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ABSTRACT

Presented are abstracts and abstractors' analyses of 10 studies related to science instruction and 3 studies related to science curriculum. Analyses in the first section (instruction) are on studies of: the influence of instructional structure and focus of control on achievement; effects of individualized audio-tutorial and frontal classroom-laboratory instructional methods on grade distribution; the relationship of teacher reinforcement and student inquiry behavior; an instrument designed to be used to obtain description about instructional methods and materials in a science laboratory; cognitive preferences of students related to a curriculum; classroom learning environment; students' difficulties in learning basic Mendelian genetics; pictorial presentation related to concept acquisition; evaluation of use of a zoo fieldtrip as an instructional method; and individualized instruction. Analyses in the second section (curriculum) are on: the aims of science laboratory courses; a longitudinal study of 5 years of Intermediate Science Curriculum Study (ISCS); and the influence of the use of the Biological Sciences Curriculum Study (BSCS) Elementary School Science Program on students' listening skills. Responses by three authors to analyses of their studies are included. (JN)

SCIENCE EDUCATION INFORMATION REPORT

INVESTIGATIONS IN
SCIENCE EDUCATION

Volume 9, Number 4, 1983

THE ERIC SCIENCE, MATHEMATICS AND
ENVIRONMENTAL EDUCATION CLEARINGHOUSE
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Center for Science and Mathematics Education
The Ohio State University

INVESTIGATIONS IN SCIENCE EDUCATION

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NOTES [illegible] EDITOR

[illegible] Issue [illegible] Investigations in Science Education contains critiques of [illegible] on [illegible] [illegible]ely related topics: instruction and curriculum. It a[illegible] [illegible] [illegible] responses to critiques of articles published in prev[illegible] [illegible]es [illegible] ISE.

[illegible] "Instruction" section are analyses of studies of the influence of [illegible] [illegible] structure and locus of control on achievement (Horak and Slob[illegible] [illegible] e[illegible]ects of individualized audio-tutorial and frontal classroom-[illegible] [illegible] instructional methods on grade distribution (Lazarowitz and F[illegible]), [illegible]he relationship of teacher reinforcement and student inqui[illegible] beha[illegible]or (Edwards and Surma), an instrument designed to be used to obtain description about instructional methods and materials in a science laboratory (Abraham), cognitive-preferences of students related to a curriculum (Tamir), the classroom learning environment (Sharan and Yaakobi), students' difficulties in learning basic Mendelian genetics (Stewart), pictorial presentation related to concept acquisition (Alesandri et al.), the evaluation of the use of a zoo fieldtrip as an instructional method (Marshdoyle et al.), and individualized instruction (Hendrix et al.).

"Curriculum" article analyses include a study of the aims of science laboratory courses (Boud et al.), a longitudinal study of five years of ISCS (McDuffie and DeRose), and the influence of the use of the BSCS Elementary School Sciences Program on students' listening skills (Barufaldi and Swift).

Replies by Goldsmith, Tamir, and Kiely-Brocato are found in the "Responses" section.

Patricia E. Blosser
Editor

Victor J. Mayer
Associate Editor

INSTRUCTION

Horak, W. and K. Slobodzian. "Influence of Instructional Structure and Locus of Control on Achievement of Preservice Elementary Science Teachers." Journal of Research in Science Teaching 17(3): 213-222, 1980.

Descriptors--*Classroom Environment; College Science; *Educational Research; Higher Education; Instructional Systems; *Locus of Control; *Preservice Teacher Education; *Science Education; Teaching Methods

Expanded abstract and analysis prepared especially for I.S.E. by David P. Butts, University of Georgia.

Purpose

The purpose of this study was to extend the knowledge of how student aptitude (locus of control) may interact with instructional treatment (amount of structure) to influence the outcomes of that instruction.

Rationale

Bases on aptitude treatment studies, it was expected that the specific kinds of psychological demands in an instructional treatment may indeed interact to influence the student's achievement. Thus locus of control which distinguishes students along on internal-external continuum may indeed be expected to influence their achievement when the instructional method specifically relates to one's personal involvement in the decisions about what to do next in achieving instructional goals. The contrast in high/low structure of the instructional procedure reflected this latter concern.

Design and Procedure

Using a post-test only control group design, 93 college juniors and seniors were randomly assigned to two treatments. In one treatment, they had instruction based on high teacher structure of the class activities which in the alternative treatment the students decided how and when to accomplish the tasks. In addition to the locus of control test, outcome variables of science content and process were developed and used.

Findings

Two findings emerge in this study--students in the teacher-structured classes did better on science process outcomes regardless of locus of control placement. However, the student-structured classes did better on the content test if they were at the lower end of the locus of control scale (internals).

ABSTRACTOR'S ANALYSIS

The contribution of this study to the aptitude X treatment interaction studies is excellent, especially as locus of control influences these interactions. The interaction the authors found requires creative understanding and use by excellent teachers. To this extent the authors were able to relate a psychological process to an instructional method. However, the study could be strengthened if the manipulated variable of the study (high or low structure) had been more explicitly defined. It may indeed be that the amount of structure in both groups was the same but the source of that structure was quite different--a source from teacher or student. If indeed this is true, then finding an interaction between a student's locus of control and the amount of control he/she had over instruction would seem logical. A second strengthening of the study would have been to examine interactions of the student variable locus of control, with student behavior in both treatments, one of which encourages student control or structure and the other that encourages teacher control of the students. Knowing what students do and relating this behavior to achievement outcomes would have an even richer meaning.

Lazarowitz, Reuven and Jehuda Huppert. "Comparison of Grade Distribution Between Junior High School Biology Students Taught by the Individualized Auto-Tutorial and the Frontal Classroom-Laboratory Methods." School Science and Mathematics 82(2): 111-117, February, 1982.
Descriptors--*Biology; *Educational Research; *Individualized Instruction; *Grade 9; Junior High Schools; Science Education; *Science Instruction; Secondary Education; *Secondary School Science

Expanded abstract and analysis prepared especially for I.S.E. by Eugene D. Gennaro and Steven J. Rakow, University of Minnesota.

Purpose

The study, carried out in Israel, seeks to determine the instructional value of an individualized auto-tutorial (IAT) approach compared to what the authors call the frontal classroom - laboratory (FCL) method.

The experimenters predicted that the posttest achievement scores of IAT students would occur more frequently in the higher range of the measurement scale than those of the FCL students, and that their distribution would produce an "abnormal" graph while the distribution of FCL student scores would produce a "normal" one.

Rationale

The study is based on the work of Postlethwait and associated auto-tutorial research. The prediction of results was based on Bloom's theory that mastery of learning can occur when sufficient time, self pacing, and individualized learning methods are provided to the student, and on Novak's assertion that "Mastery learning programs, where students have variable amounts of time to achieve success in learning a body of subject matter, can provide cognitive drive motivation to all students."

Research Design and Procedure

Four intact classes were randomly assigned to the experimental and control groups. Two classes (N=50) were taught by the experimental method (IAT) and two classes (N=34) were identified as control groups. Both groups had received previous biological instruction on "plants and water" and "animals and their environment" in the seventh and eighth grades. The content studied during the time of the experiment concerned the "cell." None for the students had received formal instruction on the "cell" prior to the experiment.

The students were tested on three areas of learning associated with the cell: general knowledge in biology, specific knowledge of biology 'identified' as being needed for learning about "cells" and information about the topic, "cell." T-test analyses of pretest scores on the above three areas indicated there were no significant differences between the experimental and control groups.

An IAT learning unit in biology was developed for ninth grade students. The didactic material consisted of three sub-units concerning the cell: membrane, nucleus, and organelles. A workbook was provided for each of these aspects which was modified from material adapted from the unity portion (Israeli adaptation) of the BSCS Yellow Version. The workbook included self-examination questions after each sub-unit studied. Correct answers were provided so that students were able to get feedback concerning their responses. The readings and the experiments were designed sequentially. Each sub-unit was also accompanied by slides and tapes. The slides depicted cell-structures and the tapes gave instructions about the readings, directions for performing experiments, and assistance in the integration of the different activities performed in the unit.

Students were able to repeat learning activities at their individual rates. The method of diagnostic self-testing and remedial instruction used was that described by Bloom (1968) and employed by Burrows and Okey (1979). Students were administered the achievement tests after they felt confident of their mastery of the material.

The control group studied the "cell" using the unity portion of the Israeli adaptation of the BSCS Yellow Version. The teaching followed the text and used an inquiry approach, progressing from one sub-unit to another. The achievement tests were administered at the end of the three learning units.

The experimental groups were taught by a teacher who had training in the individualized audio-tutorial method. The teacher of the control groups had no training in the A.T. method. Both teachers were trained in the "BSCS method of instruction" and had the same number of years of experience in teaching BSCS material.

Findings

The achievement tests used in this study consisted of 52 multiple choice questions taken from the Israeli adaptation of the BSCS Yellow Version: 20 questions relating to the cell membrane, 20 to the cell nucleus, and 12 to cell organelles. In all three tests, the experimental group achieved at a level significantly higher ($p < .01$) than the control group.

On all three achievement tests, the range of scores was greater for the experimental group than for the control group. Using an arbitrary indicator of mastery (70% of the test items), the results showed that twice as many students in the experimental group achieved this level. The test scores from the experimental group, when graphed, are positively skewed while those from the control group are negatively skewed.

Interpretations

The researchers report that the study demonstrates that the IAT method was very affective in increasing the achievement and motivation of kibbutzim students. They suggest that the IAT method succeeded in increasing student motivation as indicated by the scores on the test. The authors state that the findings of the study support Bloom's assumption that the introduction of an instructional method, focusing on student's individual styles and rates of learning can make it possible for 90% of students to master the learning.

ABSTRACTORS' ANALYSIS

The results presented by Lazarowitz and Huppert are not at all surprising when taken in light of the research on individualized instruction and the audio-tutorial approach to teaching. This body of research supports the value of these approaches. In a review of 300 research studies, Hinton (NSPI Journal, May 1978) concluded that individualized instruction and audio-tutorial instruction, when compared to traditional techniques of instruction, promote increased performance. Not only is performance increased as a result of individualized instruction, but these increases occur among a variety of students including low verbal and low aptitude students as well as gifted students.

Specifically focusing on mastery learning, research shows that retention of material acquired by mastery learning is better. This is likely due to the fact that students are reported to work harder and enjoy learning more when in a mastery learning setting than in a traditional setting. Test anxiety arising from the frequent administration of diagnostic tests does not appear to be a problem - probably because tests may be repeated until the criterion level is achieved. Additional support for the investigators' results can be found in research focusing on attitudinal outcomes as a result of individualized instruction. Student attitudes are favorable and remain favorable several years after the end of instruction.

Those same results, however, appear to conflict with the authors' assertion that student motivation is improved by the IAT approach. Many studies have shown that one of the major limitations of individualized instruction is that the students lack the self discipline required to successfully complete individualized instruction. As Hinton reports, though a majority of students complete the individualized classes in which they are enrolled, as many as two-thirds fall behind the expected schedule for completion of units during a particular unit. Thus, the achievement results reported in the article are well supported by the body of literature related to individualized instruction. However, the increase in motivation suggested by the authors appears to conflict with previous research indicating that students lack the self discipline to effectively function individually unless specific guidelines are established.

There are several points which are not addressed which would be useful for the reader to know, such as information about the length of the experiment and details of teaching. The authors do say they covered a cell unit, which was an Israeli adaptation of the unity portion of BSCS Yellow Version so that it appears an extensive allotment of time was used. It would be useful to know, too, how much time was spent in the various modes of teaching in the classes taught by FCL methods: lecture/discussion, laboratory, filling in worksheets, quizzes, etc. In other words, a more thorough description of both the control and experimental treatments should be provided for the reader. It appears from the article that other than using the Israeli BSCS Yellow as a model, there was no attempt to use parallel teaching material. For instance, were the teachers' strategies identical when the students were doing experiments in each treatment, except that in the control treatment, the teacher pre- and post-labbed and in the experimental treatment, experimental data was not shared?

Normally when teaching using mastery learning strategies, students are given the opportunity to take the achivement test and if they fail, are able to retake this test. This is a normal part of mastery learning. Hence, it appears the study did not use mastery testing as a diagnostic tool as is traditionally done. However, the students in the experimental group were still able to perform well in the final achievement test without this component, but it does raise a questions about whether the experimental variables was truly a "mastery" approach.

It would have been useful to have had one teacher teach an experimental group <u>and</u> a control group. The teachers, although they both had had BSCS training, may have had other distinguishing teaching characteristics.

The authors say "The three achievement tests used in this study consisted of 52 multiple choice questions <u>taken from</u> the BSCS Yellow Version (Israeli Version)." It would have been interesting to know whether the items in the Israeli Version of the BSCS Yellow tests are similar to the items in the American BSCS Yellow Version tests. The BSCS tests, when they were first written, were meant to be norm-referenced tests rather than mastery tests and contain items very challenging for 10th graders, not to mention ninth graders. The test means for students in both treatments in the study are good.

Or do the authors mean the tests contained mastery items based on material in the BSCS Yellow Version (Israeli adaptation)? If the tests contained mastery items, were the levels of questions at the knowledge and comprehension level using Bloom's taxonomic categories or did they use higher levels as well--those associated with inquiry? Since the authors claim gains in motivation by using IAT, it is important to identify the measures they used to identify the increased level of motivation.

Edwards, Clifford H. and Michael Surma. "The Relationship Between Type of Teacher Reinforcement and Student Inquiry Behavior in Science." Journal of Research in Science Teaching 17(4): 337-341, 1980.
Descriptors--Biology; *Inquiry; *Reinforcement; Science Education; *Science Instruction; Secondary Education; Secondary School Science; *Teacher Behavior; *Teaching Methods

Expanded abstract and analysis prepared especially for I.S.E. by Gerald Skoog, Texas Tech University.

Purpose

This study was designed to determine whether the inquiry behaviors of students in high school biology classes were influenced by 1) verbal reinforcement and mimicry, 2) teacher use and extension of student ideas, and 3) the use of token rewards that could be used to purchase a variety of privileges.

Rationale

There is ample evidence that reinforcement can be used to increase the frequency of a desired behavior. In science, asking questions, formulating alternative explanations for certain phenomena, suggesting new experiments, sharing ideas, and other aspects of inquiry behavior are seen as productive and desired behaviors.

Rowe(1) found that verbal praise and mimicry (the parroting back of student verbal responses), which are used by many teachers habitually, were associated with a decrease in the frequency of inquiry behavior in science in elementary school children. However, the effect of a variety of potent reinforcers on student inquiry had not been studied.

Research Design and Procedure

A posttest-only design was used as four intact sophomore biology classes (Group 1, 2, 3, and 4), all with the same teacher, in a laboratory high school were the subjects. The groups were viewed as equivalent on the criterion measure as almost no student inquiry behaviors were noted in any of the classes. Each class received a different treatment that required the teacher to use specified behaviors or methods. One class received verbal reinforcement (praise) and mimicry as a treatment. In the second class, student inquiry responses were used and explored. Student inquiry responses in the third class were reinforced with tokens that could be used to buy certain privileges. The fourth class was the control group. The teacher avoided using any of the aforementioned reinforcers in this class.

An unidentified number of class sessions were audiotaped and the teacher and student responses coded for each three-second interval. The categories of behavior noted were mimicry, verbal reinforcement, using student ideas, student inquiry responses, questions by the teacher, structuring and conveying information, student response to a question by the teacher, teacher responses to student inquiry, silence or confusion, and controlling responses by the teacher.

Statistical analysis included an F-test followed up by Scheffé procedures to determine the significance of the differences of means between the control group and the various treatments and between treatments.

Results

The frequency of verbal reinforcement and mimicry varied for each of the classes. In Group 1, verbal reinforcement was used an average of 12.88 times and mimicry 54.94 times per class period. The frequency of verbal reinforcement and mimicry per class period was 3.91, 4.05, and 1.89 times in Group 2, 3, and 4 respectively.

The mean length of student responses was smaller in Group 1 than in the other three groups. Also, student responses exceeded three seconds fewer times in Group 1 than in the other groups.

Scheffé values indicated statistical differences at the .001 level for treatment 1 versus 2, 1 versus 3, and 1 versus 4. Statistical differences at the .05 level were noted for treatment 2 versus 4 and 3 versus 4.

Interpretations

Less inquiry results from the use of mimicry and verbal reinforcers than from no reinforcement at all. The use of student ideas in classroom interaction and opportunities to earn and use tokens can increase the frequency of inquiry behaviors.

Teachers should become more aware of their use of mimicry, which is probably more habitual than deliberate. Patterns of reinforcement that encourage inquiry need to be learned and used by teachers.

ABSTRACTOR'S ANALYSIS

The design of this study diminishes its importance. First, it is difficult to accept the assumption that the groups were homogeneous inasmuch as scheduling procedures in schools seldom are random and classes develop different histories. Even though the groups were the same in that none were characterized by inquiry behaviors prior to the treatments, this could have been the result of the lack of opportunity to engage in sueh activity. The potential of each group to engage in inquiry behaviors could vary if there were group differences in academic self-concept, attitude toward science and/or school, locus of control, levels of logical reasoning, interaction patterns, and other factors that influence student responses.

The design of this research required the teacher to alter his behavior in each of the four classes to correspond to the appropriate treatment. The training needed to alter his previous teaching style, which had resulted in very little student inquiry behavior, was not specified. Also, there was no indication whether the teacher controlled the length of wait time, the number and type of questions asked, the distribution of questions to students of different sex or achievement level, his nonverbal behavior, and other variables that needed to be constant across all four groups.

Apparently, the verbal reinforcers used with Group 1 were applied indiscriminately and ambiguously and not directed toward the desired inquiry behaviors. How would inquiry behaviors be influenced in Group 2 if tokens were given for ambiguous behavior? There is a possibility that

Group 1 was different than Group 2 and 3 not only in treatment but also in how the treatment or rewards were used?

The study concluded that the use of mimicry and short verbal reinforcers resulted in less inquiry than from no reinforcement at all. This conclusion should not be interpreted to indicate that verbal reinforcement, used discriminately without mimicry, cannot produce inquiry behavior.

This study made no new conceptual or methodological contributions. The review of the related research was meager.

REFERENCES

Rowe, Mary Budd. "Wait-Time and Rewards as Instructional Variables, Their Influence on Language, Logic, and Fate Control: Part One-Wait-Time." Journal of Research in Science Teaching, 11:81-94, 1974.

Abraham, Michael. "A Descriptive Instrument for Use in Investigating Science Laboratories." Journal of Research in Science Teaching 19(2): 155-165, 1982.

Descriptors--Evaluation Criteria; *Evaluation Methods; *Q Methodology; *Science Curriculum; Science Education; *Science Instruction; Science Tests; *Test Construction

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

Purpose

The author states that the purpose of his paper was to introduce a Q-sort type instrument which was useful for obtaining descriptive information about teaching methods and curriculum materials used in the science laboratory. To do this the author used the instrument to obtain descriptions of twelve laboratory settings. The descriptions were then used to operationally define three laboratory formats: 1) verification, 2) guided inquiry, and 3) open/guided inquiry, and to identify specific criteria for discriminating among them.

Rationale

The author began by briefly pointing out some of the strengths and weaknesses of the existing methods of obtaining descriptive information and used this discussion as a background for Q-sorts. Some of the methods mentioned were open ended observation, content analysis, systematic observational instruments, and questionnaires. Q-sort instruments were presented as a good method for obtaining descriptive information because the information comes from the learner and comparable descriptive categories can be developed.

The author then described the Q-sort as a collection of items printed on separate cards which subjects can sort according to a criterion. After mentioning the historical controversy over Q and R Methodology and appropriate analysis techniques, the author went on to describe the instrument he used; the Laboratory Program Variables Inventory (LPVI).

The instrument contains 25 statements describing procedures, interactions, purposes, and outcomes to which the students might have been exposed during their laboratory experience. The instrument had been developed prior to this study and had been used with science students from high school through college.

Research Design and Procedure

The study consisted of administering the LPVI to students in twelve different laboratories over seven semesters and analyzing their responses. The number of subjects in each laboratory group varied from 18 to 476. One of the twelve different laboratory groups was a college organic chemistry laboratory and one was part of an elementary science teaching methods course. The remaining ten laboratories were part of a college general chemistry course; eight, first semester and two, second semester. The ten general chemistry laboratories were classified according to format; four of the ten were identified as verification laboratories, two as guided inquiry and four as open/guided inquiry.

The three types of laboratory formats were described. The verification laboratory was characterized as traditional with a stereotyped sequence of events. First the necessary theoretical and mathematical background was presented, followed by step-by-step instructions for collecting the data. Then the data were analyzed and used to show that the concept originally introduced was verified by the information collected. In contrast, the two inquiry format laboratories followed an exploration, invention and discovery cycle where students were given no initial background information but began by collecting data. They then invented a concept to explain these data and applied the concept in a new context. The main difference between the guided inquiry and the open/guided inquiry formats was the extent to which students were allowed to make decisions about what the investigations should be and how to carry them out. In particular, the open/guided group had more freedom in planning the discovery phase where their suggested concept was applied in new contexts.

The LPVI was administered during the last week of the laboratory sessions. The students were instructed to place the 25 cards into groups with group I being the statements that were most descriptive of their laboratory experience; group II being the statements that were the next most descriptive and so on. The students were told the instrument was to be used to describe the laboratory, not evaluate it. To force a normal distribution, the number of cards allowed for each group was pre-specified (group I = 2 cards, group II = 7 cards, group III = 9 cards, group IV = 6 cards, group V = 2 cards). The ranks given each statement were treated as scores. The data gathered from a group were combined by totaling the ranks given to each statement by each subject and by re-ranking the 25 statements to give a group ranking.

Several different analyses were conducted. First, Pearson product-moment correlation coefficients were calculated comparing each group with each of the other 11 groups. Next the rankings of the 25 statements obtained from the organic chemistry laboratory, the methods class and from one group from each of the three formats were listed and the top and bottom third of the statements compared. Third, five discriminate analyses were performed comparing an example of a verification laboratory with an example of an open/guided inquiry laboratory and comparing the organic chemistry laboratory and the methods class with the verification laboratory and the open/guided inquiry laboratory.

Findings

The intercorrelations were higher among laboratories that used the same formats. The groups using the verification format had intercorrelation coefficients ranging from .88 to .96 in spite of differences like having the course taught in different semesters or by different instructors or in different colleges. The two guided inquiry laboratories correlated .92 and the four open/guided laboratories had intercorrelation coefficients ranging from .90 to .97. These high correlations within formats are in contrast to the lower correlations among groups with different formats; verification with open/guided resulted in coefficients ranging from .31 to .62, guided with open/guided .59 to .82, and guided with verfication .78 to .90. These differences were examined in more detail by considering the rankings of the 25 statements.

Students in all three formats felt that their laboratories emphasized following step-by-step instructions but the students in the open/guided inquiry format felt that the statement "students are asked to design their own experiments" was much more descriptive of their laboratory than did the guided inquiry or the verification format students , while the guided inquiry and verification format students felt that the statement "the instructor lectures to the whole class" was more descriptive of their laboratories than did the open/guided inquiry students. The guided inquiry and verification groups differed in three ways. The verification group felt that knowing the general outcome of an experiment before doing it and that the development of skills and techniques was more descriptive of their laboratory than did the guided inquiry group. The guided inquiry group felt that using evidence to back up conclusions was more descriptive of their laboratory than did the verification group.

The discriminant analysis between the verification and the open/guided inquiry groups selected 12 of the 25 statements. The highest ranking statement was "students are asked to design their own experiments" followed by "students are allowed to go beyond regular laboratory exercises and do experiments on their own" and "laboratory reports require that students use evidence to back up their conclusions." These statements supported the original descriptions of the two formats.

The comparisons of the organic chemistry laboratory with the open guided inquiry and verification groups showed that although the organic laboratory had some unique elements, it was more strongly related to the verification group. Both discriminant analyses produced significant sets of statements distinguishing the organic group from the verification and the open guided inquiry group. The two sets had only one statement in common.

The methods group had some similarities with both the verification and open/guided inquiry groups, but the methods course probably constitutes a different format prototype. Both discriminant analyses produced significant sets of distinguishing statements and the two sets had four statements in common.

Interpretations

The author suggested that the LPVI could be used in evaluation efforts to provide operational definitions, to diagnostically suggest modifications, to compare treatments, to monitor implementation of particular formats and to operationally define constructs such as inquiry.

ABSTRACTOR'S ANALYSIS

I agree with the author that descriptive instruments can be valuable in assessing the impact of science education. Accurate descriptions are a vital component for effective evaluations of programs, materials, or teachers and are useful in verifying the consistent and accurate implementation of experimental treatments. Descriptions are particularly relevant now with the movement towards more qualitative research and evaluation.

The Q-sort technique and the LPVI in particular appear to be good approaches for obtaining descriptive information. The author amply demonstrates the instrument's capability to describe laboratory situations and shows how these descriptions can be used as a basis for comparing various types of laboratories. The results are quite interesting and give rise to several questions, e.g. why was the guided inquiry group so similar to the verification group? Why weren't the open/guided inquiry laboratories seen as having more emphasis on designing experiments? Why was following step-by-step instructions ranked so highly by the two inquiry groups? These questions are really separate from the main thrust of the article but become relevant because of the manner in which the author chose to demonstrate the usefulness of the LPVI. Since they are somewhat parenthetical, the author does not discuss these results in great detail. They would, however, be good starting points for future research.

Since the author is advocating the use of the Q-sort technique, it would have been beneficial if he had described some of its advantages and limitations. Along this line, research comparing results from Q-sort techniques with results from straight rankings or from a Likert scale approach would be interesting. The Likert scale approach is more familiar, is easy to administer and the data obtained are easily transferable to computer systems. It appears that the Q-sort data would be much more difficult to keep track of because someone would have to record which statements were placed in each group for each subject. A discussion of these practical implications of using the Q-sort would have provided valuable information for potential users of the LPVI.

The author is not always careful in the presentation of his results. He falls into the trap of making evaluative statements about purely descriptive information. The students selected statements they felt were characteristics of their laboratories and the statements themselves are generally value-free. The author, however, makes statements like; "The verification laboratory group believes that the development of skills and techniques is more important than the guided inquiry group does." One group believed the statements more accurately characterized their experience, not that the activity described was "more important." Other researchers using the instrument will need to be careful about assigning evaluative interpretations. This is a common problem that should always be considered when providing descriptive information. Evaluative statements should be clearly seen as evaluative, and the statements actually describing a situation should be presented in neutral terms.

Tamir, Pinchas. "Cognitive Preferences in Agriculture of Middle-School Students and Their Teachers." European Journal of Science Education 1(3): 327-338, 1979.

Descriptors--*Agriculture; *Cognitive Measurement; Cognitive Style; *Educational Interest; *Educational Research; Junior High Schools; *Middle Schools; Science Curriculum; Science Courses; Science Education; Secondary School Teachers; Student Interest

Expanded abstract and analysis prepared especially for I.S.E. by Charles L. Price, Indiana State University-Evansville.

Purpose

The purpose of the study was to:

(1) Design and validate a cognitive-preference test in agriculture for the middle school.

(2) Identify the interrelationships among the four cognitive-preference modes in agriculture.

(3) Identify the cognitive-preference orientation of middle-school students and their teachers as far as agriculture is concerned.

(4) Compare the cognitive-preference orientation of students of the "new" with that of students of the traditional curriculum in agriculture.

(5) Study the relationship between the following independent variables and students' cognitive preferences in agriculture: grade level, sex, father's occupation and father's country of birth, type of school, and ability level.

(6) Study the relationship between the cognitive preferences of agriculture teachers and the following variables: teaching experience (less than five years or more than five years), curriculum (old or new), type of school (religious or secular), and emphases in their classroom tests (principles versus applications).

Rationale

A new curriculum in agriculture was introduced in the middle school in Israel in 1968; by 1974 more than half of the students at grades 7 and 8 were following the program. The old program, still in use by the remaining students, had a heavy emphasis on memorization was well as garden work. Little coordination between practical and theoretical studies was attempted. The new program was characterized by: (1) learning by inquiry, (2) development of positive attitudes, (3) problem solving, and (4) learning of principles and application into actual settings.

Heath (1964) identified four ways by which a person might relate to scientific information:

(1) Recall (R) of information without considerating its implications, applications, or limitations.

(2) Principles (P): acceptance of information which exemplifies fundamental principles or relationships.

(3) Critical questioning (Q) of information as regards its completeness, validity, and limitations.

(4) Application (A): dealing with the usefulness and applicability of information.

The examination of students and teachers in "old" and "new" agriculture programs and their cognitive preferences was the topic of this study.

Research Design and Procedure

Instrument Development. A 40-item cognitive-preference test based on four areas of subject matter (farm animals, plants, plant protection, and propagation) found in both the old and new programs was developed. Each item consisted of a stem and four options, the options representing the cognitive-preference modes. Students were asked to rank order the options from "most preferred" to "least preferred."

Items were validated by a panel of ten teachers and five inspectors. Only items which reached an agreement level of 90 percent by ten judges were used in the final administration. Alpha-Cronbach reliabilities for students and teachers on each cognitive preference were measured and ranged from 0.72 to 0.92.

Administration. In order to reduce administration time, the test was divided into two forms each containing 20 items equally representing subject matter areas. Each student was assigned at random to one form only. The student sample consisted of 943, of which 55 percent were at the 7th grade level and 45 percent at the 8th grade level. Of the sample, 56 percent were males; 78 percent were in secular schools and 22 percent in religious schools. Fifty-seven percent of the students in the study were following the new program in agriculture. Twenty-two of the 30 teachers whose students participated in the study comprised the teacher sample. The instrument was administered in a posttest-only manner to participants in the old and new programs.

Findings

A general finding was that teachers had a much lower preference for recall (R) than for the other three modes. In three of four subject areas, students ranked Principles (P) highest (most preferred), Questions (Q) next, then Application (A), and Recall (R). In the animals subtest, A ranked highest. With regard to intercorrelations, A was significantly negatively correlated with all three other modes while other intercorrelations were not significant. Factor analysis with varimax rotation revealed three relatively independent bipolar factors: R↔A, P↔A, and Q↔A.

Of demographic variables, females were found to have generally higher preferences for R and P, while males preferred A and Q. Children whose fathers were workers had the highest preference for R, while children of teachers and academics had lowest preference for R.

Interpretations

With an average alpha-Cronbach coefficient of 0.84 it was concluded that the cognitive preference instrument was indeed reliable and adequate.

The three bipolar scales ($R \leftrightarrow A$, $P \leftrightarrow A$, and $Q \leftrightarrow A$) which emerged in factor analysis indicated that application was a significant and distinct entity in the study of agriculture. A high correlation between teachers' cognitive preferences as expressed and measured by instrument provided evidence for the construct validity of cognitive preferences. The correlations between preference for recall and father's occupation indicated a possible socio-economic and cognitive preference relationship.

ABSTRACTOR'S ANALYSIS

Where previous studies have examined the cognitive preferences of students enrolled in inquiry-based science programs, this research considered the preferences of students in a curriculum which emphasized questioning, principles and application. Because the state curriculum was in the transition from an "old" program which emphasized recall to the "new" program, there were available for study groups of students in either of these curricula.

Research Design

In terms of design, the study must be considered descriptive, rather than experimental. The methodology by which schools were selected for transition to the new program was not described. For this reason, groups (new and old programs) cannot be considered equivalent.

Of demographic variables measured, little information was given concerning comparisons between groups. Group I.Q. scores were not available. Although interpretations of fathers' occupations to their childrens' cognitive preferences were made, no information relating the distribution of occupational levels to participation in new and old programs was provided.

Instrumentation

A cognitive preference test was developed. On the basis of alpha-

Cronbach values and validation processes, the instrument appears to be appropriate for the topic and audience.

Findings

An interesting finding is that teachers, regardless of emphasis of the program in which they instructed, had a significantly lower preference for R (recall) than for other modes. Students, however, revealed closer allegiance to the program in which they were enrolled. Students in the new program showed a significantly lower preference for recall than did their counterparts in the traditional curriculum. An examination of the interrelationships of cognitive preferences of teachers and instructional materials upon the formation of preferences of children could be a valuable contribution of knowledge.

In the study, the occupations of participants' fathers were divided into five groups: (a) teacher or academic, (b) clerk, (c) farmer, (d) manager, or (e) worker. Children of teachers or academics exhibited significantly lower preferences for recall than did children from other groups. The finding leads to the speculation of a socio-economic relationship between cognitive preference for recall and the father's occupation. The investigator correctly points out that further studies are needed before any generalizations about the effects of home on cognitive predereences could be made.

REFERENCES

Heath, R. W. "Curriculum, Cognition and Educational Measurement." Educational and Psychological Measurement, 24:239-253, 1964.

Sharan, Shlomo and Duba Yaakobi. "Classroom Learning Environment of City and Kibbutz Biology Classrooms in Israel." European Journal of Science Education, 3(3): 321-28, 1981.

Descriptors--*Biology; *Classroom Environment; Foreign Countries; Grade 10; High School Students; Learning; Science Course Improvement Projects; Science Curriculum; Science Education; *Science Instruction; Secondary Education; *Secondary School Science; Social Development; Social Environment; *Social Influences; Teaching Methods

Expanded abstract and analysis prepared especially for I.S.E. by C. Carter, H. H. Cho, S. Gilbert, J. Heuschert, M. L. Matyas and J. B. Kahle; Purdue University.

Purpose

This study compares the social climate of 10th-grade biology classes in urban and kibbutz schools in Israel. The expectation was that students in kibbutz schools would have more positive perceptions of biology classroom social climate than would urban students and that this difference would be traceable to policy differences in the schools.

Rationale

The authors state that classroom climate affects academic achievement, affective adjustment, and learning interests. However, the literature reviewed was dated (1968, 1969, 1976, 1977), and little recent research on classroom social climate was discussed. The researchers chose to compare urban and kibbutz schools because they anticipated different social and academic norms among these two school types. In urban schools, the authors stated that peer competition for grades, performance on national college entrance exams, "teaching-to-the-test," and presentation-recitation teaching methods would be stressed, while there is little concern for teacher-student relationships or for student social life and emotional health. Kibbutz schools were described as emphasizing evaluation of achievement by individual effort, using a wider range of achievement criteria, developing student social life, and de-emphasizing peer competition.

Research Design and Procedure

As ex-post-facto survey research, this field study had a 2X2 factorial design with community type (kibbutz vs city) and sex as independent variables. The designated sampling units were 20 10th grade biology classes, six from kibbutz schools and 14 from urban schools in the greater Tel-Aviv area. The procedure for selecting the classes was not reported, except that all used BSCS Yellow Version texts. The number of schools from which the classes were chosen was not given, nor was the number of classes selected in each school. The two samples of classes (kibbutz and urban) were matched on social and ethnic bachgrounds.

Dependent variables were students' reported perceptions of the degree to which their class was characterized by cooperation, apathy, satisfaction, cohesiveness, difficulty of materials studied, cliquishness, favoritism, and disorganization. These variables, not operationally defined, were measured by an Israeli version of the Learning Environment Inventory (LEI) (Walberg and Anderson, 1968). Construct validity and reliability were reported, with internal consistency alphas ranging from .52 to .80 (mean=.65).

Findings

Analysis of variance (community type X sex) was performed for each of the nine scales of the LEI. Only the main effect of community type was reported. There was no significant difference between schools on the scales of Apathy and Disorganization. For the measures of positive classroom relationships (Co-operation, Cohesiveness, and Satisfaction), kibbutz students attained significantly higher scores than city students

($p<.05$, $p\leq.001$, and $p<.001$, respectively). Likewise, kibbutz students had significantly lower scores ($p<.01$, $p<.001$, $p<.001$, and $p<.05$, respectively) for measures of negative classroom relationships (Competition, Cliquishness, Favoritism, and Difficulty). No main effect of sex was reported. Only three sex x community type interactions were reported; kibbutz girls had lower scores for classroom measures of Competition, Favoritism, and Cliquishness.

Interpretations

The authors state that the city and kibbutz schools comprise "different worlds" in terms of social learning environments even though they use the same biology curriculum. They also state that urban schools display high divisiveness (term undefined), high cliquishness and low cohesiveness. Furthermore, they reported that cliquishness and favoritism were correlated ($r=.61$).

The authors imply that the social activities program in kibbutz schools is responsible for the more positive social climate. They state that an inquiry approach to high school science study "will not necessarily alter the fundamentally competitive and clique-ridden character of the classroom's social climate" (p. 327).

According to the authors, the findings of the study cannot be attributed to differences in school size, or to an urban-rural dichotomy. Rather, the findings can be attributed to differences in school-wide social and academic policies. They conclude that schools can provide a good social climate by implementing policies for cultivating positive relationships among teachers and pupils.

ABSTRACTORS' ANALYSIS

Although this study attempts to clarify important relationships between school types and student perception of classroom environment, the results are confounded because the variables for analysis were not adequately identified and operationally defined. The stated purpose of this research was to use the different educational policies of urban and kibbutz schools as independent variables. The variable, community type, however, is actually composed of many subcomponents including school policy differences. It can reasonably be assumed that there is a difference between kibbutz schools and urban schools in Israel. These two locales have a different set of environmental influences and may attract different kinds of people. Therefore, the question remains: which of the subcomponents accounts for the results of this study.

Of the 20 classes participating in he study, six were from kibbutz schools and fourteen were from urban schools. However, the number of high schools of each type was never specified. There are differences among high schools of any country, both in climate and morale; therefore, the variable of school must not be overlooked when comparing effects of school policy. The authors should specify the methods of sampling and the location of the schools as well as other pertinent demographic data of the schools. Furthermore, the unit of analysis should be consistent throughout the study. For instance, the authors began by reporting the number of classes to be used in the study (implying that these were the units of analysis), then used individual students as the subjects for their data analysis, and finally based their conclusions on a comparison of kibbutz and urban schools. This inconsistency both confuses and weakens the investigation.

The authors conclude that "schools can promote a positive social climate if the school as a social system implements school-wide policies for cultivating positive relationships among teachers and pupils" (p. 328). However, they do not provide evidence to indicate that such policies exist in the schools in the study, nor can an ex-post-facto study substantiate causality.

The conclusions about the effect of BSCS materials on classroom climate also must be questioned. Since BSCS Yellow Version was used in all of the classrooms studied, the authors stated that the use of this text "will not necessarily alter the fundamentally clique-ridden character of the classroom social climate" (p. 327). Without proper controls, this finding may be spurious. A major weakness of the report is the failure to adequately describe the methodology used and clearly state the hypotheses proposed. The unsupported conclusions about BSCS Yellow Version and school policy effect as well as a general lack of operational definitions of terms and variables create uncertainty about the study's validity. Future research should define the terms and variables being researched and use concise problem statements and hypotheses as guidelines.

Stewart, James. "Difficulties Experienced by High School Students When Learning Basic Mendelian Genetics." The American Biology Teacher, 44(2): 80-84, 1982.

Descriptors--*Biology; *Genetics; *Grade 9; *Knowledge Level; *Problem Solving; Science Education; Science Instruction; Secondary Education; *Secondary School Science

Expanded abstract and analysis prepared especially for I.S.E. by Linda R. DeTure, Rollins College.

Purpose

The purpose of this study was to examine the relationship of knowledge to problem solving strategies that ninth grade biology students used to solve basic Mendelian genetics problem. Stewart uses a small sample, case study approach to report the initial phase of a broader research project.

Rationale

The aim of this research is to provide information and data that will be helpful in establishing a general theory of problem solving. For much of the early research little prerequisite knowledge was required to solve the problems. Subjects were not required to integrate a conceptual understanding with the process of seeking solutions to the problem. Recent research has been examining meaningful problem solving in which students explain each step carried out in terms of its conceptual reference. The research methods utilized are similar to those of the information processing psychologists.

Mendelian genetics was chosen as the content topic because it was rated as being both important and difficult to understand by classroom teachers. In a preliminary study, Finley, et.al. had teachers rank 50 content categories. In terms of importance, seven of the top fifteen were related to genetics. Four of the items; mitosis/meiosis, Mendelian genetics, chromosome theory of heredity and gene concept, were also rated in the top ten for difficulty. For meaningful problem solving in genetics, an understanding of each of these is important. Stewart questioned the assumption that successful problem solvers had a basic understanding of the underlying principles of meiosis, segregation and independent assortment.

Research Design and Procedures

This study is an example of research utilizing a case study approach. The techniques for collecting and analyzing data are typical of this type research. Students were interviewed and invited to think aloud while solving problems. Audio tapes were transcribed and any written notes the students used while solving the problems were collected. Because of the time required for analysis, a small sample of fourteen ninth grade biology students was selected to solve three types of genetics problems. Monohybrid with genotypes presented, monohybrid with genotype embedded and dihybrid cross made up the 100 problem sample. The subjects had a success rate of greater than 90%. Since all students had received instruction in problem solving, this rate was not unexpected. However, teachers expect more than simple success. For a meaningful performance, students should be able to describe, explain and predict using interrelated genetics concepts, why each step was done, and why a different way might or might not be correct. The distinction between rate and meaningful performance was a focus for the analysis and consequent findings.

Findings

All fourteen students based at least a part of their solutions on knowledge of Mendelian genetics, but many expressed only partial conceptualization and/or misconceptions. Due to the qualitative nature of the study, the faulty ideas can be traced directly to the student's statements.

The most notable deterrent to finding meaningful solutions to problems was a weak understanding of the relationship between meiotic division and mono and dihybrid crosses. Although students could correctly solve the problems using mathematical algorithms, many could not explain the process as it related to chromosomal segregation and assortment. Moreover, given incorrect or impossible genetic combinations, they could not explain why they were faulty. Some students were able to verbalize an operational understanding of the process, but could not attach the appropriate concept labels.

Students who employed algebraic techniques rather than the Punnett Square method were even more confused about how the principles of fertilization and meiotic division related to problem solutions. They could correctly solve the problems in a rote but non-meaningful fashion.

Interestingly the difficulty did not seem to stem from a lack of understanding of individual concepts. How the concepts related to one another in a coherent whole was the greatest hindrance to meaningful understanding. During instruction, these relationships were implied but not explicitly established which apparently led to partial conceptions and misconceptions.

Interpretations

Based on the problems identified in the interviews, five conclusions and/or suggestions for instruction were made.

1) Most students will be able to solve monohybrid crosses but some will do so in a non-meaningful way.
2) Although students may be able to solve monohybrid crosses in a meaningful way, this does not necessarily generalize to dihybrid crosses especially when using the algebraic method.
3) The difficulty is not related to an ability to use combinatorial reasoning, but in a lack of adequate knowledge of genetics.

4) Students may operationally understand the process knowing the appropriate terms for it.

5) Although students could adequately define individual concepts, they did not have a good understanding of the relationship among concepts.

Explicit instruction in the relationship of concepts should be a primary objective of genetic instruction.

ABSTRACTOR'S ANALYSIS

A major concern in science education is the weak association between research and practice in science teaching (White et al.). Three factors that have contributed to that problem are addressed by this study. One concern is that teachers view research as having a lack of relevance to their daily concerns. Secondly, the style of communicating the results is too technical and, therefore, ineffective. Lastly, the usual methods of dissemination of results via research journals reach few classroom teachers. Stewart overcomes all three problems especially well. The general area of study, problem solving, is a widely recognized concern of teachers. The content, Mendelian genetics, was specifically selected because it was identified by classroom teachers as being important. The study is a good model of practical, relevant research. The case study approach and writing style is easily understood by the non-research oriented person. Finally, the publication journal is targeted to the practitioner. While it is apparent that the study was written to and for the teacher, the potential also exists for the research to make a significant conceptual contribution to the understanding of how children solve problems.

Conceptually the study fits in the body of research pertaining to problem solving and less directly to research concerning the inter-disciplinary dimension of math and science. In this case, the subjects are able to carry out the mathematical functions but have difficulty relating those back to the scientific foundations. Since this is the reverse of what is usually expected, a second set of research questions can be quickly generated.

The study is an example of descriptive research in which information is sought concerning the state of the phenomena, i.e. problem solving in a content area. An aim of case study research is to examine a single case or small sample in depth in an attempt to discover all the variables associated with the problem (Afy et al.) Stewart is faithful to that aim and is able to identify some significant problems associated with solving Mendelian genetic problems. As a result, he makes several useful suggestions for instruction to the classroom teacher.

However, the strength of case study research, the indepth analysis of a few samples, may also be its greatest weakness. Generalizing from the research sample to a target population is always a concern even with large sample experimental studies. With case studies, in which it is not feasible to establish controls, it becomes an even greater concern. For example in this study, the researcher is attempting to gain knowledge about students' problem solving strategies. Yet, it is not clear whether students encounter difficulties because of poor problem strategies or inadequate instruction. In fact, some evidence suggests that problems are due to instruction weakness. The findings appear to be confounded and without any controls questions concerning validity are raised.

The case study is a better tool for producing hypotheses than for testing them. Once identified, the hypotheses can be submitted to rigorous testing much in the way that Piaget's insights were tested. A number of potential hypotheses have been generated from this study and it will be interesting to discover whether the next phases of research will include hypotheses testing. Stewart states that the study is the initial phase of a broader research project, but he does not indicate how the results will be utilized and which directions additional research will take. The omission leaves many questions unanswered.

While the research focuses on some significant issues, the methodology used is not the type usually found in science education research journals. The paper cannot and should not be critiqued using the criteria for experimental studies. This report was directed to the classroom teacher rather than the researcher and as such is very informative. From the researcher's perspective though, it is less informative. In addition to the uncertainty about how this fits in to broader research projects and future research directions, there are also some unanswered questions about procedures.

Case studies inherently suffer from sampling problems and subsequent generalizations. For this study, fourteen students were selected for interviews, but no reasons for the basis of selection were given. How was the number determined? Were subjects randomly selected or were they chosen because of their ability to solve problems? With such information about procedures, valid decisions regarding the research cannot be reached.

The study serves its purpose as a report to teachers and provides a rationale for experimental researchers. A few explanatory paragraphs regarding the research design would make the study more useful to researchers. Although perhaps it is unfair to expect a single paper to address two audiences with rather widely divergent needs and interests. From a research point of view, it seems that the next steps are to identify hypotheses that will be subjected to experimental problem solving. Stewart has begun a crucial first step and it is hoped the next phases of the research will be as fruitful.

REFERENCES

Ary, D., L.C. Jacobs, and A. Razavich. Introduction to Research in Education. New York. Holt, Rinehart and Winston, 1979.

Finley, F.N., J. Stewart, and W. Yarrach. "Teachers' Perceptions of Difficult and Important Science Content for Students to Learn." (in press)

White, A.L., R.H. Yeany, L.R. DeTure, and J. Dura. "A Study of the Research Priorities as Perceived by Elementary and Secondary School Science Personnel," presented at the 28th NSTA National Convention, Anaheim, California, 1980.

Alesandrini, Kathryn Lutz, and Joseph W. Rigney. "Pictorial Presentation and Review Strategies in Science Learning." Journal of Research in Science Teaching, 18(5): 465-474, 1981.

Descriptors--Attitude Change; Chemistry; College Science; *Computer Oriented Programs; Higher Education; *Pictorial Stimuli; *Review (Reexamination); Science Education; *Science Instruction; *Student Attitudes; Teaching Methods; Undergraduate Students; Visual Aids

Expanded abstract and analysis prepared especially for I.S.E. by Joel J. Mintzes, University of North Carolina at Wilmington.

Purpose

This study examined the effects of pictorial presentation and a pictorial review task on the acquisition of concepts related to electrochemistry.

Rationale

Although several studies have demonstrated that the presentation of pictures before or during a learning session facilitates concept acquisition (Holliday, 1975; Weisberg, 1970), the relative effectiveness of pictorial and verbal learning strategies remains in doubt. "The effect of pictorial presentation on science learning has not been tested under conditions in which a verbal strategy was also manipulated."

Design and Procedures

Two experiments were conducted. In the first experiment, 98 undergraduate students who enrolled in an introductory psychology course were randomly assigned to four treatment groups:

1) Pictorial lesson/Pictorial review
2) Pictorial lesson/No review
3) Verbal lesson/Pictorial review
4) Verbal lesson/No review

Each group was taught 14 concepts of electrochemistry relevant to a simple primary cell ("battery"). Both the pictorial and the verbal lesson were presented by computer-assisted instruction. The concepts (eg. electrolyte, anode/cathode, oxidation/reduction) were introduced by written description. In the pictorial lesson the description was followed by an interactive graphics elaboration of the concepts; in the verbal lesson the description was followed by an equivalent verbal elaboration. In both lessons 20 questions were inserted at strategic points which required students to respond by typing answers. Lessons required about 30 minutes of student time.

After the lesson, half of the students engaged in a pictorial review task which required the learner to interact with the display in order to create a working model of a battery. The remaining students (no review) spent an equivalent amount of time (about 30 minutes) in computer game play.

Differences among treatment groups with respect to prior knowledge and spatial ability were assessed and found to be nonsignificant. Two posttests were administered to measure student learning: (1) a verbal test composed of multiple-choice, true/false, and matching items representing Bloom's Knowledge, Comprehension and Application levels of cognitive difficulty, and (2) a pictorial test which assessed recognition of the names, characteristics and functions of nine battery parts. An attitude inventory consisting of five bipolar adjective scales was also administered to assess impact of the instructional treatments. The authors state that a 2 x 2 factorial design was used to investigate the effects of lessons (pictorial vs. verbal) and review strategies (pictorial vs. none) on concept learning.

The authors suggest one problem with the experimental design: "... time was inadequately controlled since learners in the review condition spent more time with the lesson concepts than did learners in the control condition." To better equate time-on-task, a second experiment was conducted.

In the second experiment 50 students were randomly assigned to two treatment groups. One group received the verbal lesson followed by the pictorial review. The other group received the same verbal lesson followed by a re-read of the verbal lesson:

1) Verbal lesson/Pictorial review
2) Verbal lesson/Re-read

The effect was to equalize the exposure time to the material. Students were administered the same attitude inventory, the pictorial test, and an expanded version of the verbal test.

Findings

Results of the first experiment show:

1) No differences among treatment groups on the verbal test.
2) Differences ($F_{3,92}=3.42$, $p<.05$) among treatment groups on the pictorial test. Pairwise comparisons revealed that students in the Pictorial lesson/Pictorial review group recognized more items than those in the Verbal lesson/No review group. No other pairwise comparisons were significant.
3) No differences among treatment groups on the attitude inventory.
4) No relationships between spatial ability and attitude but mild relationships between spatial ability and scores on the verbal ($r_{94}=0.33$, $p<.05$) and pictorial ($r_{94}=0.24$, $p<.05$) tests.

Results of the second experiment show:

1) No differences among treatment groups on the verbal test.
2) Differences ($t_{48}=2.20$, $p<.05$) among treatment groups on the pictorial test favoring those who used the pictorial review strategy.
3) Differences ($t_{48}=2.31$, $p<.05$) among treatment groups on the attitude inventory favoring those in the pictorial review condition.

Interpretations

The authors conclude that "... a weak effect favoring the Pictorial (lesson) on a picture recognition test but not a verbal test" was found and that similar results were observed in respect to a Pictorial review strategy. They go on to say that "...the educational significance of strategies that raise test performance only a few points is questionable." Finally, they speculate that "...the weak results observed in these studies may have resulted because the pictorial strategies were compared to other facilitative strategies" (eg. inserted questions and verbal review).

ABSTRACTOR'S ANALYSIS

This study is part of a growing body of research on the effects of pictorial learning strategies in diverse subject areas (eg. Holliday, 1975; Lesgold et al., 1975). Several of these studies have shown that pictures significantly enhance learning of complex concepts. Other studies (Snowman & Cunningham, 1975) have shown however that verbal strategies such as inserted questions are as effective as pictures. The authors attempted to further understanding in the field by comparing the combined effects of pictorial and verbal strategies with verbal strategies alone.

Although the study was well-conceived and the effort worthwhile, several design and analysis problems detracted from its value. The most significant problem appears to be an attempt to "juggle" too many variables at the same time without adequate control.

One might ask, for example:

1) Why were two separate experiments necessary? Shouldn't the authors have anticipated the lack of control in the first experiment and adjusted their design accordingly?
2) Why were one-way ANOVAs used throughout when the authors clearly state that a 2 x 2 factorial design was employed? Shouldn't we be concerned about the main effects (lessons and review strategies) as well as the possible interactions?

3) Would a 2 x 2 x 3 factorial design have been more appropriate? —eg.: 2 lessons (pictorial; verbal) x 2 verbal strategies (inserted questions present; absent) x 3 review tasks (pictorial; re-read; control).

4) Why were no data on reliability and validity of measurement instruments provided?

In general the written report was adequate. Descriptions of the subjects, experimental treatments, procedures and results were clear and unambiguous. However, an explicit statement of the research hypotheses would have added to the clarity of the report.

The discussion sections were well written. The authors considered their own results in light of previous research, pointing out where their findings supported and differed from those of earlier workers.

One methodological contribution of the study was the interactive use of the computer to administer treatments and the on-line collection of posttest data. This approach reduces the variability inherent in any experimental study in which the investigator must interact with subjects.

One of the marks of a mature discipline is the extent to which research grows out of and contributes to a theoretical matrix. Recent work in science education has been rooted in the assertions of Ausubel, Gagne, and Piaget, to name just a few influential advocates.

In a closely related paper published in another journal, the authors describe several broader lines of theory and research which bear on the issue of pictorial learning strategies (Rigney & Lutz, 1976). An example is Paivio's (1971) work on mental imagery. Why were these elements omitted from the present paper? While the authors did an admirable job of relating their work to earlier work on pictorial learning per se, they may have missed an opportunity to relate their findings to the broader and largely theoretical issues of non-verbal learning in general.

Future research efforts might profitably focus on the QUALITY of concepts acquired as a result of pictorial and verbal learning strategies.

The growing acceptability of naturalistic modes of inquiry (Welch, 1983) and idiographic modes of assessment (Driver & Easley, 1978) may encourage research efforts which aim at <u>describing</u> conceptual outcomes. Rather than comparing scores on multiple-choice tests, these studies would employ qualitative approaches (eg interviews, essays, observation) to uncover "naive concepts" (Resnik, 1983) and "alternative interpretations" prior to and following instruction. How, for example, might students' concepts of a primary cell differ when exposed to pictorial and verbal instruction?

REFERENCES

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.

Holliday, W. G. "The Effects of Verbal and Adjunct Pictorial-Verbal Information in Science Instruction." Journal of Research in Science Teaching, 12: 77-83, 1975.

Lesgold, A. M. et al. "Pictures and Young Children's Learning from Oral Prose." Journal of Educational Psychology, 67: 636-642, 1975.

Paivio, A. Imagery and Verbal Processes. New York: Holt, Rinehart & Winston, 1971.

Resnik, L. B. "Mathematics and Science Learning: A New Conception." Science, 220: 477-478, 1983.

Rigney, J. W. and K. A. Lutz. "Effect of Graphic Analogies of Concepts in Chemistry on Learning and Attitude." Journal of Educational Psychology, 68: 305-311, 1983.

Snowman, J. and D. J. Cunningham. "A Comparison of Pictorial and Written Adjunct Aids in Learning from Text." Journal of Educational Psychology, 62: 307-311, 1975.

Weisberg, J. S. "The Use of Visual Advance Organizers for Learning Earth Science Concepts." Journal of Research in Science Teaching, 7: 161-165, 1970.

Welch, W. "Experimental Inquiry and Naturalistic Inquiry: An Evaluation." Journal of Research in Science Teaching, 20(2): 95-103, 1983.

Marshdoyle, E., J. L. Bowman, and G. W. Mullins. "Evaluating Programmatic Use of a Community Resource: The Zoo." Journal of Environmental Education, 13(4): 19-26, 1982.

Descriptors--*Academic Achievement; *Environmental Education; Elementary Education; *Elementary School Science; Educational Objectives; Learning; Motivation; *Program Evaluation; Science Education; *Teaching Methods; Teacher Attitudes; Teacher Participation; Wildlife

Expanded abstract and analysis prepared especially for I.S.E. by Lowell J. Bethel, The University of Texas at Austin.

Purpose

The purpose of the study was to investigate the effects of a student fieldtrip to a community zoo. The primary focus was environmental education through the use of the zoo. Research questions investigated were: First, do students learn a significant amount of wildlife information as a result of the zoo field trip? Second, what are the teacher's objectives for the zoo field trip? Third, what are the differences between the teachers who do and do not integrate a zoo field trip into classroom teaching?

Rationale

The investigators cite many references from the research literature. Primarily, the concern is to further the objectives of environmental education. Specifically, they feel that zoos may be an excellent means for teaching children about the environment. They go on to point out that little is known about the effectiveness of zoo education programs. In addition, little is known about the effectiveness of pre and posttrip planning, as well as the extent to which zoo field trips meet objectives of the local school curriculum.

Research Design and Procedure

The investigators employed a modified pretest-posttest design to answer the research questions identified above. The factors were knowledge of wildlife gained from the zoo field trip by the students, teachers' objectives for participating, teachers' perception of the zoo's role in field trips, and teacher preparation before and after the field trip.

The investigators looked at various components of this study also. They looked at the function of the study zoo as well as the docents' tour for students, the docent program, and training manual used by the docents.

Teachers participating in the study were questioned as to the reasons for conducting the zoo field trip using a Likert response scale. The purpose was to answer these questions:

1) What, if any, were the teacher's objectives for conducting the school zoo field trip?
2) Did the teacher perceive the zoo's role in the role in the zoo field trip to be educational?
3) How satisfied was the teacher with the school zoo field trip?

To determine the amount of preparation undertaken by the teachers for the zoo field trip and the amount of posttrip follow-up activities. The survey was designed to answer the following questions:

1) What, if any, preparatory activities did the teacher conduct prior to the zoo field trip?
2) What, if any, follow-up activities did the teacher conduct after the school zoo field trip?

The sample consisted of 69 fourth, fifth, and sixth grade students from the same school. To protect against pretest sensitization, one half of the students were administered a placebo pretest while the other half received the wildlife pretest to measure wildlife knowledge prior to taking the zoo field trip.

All students (N = 69) then participated in a one and one-half hour zoo tour which was the treatment. The purpose of the study was explained to all docents so that the exact guided tours were given to all of the students (two study groups). A wildlife posttest was administered to all students the next day after the zoo field trip.

Sixty teachers who had conducted zoo field trips within the past year were selected from zoo records. They were randomly selected from the records to participate in the study. A total of 46 self-administered teacher questionnaires (77%) were returned.

The students' questionnaire was based on a survey of science texts (grades 3-6) available to students and the zoo's educational program. The wildlife test was based on concepts: identification, food habits, and animal habitats. The first part of the test was divided into three sections entitled, "Who am I?", "What do I eat?", and "Where do I live?" Questions were of a matching type.

In addition, content questions on food chains, wildlife ecology, and wildlife habits were asked. Questions ascertaining student's perception of the trip were included.

The investigators reported measures of central tendency and Pearson-product moment correlations for the teacher survey. T-tests for both independent and paired samples were used. Level of significance used for all tests was 0.05.

Findings

The following results were reported:

Student Learning

1) There was no significant difference between the means of the posttests in either Group 1 or Group 2 using the t-test for independent samples.
2) There were no pretest sensitization effects.
3) Using the t-test for paired samples, pre- and posttest mean scores within subgroups revealed significant differences in all tests except "Who am I?"

Teacher Objectives

1) Over 96% of the teacher agreed or strongly agreed that zoo field trips were educational and not recreational.
2) Ninety-seven percent agreed or strongly agreed that students should have fun on the zoo field trip.
3) Over 73% of the teachers agreed or strongly agreed that they selected a zoo field trip for educational reasons.
4) About 91% reported that students enjoy classroom wildlife topics more due to zoo field trips.
5) About 63% disagreed or strongly disagreed that the main reason field trips are attractive to students was that they get to leave the classroom.
6) Positive correlations were found to exist between objectives that indicate zoo field trips to be educational and statements that indicate satisfaction.
7) Positive correlation exists between respondents who go to the zoo, have set educational objectives, and have those objectives met.
8) Negative correlations exist between those statements that indicate lack of control due to novelty of the setting, inability to set objectives, student perception of the field trip as fun time or that learning does not occur, and statements that indicate satisfaction with the field trip or that the purpose of the field trip is educational.
9) Respondents favored the expansion of the zoo's educational role with respect to the zoo field trip.
10) All respondents conducted some type of pretrip activity or posttrip activity.
11) All respondents incorporate the zoo field trip into the school curriculum.

Interpretations

The following conclusions follow from this study:

1) Learning, as defined in this study, did occur.
2) Students were motivated to learn about zoo animals.
3) Teachers perceive that these zoo field trip experiences are educational and establish objectives to guide the experiences.
4) A strong relation exists between goal attainment by the class and the teacher's desire for future such trips.
5) The majority of teachers utilize both pre- and posttrip activities to prepare for and reinforce the experience.
6) The teachers desire an expanded role for zoo education services.

ANSTRACTOR'S ANALYSIS

The questions investigated in this study are important to teachers because of the emphasis placed on field trips and field trips to the zoo in particular. Little is known about their effectiveness or what specifically about them may enhance cognitive growth. This is one of a few that begins to undertake this vexing question and sheds some light on it. It now remains for future investigators to begin to study some of the questions raised in the study as well as some of the factors which were not studied.

It was not surprising that learning did occur as a result of the treatment (zoo field trip). This is to be expected. That it was significant in so short a period (1½ hours) is not expected. A post posttest given at a later time (4-8 weeks) would determine the degree of retention of the concepts learned. This would answer the questions of "how much" and "for how long."

It would have been helpful to have compared the experimental group with a control group. Since students use the same texts that emphasize the same content as the zoo's educational program, it is hard to determine causality here. This would have certainly strengthened the design and eliminated competing hypotheses.

There were some other methodological considerations. For instance, it is not clear how the students were selected for the study. In addition, information is incomplete as to the number of female students in the sample or any other descriptive data. This would certainly be helpful for replication purposes. It is never made clear why fourth and fifth graders were compared to fifth and sixth graders. This certainly might have some effect on the results.

The prevention of pretest sensitization was certainly a plus in the study's design. It is never made clear whether the instructors of the two groups were part of the teacher sample. Follow-up procedures are not mentioned in the paper.

No validity or reliability data are reported for the test given for the students' wildlife test. This should have been reported or determined because it is necessary for ascertaining the strength and value of the instrument. This is absolutely critical to the results of the study here.

As the investigators point out, all of the factors studied may contribute to student learning and motivation. But because of the focus and research design it is impossible to construct a causal model for evaluation. Because of the nature of the problem there are certain methodological considerations. Examples are combining different factors of the zoo trip into a set of measures. There appears to be no instruments available to measure these separately. Certainly the random selection of students as well as assignment to different groups including a control is a real problem here.

While there are research and design problems to be worked out in future studies, the present results do reveal that field trips to a community zoo enhance student learning about wildlife and the environment. It has helped to define the role of teachers and zoos in relation to educationally oriented field trips, and certainly field trips to such community resources such as zoos and effective learning sites for environmental education. The findings have modest value, but further work is needed to isolate the factors in field trips that directly contribute to learning and cognitive development.

Hendrix, Jon; Thomas R. Mertens, and Randall S. Baumgartner. "Individualizing Instruction Through Concept Assessment." The American Biology Teacher, 43(5): 246-253, 1981.

Descriptors--College Science; *College Students; *Cognitive Tests; *Field Tests; Higher Education; Science Education; Science Secondary School Students

Expanded abstract and analysis prepared especially for I.S.E. by David R. Stronck, University of Victoria, Canada.

Purpose

The purpose of this study was to develop, validate, and use the Cognitive Biological Concept Assessment Instrument (CBCAI).

Rationale

Ball State University, Muncie, Indiana, has three courses which emphasize human genetics with bioethical decision making: Human Genetics and the Problems of Humankind; Bioethical Decision-Making; and the freshman honors Symposium in Human Genetics and Bioethical Decision-Making. Students from different backgrounds who enroll in these courses have various levels of understanding of the biological terms and concepts used in the courses. The instructors want to determine the initial levels of understanding in order to become more effective in helping students attain desired concept levels.

Articles in newspapers and magazines often incorrectly or inadequately describe concepts of many biological and bioethical terms. Students at the beginning of the courses may interpret the meaning of terms differently from their instructors. Preassessment of the students' concepts is essential to meet the needs of the students with respect to the educational objectives of the courses (Geisert, 1974; Park, 1971; Silber, 1974).

Research Design and Procedure

The goal of the study involved developing an instrument for measuring the levels of students' understanding of certain biological terms used in bioethics courses or social biology courses. The design of the study was the one-shot case study without reference to other studies or control groups. Nevertheless, the procedures used were appropriate for determining the reliability, validity and some norms of the instrument. Reliability was established by test-retest method (Thorndike & Hagen, 1969). Face validity for the items in the instrument was established by a panel of experts.

Popular magazines such as <u>Time</u> and <u>Newsweek</u> provided over fifty articles using concepts and terms of the bioethics courses. From these articles 50 biological and bioethical terms were compiled that are also used in the objectives of the courses. Definitions of the 50 terms were taken from books ranging from biological dictionaries to advanced genetic textbooks. Each term had three definitions at different levels of Bloom's cognitive domain (1956): (1) a simple definition requiring only some knowledge, i.e., memorization; (2) a definition showing comprehension; and (3) a definition involving abstractions, e.g., application or analysis.

The researchers hypothesized that individuals of different educational and experiential backgrounds would select definitions corresponding to their educational attainments. To test this hypothesis, the researchers selected three samples of different biological educational levels: (1) 38 high-school sophomores and juniors enrolled in Academic Biology for the 1978-79 school year at Paul Harding High School, Ft. Wayne, Indiana; (2) 12 college freshmen enrolled in Bio 100 during the spring quarter of the 1978-79 school year at Ball State University; and (3) 39 high-school life-science teachers from various high schools throughout the state who had participated in a four-week NSF project on "Human Genetics and Bioethical Decision-Making for Secondary-School Biology Teachers." Each sample completed the instrument before instruction in basic genetics, human genetics, and/or bioethics.

The 50 terms were divided into five major groups: (1) 22 terms in "Mendelian genetics"; (2) 12 terms in "human genetics"; (3) 6 terms in "philosophy and ethics"; (4) 5 terms in "reproductive physiology"; and (5) 4 terms in "human behavioral control." The results were reported in these five categories.

Findings

Generally for all categories, the teachers used the "don't know" response less frequently than either group of students. There were trends for the teachers to select higher levels of conceptual understanding than either group of students. The college freshmen tended to select higher levels of understanding than the high-school students.

Interpretations

The instrument can be used to identify the terms which are unfamiliar to the students. For example, all of the high-school students chose the "don't know" response for the term "Hardy-Weinberg Equilibrium" while only 41% of these students selected "don't know" for the term "sex linkage." Teachers can use the information to give much class time to the "Hardy-Weinberg Equilibrium" and more individualized assignments for "sex linkage."

The CBCAI demonstrates the student's level of cognitive development for understanding specific terms. For example, 45% of high-school students identified the lowest concept level response for "abortion" as closest to their own definition; 29% of these students selected the highest concept level response for the same term. The data on teachers show a reversal of the students' percentages. Fifty-nine percent of the teachers chose the highest concept level response for "abortion" while only 26% had the lowest concept level. A recognition of such differences is helpful for improving instruction on terms that are variously understood.

When the CBCAI is used again at the end of instruction, the teachers can assess the effectiveness of the instruction to raise the concept levels of the students. Nevertheless, the researchers explain that the CBCAI can be used successfully only when the respondents understand and follow the instructions given at the beginning of the instrument. Failure at following these directions or dishonest responding completely invalidates the results.

ABSTRACTOR'S ANALYSIS

The CBCAI is designed for formative evaluation. Henson (1981) defines formative evaluation as the designing and using of tests for one specific purpose: to promote learning. The results of such tests are not used in determining students' grades. Throughout the history of American schools, few teachers have used formative evaluations (Henson, 1981).

Because teachers have used tests almost exclusively for determining student grades, students will need very explicit directions to accept the directions of the CBCAI. They can easily misinterpret the instrument as designed for summative evaluation and easily obtain high scores by dishonestly responding, i.e., by selecting the more abstract definitions, although they do not correspond to the students' own definitions. Students can more easily accept the goal of formative evaluation when the instrument is clearly presenting attitudinal scales.

There is increasing interest in providing formative evaluation because teachers and textbook authors want to improve their skills in assisting with concept formation. Minstrell (1982) predicts that conceptual development research will become a major factor in the development of curriculum and instruction for the 1980's. In recent years Piagetian studies have attempted to describe the need for more sequential presentation of concepts. Hasting (1969) observed that the notion of concept sequence has seldom been appropriately studied in the instructional setting of school classrooms using the new curriculum ventures. An excellent example of the needed research was "Conceptual Development Research in the Natural Setting of a Secondary School

Science Classroom" by James Minstrell (1982). His naturalistic project obtained results similar to those incorporating clinical procedures at a university (McDermott, 1982). These recent studies demonstrate that students come to classrooms with preconceived concepts. To be more effective, teachers must know more about their students' precourse conceptions and then base their instruction on the learners' needs. If their precourse conceptions are ignored, students may never accept a new organization of their concepts in any meaningful way.

Most of the studies on scientific concept formation have been emphasizing mathematics or the physical sciences. The CBCAI seeks to determine levels of concept formation for biological and bioethical terms. Concepts of bioethics seem to involve many problems stemming from the cultural or religious backgrounds of the students. Values clarification for bioethical concepts is described in many published books and articles. The CBCAI is relatively unique in dealing with cognitive concept formation of bioethical terms.

The May, 1981, issue of The American Biology Teacher published the study on CBCAI by Hendrix, Mertens and Baumgartner. More recently in this same journal, Mertens and Hendrix have provided additional articles on the teaching of bioethics. In March, 1982, they provided a "Bioethical, Value-Clarifying, Decision-Making Model." This article focuses on the personal use or application of biological knowledge. In January, 1983, Barman and Hendrix presented "Exploring Bioethical Issues: An Instructional Model." This article includes many practical examples employing the "Bioethical, Value-Clarifying, Decision-Making Model." The American Biology Teacher has also published articles by other university instructors describing their teaching of bioethics, e.g., "Teaching Bioethics from an Interdisciplinary Perspective" by Singleton and Brock (1982).

Relatively few precollege biology teachers are considering bioethics in their classroom discussions. Kieffer (1980) describes the opposition to teaching bioethical issues and argues in favor of presenting these issues. Yager (1982) observes that secondary-school biology teachers have made academic preparation almost the only goal of instruction although Project Synthesis advocates including the following goals: "decision making involving biological knowledge in biosocial contexts; value, ethical and moral considerations of biosocial problems and issues." If the recommendations of Project Synthesis are accepted, the the CBCAI may become a helpful instrument at the precollege level as well as the collegiate level of biology instruction.

REFERENCES

Barnum, C. R. and J. R. Hendrix. "Exploring Bioethical Issues: an Instructional Model." The American Biology Teacher, 45(1): 23-31, 1983.

Bloom, B. S., M. D. Englehart, E. J. Furst, W. H. Hill, and D. R. Krathwohl. A Taxonomy of Educational Objectives: Handbook 1, the Cognitive Domain. New York: David MacKay Company, Inc., 1956.

Geisert, P. "Individualization of Student Rate, Goals and Instructional Methods for an Introductory Biology Program." Journal of College Science Teaching, 4(2): 107, 1974.

Hasting, J. T. "Curriculum Evaluation: The Why of the Outcomes." In Anderson, R. C., G. W. Faust, M. C. Roderick, D. J. Cunningham, and T. Andre, eds., Current Research on Instruction. Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1969, pp. 379-384.

Henson, K. T. Secondary Teaching Methods. Lexington, Massachusetts: D. C. Heath and Company. 1981.

Kieffer, G. H. "Should Bioethics be Taught?" The American Biology Teacher, 42(2): 110-113, 1980.

McDermott, L. C. "Problems in Understanding Physics (kinematics) Among Beginning College Students - with Implications for High School Courses." In Rowe, M. B., ed., Education in the 1980's: Science. Washington, D. C.: National Education Association, pp. 106-128.

Mertens, T. R., and J. R. Hendrix. "Responsible Decisionmaking: a Tool for Developing Biological Literacy." The American Biology Teacher, 44(3): 148-152, 1982.

Minstrell, J. "Conceptual Development Research in the Natural Setting of a Secondary Science Classroom." In Rowe, M. B., ed., Education in the 1980's: Science. Washington, D. C., National Education Association, pp. 129-143.

Park, Y. "Learning Accountability and Instructional Objectives" Address delivered to the Third Audio-Tutorial Conference, West Lafayette, Indiana, November 2, 1971.

Silber, R. L. "Individualized Teaching and Learning." The Science Teacher, 41(6): 20, 1974.

Singleton, R., and D. H. Brock "Teaching Bioethics from an Interdisciplinary Perspective." The American Biology Teacher, 44(5): 280-285, 313, 1982.

Thorndike, R. L., and E. Hagen. Measurement and Evaluation in Psychology and Education. 3rd ed. New York: John Wiley and Sons, 1969.

Yager, R. E. "The Crisis in Biology Education." The American Biology Teacher, 44(6): 328-336, 368, 1982.

CURRICULUM

Boud, D.J., J. Dunn, T. Kennedy, and R. Thorley, "The Aims of Science Laboratory Courses: A Survey of Students, Graduates and Practising Scientists", European Journal of Science Education, 2(4): 415-428, Oct. - Dec., 1980.

Descriptors--Biology; College Science; Chemistry; Educational Research; Graduates; Higher Education; Physics; *Science Curriculum; Science Education; Science Instruction; *Science Laboratories; Scientists; *Surveys; Undergraduate Students

Expanded abstract and analysis prepared especially for I.S.E. by Frank A. Smith, Jr., West Chester State College.

Purpose

This study was performed to determine to what extent undergraduate students, recent graduates, and practicing scientists agree in their ratings of 22 selected aims for undergraduate laboratory programs in biology, chemistry, and physics. In addition, for the undergraduate group, a comparison was made between the undergraduates rating of the "preferred" importance of each aim and its "observed" importance in the laboratory course.

Rationale

In recent years greater emphasis has been placed upon the explicit statement of course objectives or aims. Students can examine stated aims to determine if a particular course can meet their needs. Thus, the determination of course aims, the rationale for their determination, and who makes the determination is important. Since laboratory work consumes a large proportion of the students' time and is expensive to the institution, the determination of laboratory aims assumes even greater importance. The determination of laboratory aims can be made more realistically if the views of graduates and practicing scientists are considered as well as the views of undergraduates and teaching staff.

Research Design and Procedure

The instrument used in the investigation was a 22-item questionnaire based upon a similar questionnaire used by one of the authors (Boud) in a previous investigation. Respondents were asked to rate each item on a numerical scale of 1 to 5 according to its importance. The instrument was administered to three different groups:

1) Students currently taking undergraduate courses in biology, chemistry, and physics at the Western Australia Institute of Technology. (N = 151).
2) Past graduates of the same courses at the institute. (N = 115).
3) Practicing scientists in Western Australia. (N = 307).

Each of these major groups was divided into subgroups of biology, chemistry, and physics. The practicing scientists were also divided into subgroups corresponding to their areas of employment consisting of research and development, management, quality control and analysis, and teaching at the secondary and tertiary levels. The undergraduate group was asked to rate each aim twice; in terms of its observed importance in the course they were taking, and in terms of its preferred importance.

The two major questions to be answered by analysis of the data were:

1) Which aims are considered to be of greatest and least importance?
2) Are there any differences between the ratings given by the subgroups of the sample?

The data were analyzed by means of tables and graphs. Tables were constructed showing the five laboratory aims ranked highest by each of the major groups and the five laboratory aims ranked lowest. Four scattergrams were constructed. They displayed:

1) the percentage of tertiary-level teachers and of students rating different laboratory aims as important.
2) a comparison of the students' "preferred" ranking and their "observed" ranking of different aims.

3) a comparison of the rank orders given to different laboratory aims by practicing scientists and by past graduates.
4) a comparison of the rank orders given to different laboratory aims by practicing scientists and by undergraduate students.

Findings

The findings can be summarized as:

1) There was close agreement between the groups of students, graduates, and practicing scientists on the five laboratory aims ranked highest and lowest. The graduates and practicing scientists ranked exactly the same aims among the five highest and exactly the same aims among the five lowest. The student group ranked three aims in common with the other groups among the five highest, and three aims in common among the five lowest.
2) Aims that were related to educational practice, such as, "To illustrate material taught in the lectures", were considered to be of more importance by the students than by the practicing scientists.
3) Differences occurred between the students' ranking of the "preferred" and "observed" importance of aims. Generally the mean importance of any aim was ranked higher on the preferred scale.
4) There were no significant differences in rankings between the subgroups of practicing scientists and the total sample.

Interpretations

The authors' conclusions can be summarized as:

1) Practicing scientists and recent graduates agree on the most important and least important aims of laboratory work. They view the laboratory in pragmatic terms emphasizing practical skills, use of equipment, observation, interpretation of data, and critical thinking.

2) Students mainly agree with the recent graduates and practicing scientists but view with greater importance the laboratory as a means of integrating theory and practice and of illustrating what is taught in lectures.

3) The importance placed on the practical skills acquired in a laboratory course by all groups suggests that, in some cases, the laboratory work can stand on its own.

4) If laboratory and lecture are to be linked together, then the links should be made explicit.

5) Students have some perceptions of laboratory work that differ from perceptions of their future employers. The relationship between laboratory aims to future employment could be made more explicit.

6) More dialogue between teachers and practitioners may allow more rational determination of laboratory aims.

ABSTRACTOR'S ANALYSIS

The authors indicate that this study is part of a larger study involving undergraduate laboratory teaching. Many readers will have difficulty locating some of the references to the larger study that are cited and a brief discussion of the relationship of this study to the larger study would help place this study in perspective.

The instrument used in this study was a 22-item questionnaire originally developed for use in a first year physics laboratory course. The use of the instrument is extended in this study to include courses in biology and chemistry. Would the aims be different if the list had originally been developed for, say, a biology course? The assumption is made in this study that the aims are discipline independent. The aims are of a general nature, and the assumption may be valid, but I would prefer that the authors justify it.

The sample used in the study consisted of students currently enrolled, past graduates, and practicing scientists. The report does not specify how the past graduates and practicing scientists were chosen.

Were all practicing scientists in Western Australia invited to respond? The report would be improved by making more explicit how the sample was chosen.

Two other questions related to the sample are related to the implications of the study and the generalizability of the results. They are:

1) How many students currently enrolled, or how likely is it that a student currently enrolled, will enter the ranks of practicing scientists? Is there any information about the future plans of these students? How many of the current students will graduate from the institute?

2) The authors' statement, "There was a small overlap in the sample of Institute graduates who were also found in the practicing scientists group", seems to indicate that few of the Institute's graduates actually become practicing scientists (at least in Western Australia). This bears on the authors' stated implication, "...students have some perceptions and expectations of laboratory work which are not shared by _their future employers and colleagues_." It is not clear who those future employers and colleagues are.

The analysis of the data in tabular form and by scattergram is appropriate to the nature of the data and clearly presented. It would help, however, if statements about the data such as "not sufficient" and "diverged significantly" were accompanied by criteria for such judgements.

In discussing the implications of the study, the authors have generally based their implications on the data obtained. In a few instances, they have speculated on possible reasons for the differences in some rankings of aims between the student group and the graduates and practicing science groups. While such factors as experience and familiarity with the work place may have an influence on the difference in responses, it must be pointed out that other factors, such as maturation and past history, could also have an influence. In any event, the study cannot justify any reasons for differences in the data between groups.

The study adds the opinion of graduates and practicing scientists on laboratory aims to the more usually surveyed opinions of undergraduates, students, and teaching staff. As such, it adds another dimension to the consideration of aims in laboratory course design. Continued study in this area might identify variables underlying the differences between groups.

McDuffie, Thomas E. and James V. DeRose. "Five Years of Achievement in ISCS." Science Education 66(1): 35-43, 1982.

Descriptors--*Academic Achievement; Biology; *College Science; Higher Education; *Individual Differences; *Individualized Instruction; Science Education; *Science Instruction

Expanded abstract and analysis prepared especially for I.S.E. by David R. Stevenson, Nova Scotia.

Purpose

The researchers undertook a descriptive and longitudinal study to explore the relationships among IQ and reading scores as correlates to achievement, ISCS learning relationships over time, and student ability to understand how well they have learned concepts.

Rationale

Approximately 2,800 students in a middle to upper middle class suburban Philadelphia school system were enrolled in Level 1 of the Intermediate Science Curriculum Study (ISCS) program over the five-year period 1970-1975. The system had a committed science co-ordinator. Teachers received a summer workshop prior to implementation, and in-service days during the first year for ISCS.

Research Design and Procedures

Data collected for the study included Otis-Lennon Mental Ability Test scores (I.Q.), sex, Stanford Achievement Test scores (reading ability), number of chapters for which 70% or better was achieved on the chapter test, number of excursions successfully completed (at 70% level on tests), pre- and post-test scores on the ISCS-based Level 1 examination, an index (Know You Know) of student awareness of readiness for tests, and a Quality Index derived from results of tests based upon each chapter.

The authors provide information about administration of the course within the school. The self-pacing nature of ISCS was accomodated through levels for course credit, with quantity variations between levels. The extent to which there were statistical effects is noted below.

Data were analyzed using descriptive statistical techniques and correlations. Means, standard deviations and ranges were calculated on eight variables. X^2 was used for correlational comparisons. In addition, subjects were compared on the basis of levels for course credit, and in groups according to sex.

Findings

The researchers found no difference over the years in academic potential or scientific knowledge; I.Q. and reading scores were consistently one standard deviation above general norms; quality of work remained constant while quantity increased because of altered course requirements, and the Know-You Know Index rose during the study. Minimal differences were found in qualitative measures of achievement among the course credit levels although the percentage of students opting for the highest level almost doubled. Within the course credit levels the researchers found bimodality for both sexes, but with minimal differences in achievement by sex.

In correlation calculations significant results were found. Quantitative and qualitative measure of achievement were found to be correlated with IQ and reading ability to a X^2 level of 0.001. The same level of significance was found for quality of achievement from pre- and post-test scores as compared to amount of work completed. Reading ability was not significantly related to these variables.

ABSTRACTOR'S ANALYSIS

Descriptive studies are important to educators. At the same time, they may be undramatic. The researchers found in this five-year study that variables tended in straight line patterns which produced limited significant change upon which to comment.

Nonetheless, information has been gained. This is another study which has confirmed the effectiveness of system commitment, administrative leadership, and training support for teachers. Perhaps other gains from the study are gratuitous.

Several questions were asked by researchers in the study, and are summarized in the second paragraph of this abstract. IQ and reading ability scores are highly correlated with achievement, both quantitatively and qualitatively. ISCS learning relationships in this study held over time. Students were able in the study to evaluate how well they understood concepts before they completed tests. These are findings school systems would be pleased to know following careful implementation of any program, especially one to which substantial commitment has been made.

Barufaldi, James P. and Jennifer W. Swift. "The Influence of the BSCS-Elementary School Sciences Program on First-Grade Students' Listening Skills." Journal of Research in Science Teaching 17(5): 485-490, 1980.

Descriptors--Elementary Education; *Elementary School Science; Grade 1; *Listening Skills; *Science Course Improvement Projects; *Science Curriculum; Science Education

Expanded abstract and analysis prepared especially for I.S.E. by Steve Tipps, University of Virginia.

Purpose

The study was designed to ascertain the effect of BSCS-ESSP instruction on listening skills of first grade students. A total listening score and three subscores--identification, recall, and interpretation--were compared with the student demographic variables of age, gender, SES, and school experience to determine if interaction among variables existed.

Rationale

A number of studies have shown a positive relationship between inquiry-oriented science instruction and reading/oral communication. However, specific research on listening has been minimal. This study expands previous efforts relating science and language into the possible impact of inquiry techniques on listening skills.

Research Design and Procedure

Four hundred eighty-one first grade students participated. Schools and classrooms were randomly selected. Twelve hands-on activities from BSCS-ESSP were selected as the treatment. Selected activities about concepts of sound included instructional strategies of discussion and questioning felt to encourage listening skills. Teachers were asked to follow the teachers' guide on a suggested schedule. Participation in

BSCS-ESSP was the independent variable. The Cooperative Primary Series Listening Test (CPSLT) was used as the dependent measure for total listening performance and three subskills--identification, recall, and interpretation. A Solomon Four-Group design was used for analysis. Pre-test was used as a covariate and post-test as the criterion variable. Regression lines were generated to demonstrate the relative gains made by the experimental and control groups. Demographic variables considered in additional analyses were age, gender, socioeconomic status, and prior experience in school.

Findings

Students who scored above the mean on the pretest and who participated in the BSCS-ESSP activities improved total listening performance and on the recall listening subskill. Experimental students also scored above control groups on the interpretation subskill.

Among experimental subjects, previous-school experience and higher SES were related to gains in total listening scores. For all subjects, previous experience in school and age were related to total listening performance. The oldest and youngest children scored lower on listening as did those from lower SES backgrounds. A similar pattern of results was found with listening subskills. Gender was not a factor, however age, experience, and SES were.

Interpretations

Participation in activity oriented science with verbal interaction was found to have a positive influence on listening with some first grade students. Students who already had average or above listening skills improved the most. Students with prior experience in school settings and from higher SES backgrounds also scored higher in listening after the science lessons.

These findings were compared to others which also reported that listening skills did not change for lower SES subjects. However, the finding that listening was improved from some students is consistent with recommendations that science instruction can facilitate communication skills.

ABSTRACTOR'S ANALYSIS

This study is a positive contribution to validating the relationship and importance of science in the primary curriculum. Science provides activity and information for children's talking, writing, reading, and listening. The practical importance of continued research in this area is immense when the needs of young children for science are eclipsed by demands for narrow definitions of literacy.

Organization of the study appears thorough and the analysis is appropriate. Report of the study could have been improved with the addition of some specific information. The sizes of the experimental groups and control groups were never stated. Actual test scores (means, standard deviations), especially on the comparison of demographic variables and subskills, would have helped the reader follow the conclusions. Importance versus significance of the gains is an unanswered question without some mean scores.

With respect to treatment, monitoring of the actual conduct of lessons was not reported. Whether the lessons were actually taught according to the BSCS-ESSP program reflects on the conclusions. In addition, analysis by classroom might have been a useful adjunct to the findings. Results based on different adherence to the lessons or differing questioning/teaching strategies could be addressed.

An especially nagging issue is whether any of the classrooms showed listening improvement for the below mean pre-test subjects or for lower SES, no prior experience children. Should the readers conclude that inquiry science is not appropriate for these children? Such questions need to be addressed in future research to follow the positive findings of Mary Budd Rowe. The difficulty of these questions is the implied evaluation of individual teachers.

RESPONSES TO CRITIQUES

IN RESPONSE TO THE ANALYSIS OF

Goldsmith, R. H. "Readability and Filmstrip Selection in Science" by John Edwards. Investigations in Science Education 9 (3): 62-64, 1983.

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The author is happy that the abstractor found the study to be an interesting addition to the literature on materials selection. This work represented the first study on filmstrip readability.

First, in response to the abstractor's comments, I agree that the design of many filmstrips does not lend itself to readability analysis. As the article noted, this approach works only with passages that can be treated as continuous reading materials. Concerning the comment that captions are not meant to stand alone, it must be noted that captions with their accompanying pictures are in a similar category to many texts where a large number of pictures accompany a text. These pictures provide context clues and may make a material easier to read. Readability measures can be used in these cases if one keeps these points in mind. Follow-up studies involving the Cloze procedure would be a valuable follow-up to this study.

The use of means reported with standard deviation is a legitimate method for reporting data. Considering the size of each group and the variety of reading levels involved, the alternative of giving a complete list of all or nearly all of the reading levels would be combersome. Means provide a concise manner in which to summarize the data. Thus the use of means used with standard deviations is not counterproductive but indicates the trends and clearly points out the average reading levels found in each group using each formula.

The reason to refer to the percentage above minimum levels is not to be hard on publishers but to provide a value that is most useful to teachers. A teacher's students may be reading at several levels but there is usually a minimum reading level at which many material at that level or above can be read by the entire class. The teacher may be more confident in using filmstrips which are at least at this reading level. Knowing that the actual reading level is above the minimum level of class use would allow the teacher time to decide in advance either to avoid the filmstrip or to prepare the class for its use by using some of the techniques mentioned in the article. It is important, as suggested, that filmstrip producers give some attention to this area in advance. The abstractor's overall positive attitude to the article and recommendations for follow-up studies are appreciated. This article, by focusing attention on this neglected area, was designed to promote debate and discussion. It is hoped that it will provide encouragement for more studies in this area.

IN RESPONSE TO THE ANALYSIS OF

Silberstein, Moshe and Pinchas Tamir. "Factors Which Affect Students' Attitudes Towards the Use of Living Animals in Learning Biology." by Constance M. Perry. Investigations in Science Education 9(2): 7-10, 1983.

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Our conclusion regarding the greater tendency of students to agree with sacrifice of animals for research purposes is not based on the comparison of the results in Parts B and D, but, rather, on the direct responses to items in the questionnaire which are explicitly mentioned in Item 2 of the review.

It is true that the article is complex. Yet, the relatively complex statistical analyses which most teachers would not understand were necessary to uncover the information about the relative effects of different factors.

While I accept the suggestions for further research, I would like to see a comparative study among students in different countries (Japan, U.S.A., Britain, Hungary, West Germany, China).

IN RESPONSE TO THE ANALYSIS OF

Kiely-Brocato, Kathleen. "An Assessment of Visitor Attitudes Toward Resource Use and Management." by Ronald D. Simpson. Investigations in Science Education, 9(3): 67-72, 1983.

Kathleen Kiely-Brocato
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The abstractor appropriately points out that the paper did not report the basis on which the 44 items included in the attitude scale were selected and reviewed. An explanation of the origin of these attitude items is in order, particularly since the formulation of the items is also based on Fishbein's theoretical framework. The methodology is detailed in Kiely (1979) and the following is from that dissertation.

According to Fishbein and Ajzen (1975), a person may hold a large number of beliefs about an object, but his attitude toward an object is primarily determined by his salient beliefs about the object, beliefs which stand out against all others. Since people may hold different salient beliefs and the number of salient beliefs may differ from person-to-person, it is difficult to obtain a precise measure of beliefs determining a given individual's attitude using a standard attitude scale. However, an approximation can be made of modal salient beliefs within a given population. This can be accomplished by asking a sample of the population in free response. The beliefs occurring with the greatest frequency are then considered modal salient beliefs and form the core of an attitude survey.

Research on human attention and information processing indicates that people can process only five to nine items of information at a time (Mandler 1967). It can be argued that a person's attitude toward any given object is primarily determined by no more than five to nine beliefs about that object, beliefs that are salient at that temporal point. In light of this, it seems reasonable to assume that an overall attitude toward resource use and management may best be described as a composite score consisting of attitudes toward various policies or various components of resource management. In view of the Lane letter (1918), long range goals and objectives set down by Secretary of the Interior Udall (1964), the Compilation of the Administrative Policies for the National Parks and National Monuments of Scientific Significance --Natural Area Category (1967) and consultation with National Park Service personnel at Shenandoah, policies and actions under four major topics were chosen for attitude assessment: vegetation, wildlife, fire, and backcountry.

Twenty-five open-ended questions were developed using subtopics suggested by the chief park ranger. These items formed the core of the questionnaire designed to determine what aspects of resource use and management were salient to visitors. This was done to avoid creating attitudes on the final questionnaire by asking questions about policies or actions of no concern to park visitors.

Questionnaires were distributed to a nonrandom sample of 100 Shenandoah National Park visitors in the Big Meadows campground during the period of July 8 through July 15, 1977. Forty responses were also obtained via collection boxes placed in Byrd and Dickey Ridge Visitor Centers, and Skyland and Big Meadows Lodges.

A frequency count of responses to each question formed the basis of a pretest questionnaire which contained items similar to the 44 attitude items used in the final survey instrument. The pretest was administered via a mail questionnaire, under conditions comparable to those anticipated in the final study. In order to contact participants, an information release form was presented to visitors as they registered for campground, backcountry, or lodge use by park or concession personnel. Visitors were contacted on randomly selected days at the following placed: Big Meadows and Matthews Arm Campgrounds, Byrd and Dickey Ridge Visitor Centers, and Skyland and Big Meadows Lodges. Separate random samples of lodge, backcountry, and campground users were drawn from the list of names obtained. Total sample size was 150. Individual samples were indicative of the population toward which the final study was directed.

More than 55 percent of the questionnaires were returned in response to the intial mailing and follow-up postcard. Another 22 percent were returned after the second and third mailings. Over 90 percent of the questionnaires returned were completed. As requested, many respondents indicated those items they found difficult or confusing and offered useful suggestions considered in final questionnaire design.

The pretest helped estimate cost, variance of items, subgrouping (i.e., lodge, backcountry, lodge users) sample sizes, and potential problems for the final version of the questionnaire. Several open-ended questions were used to aid in final categorizations for the items.

Individual items were scrutinized to check for nonresponse or indicated confusion. Only items exhibiting discriminability were retained in the final questionnaire. Elimination was the via t-tests comparing attitude item scores of the upper and lower 25 percent of the respondents, in terms of overall attitude scores (Edwards 1957). Analyses of variance suggested a more finely tuned scaling procedure was needed; hence, the modified matrix technique was developed for use in the final study.

REFERENCES

Edwards, A. L. Techniques of Attitude Scale Construction. New York: Appleton-Century-Crofts, 1957.

Fishbein, M. and I. Ajzen Belief, Attitude, Intention and Behavior: An Introduction to Theory and Research, Reading, Massachusetts: Addison-Wesley, 1975.

Kiely, K. A. An Assessment of Visitor Attitudes Toward Resource Use and Management in a National Park. Unpublished doctoral dissertation. Virginia Polytechnic Institute and State University, 1979.

Lane, F. Letter to Stephen B. Mather, Director, National Park Service, May 13, 1918; in Our Heritage: A Plan for its Protection and Use, Mission 66, by U.S. Department of the Interior, Washington, D.C.: National Park Service, n.d.

Mandler, G. Pages 1-50 in New Directions in Psychology, Vol. 3., edited by T. M. Newcomb, New York: Holt, 1967.

Udall, S. Memorandum to Director, National Park Service, management of the National Park System, July 10, 1964, in Road to the Future by U.S. Department of the Interior, Washington, D.C.: National Park Service, 1964.

U.S. Department of the Interior, National Park Service. Administrative Policies for Natural Areas of the National Park System, Washington, D.C.: U.S. Government Printing Office, 1967.