than individual differences within age groups. Eight year olds from Ithaca, New York, (Nussbaum and Novak, 1976) were exceptionally able in comparison with other American children as well as their Nepalese counterparts in the Mali and Howe study (1979).
6. Only individual differences on verbal opposites (Verbal Opposites Task, Detroit Tests of Learning Aptitudes, 1935/75), spatial reference system ability (the Water Level Task, deAvila, Havassy and Pascual-Leone, 1976) and gender contributed significantly to level of Earth Concept development. Verbal scores contributed the most, followed by ability to use a spatial reference system. Neither field independence/dependence nor science interest accounted for significant amounts of variance.

Interpretations

Sneider and Pulos concluded that their research supported the findings of previous investigators. Children do interpret earth shape and gravity phenomena in terms of their own models. They may modify information about the "roundness" of the earth into an image of a flat but circular island-like earth.

The authors discuss two perspectives for interpreting the data and drawing conclusions for educational practice. First, they borrow from Driver and Easley (1978) and refrain from labeling children's notions as misconceptions. Rather, they judge early notions of earth shape and gravity as "alternative frameworks" having logic and coherence.

Secondly, they invent the idea of a "physico-cultural" concept. This is "a view of the physical world held in common by a cultural group" (p. 220). Acquisition depends upon integrated observations of physical phenomena with culturally transmitted information. Earth Shape and Gravity concepts arise from everyday observations of things falling down and shared information about the Earth appearing flat because we see such a small portion of it at one time. Developmental maturity combines with culturally acquired information to produce children's alternative frameworks.

ABSTRACTOR'S ANALYSIS

Theory and research have yet to persuasively document or explain how "developmental maturity" and "culturally acquired information" combine to modify, restrain and enhance each other thus producing children's spontaneous, alternative frameworks. In other words, we do not really know how to specify where the Earth Concept in its various guises comes from. Thanks to Sneider and Pulos, however, we are gaining much confidence in the nature and existence of the Earth Concept. They have blended quantitative techniques with interview protocols and effectively extended the utility of the Nussbaum scheme.

The Nussbaum scheme has only five levels, from highly egocentric (flat Earth, down is toward the surface), through intermediately egocentric (Earth up in space, people on flat surface with sky above the Earth below or people on top) to mixed decentered (spherical Earth in space, people everywhere, Gravity acts downward) and, finally, decentered (space surrounded sphere, center-directed Gravity). The endpoint of this scheme

The presence of two key concepts can be detected in the background of the Sneider and Pulos work. One of these is the concept of "scale." How do we teach children to overcome the limits to thought imposed by the scale of everyday experience? The Nussbaum and Sharoni-Dagan report presumably has more to say on this issue in regards to the Earth Concept. Needed is work toward a more general, theoretical understanding of this goal for science instruction.

The second is "frame of reference." Children as young as five learn about right and left hands, in front and behind, above and below. Implicit is the self as a frame of reference. When standing, a primary grade child will readily describe what is in front. The implied frame of reference is the child's own body. If the same child lies down and stares at the ceiling, the child will switch to a different frame of reference when asked, "Where is the light?" The answer will not be "In front of me," but rather, "Above me." Here the frame of reference is centered on the room. The switch back and forth between body-centered and room-centered frames of reference is automatic and immediate. Research using two and three dimensional representations of the earth must become more explicit in addressing how children switch between frames of reference, either knowingly or unknowingly.

Although most students believe that the earth orbits the sun, few can see patterns in the change of position of celestial objects hourly, daily, weekly, monthly, or annually. They less seldomly interpret these changes in terms of a Solar System Concept (one involving a movable observer on a spinning sphere circling another). The belief in an orbital model and facility with language about it often belies the haunting presence of an intuitive understanding of a flat earth even for adolescent students.

Recognizing patterns of motion does not equate with understanding how to see those patterns as the result of orbital motion, but beginning to comprehend the need to report any motion with a well defined frame of reference helps. Playful tasks like reporting the path of a yo-yo as seen by the walking yo-yoer versus reporting its motion as seen by someone seated can make this point. Then questions can revert to the celestial sphere: "Will a Brazilian see the same moon phase as a Canadian tonight? When does the sun shine on the south wall of a home in Sydney, Australia? How can shadows be used to prove which direction is North for someone in Ohio?" Answers to these questions can be derived from an understanding of up and down on a sphere in space (that is, the position of the observer) and the relative direction to a fixed object in the distance.

These frame of reference questions are difficult for adults -- even science education graduate students. They also point out that the Gravity Scale separated by Sneider and Pulos from the Earth Concept only partially includes the up and down attribute of directions on a sphere in space. By its nature, research tends often to look at concepts atomistically, disentangled from a web of relationships with other concepts. The teaching (and evaluating) of elementary science necessarily simplifies abstract systems or ideas into isolated parts. The Gravity Scale of Sneider and Pulos ignores the phenomenon of acceleration, for instance. What implicit knowledge confounds children's answers to questions in an artifically restricted setting? The tradition of structured interviews needs to explore this question.

Sneider and Pulos are to be commended for a research project that focuses on a particular science concept having importance for much later learning. They have clarified many issues about the development of the Earth Concept and the frequency of Earth Concept notions among children of similar age while raising new questions about contributions to development from general cognitive abilities.

Research with young children suggests that logical reasoning improves when the question makes intentional sense to the child (Donaldson, 1982). That is, the reason for asking the question and the question itself fit purposes that have meaning to the child. Do the props used in the Earth Concept interviews help frame questions whose purposes make sense to the children? Or are the children attempting to answer a question wholly different from the one in the mind of the interviewer? Future research, analogous to what has been done with Piagetian task interviews, could well pursue this question.

is a conceptual model, historically validated by evidence and mathematical elegance. The universality of levels of the scheme and the fixed, discrete progression of individuals through it is a striking hypothesis.

Educators need to know how variable within an age group Earth Concept attainment might be. The Sneider and Pulos work adds to the answers. Controversy exists over when and to what degree of abstractness the Earth Concept should be deliberately taught to children. Nussbaum's (1976) own work suggests that instruction in second grade may have little impact on children's understanding of the Earth Concept. However, in 1981 he found evidence that tutorials could help second graders improve their understanding. All related studies of the Earth Concept -- the Sneider and Pulos one included -- demonstrate great variation in concept attainment among individuals of the same age.

In part, Sneider and Pulos attempt to explain the universality and ordinality of the Earth Concept notions with their idea of a "physico-cultural concept." The earth-in-space is bound temporally to culture -- it's a concept of the present. Moreover, the physical events accounted for within the framework (or frameworks) of the Earth Concept happen for individuals regardless of culture. Culture helps an individual move away from egocentrism when learning physico-culture concepts.

Still, there are many unanswered questions that this line of research can continue to address. What factors make the Earth Concept difficult to grasp? Is spatial reasoning and frame of reference thinking critical to understanding the Earth Concept, a developmental phenomenon relatively immune to instruction? Does everyday experience of a flat Earth hinder the development of Earth in space notions or does the cultural background of space shuttles, television specials, museums and planetariums accelerate development? Are the levels of understanding of the Earth Concept discrete, with mastery at one level prerequisite to advancing to the next or do individuals hold incompatible views from two or more levels simultaneously? Why does verbal aptitude correlate so strongly with understanding the Earth Concept?

79

REFERENCES

Donaldson, M. "Conservation: What is the Question?" in Peter Bryant (ed.), Piaget: Issues and Experiments. Cambridge, England: University Press, 1982.

deAvila, E., B. Havassay, and J. Pascual-Leone. M...ican American Schoolchildren: A Neo-Piagetian Analysis. Washington, DC: Georgetown University Press, 1976.

Detroit Tests of Learning Aptitudes. Indianapolis, IN: Bobbs-Merrill Co., Inc., 1935/75.

Driver, R., and J. Easley. "Pupils and Paradigms: A Review of Literature Related to Concept Development in Adolescent Science Students." Studies in Science Education, 5: 61-84, 1978.

Hildebrand, D. K., J. D. Laing, and H. Rosenthal. Prediction Analysis of Cross Classifications. New York: Wiley, 1977.

Mali, G. and A. Howe. "Cognitive Development of Nepalese Children." Science Education, 63 (5): 685-691, 1979.

Nussbaum, J. and J. Novak. "An Assessment of Children's Concepts of the Earth Utilizing Structured Interviews." Science Education, 60 (4): 535-550, 1976.

Nussbaum, J. "Children's Conceptions of Earth as a Cosmic Body: A Cross-age Study." Science Education, 63 (1): 83-93, 1979.

Nussbaum, J. and N. Sharoni-Dagan. "Changes in Children's Perceptions and Alternative Frameworks about the Earth as a Cosmic Body Resulting From a Short Series of Auto-tutorial Lessons." Israel Science Teaching Centre, the Hebrew University of Jerusalem, Israel, 1981.

Piaget, J. and B. Inhelder. The Child's Conception of Space. London: Routledge and Kegan Paul, 1956 (originally published in 1948).