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ABSTRACT

This report consists of an evaluation of the effects of introducing the Intermediate Science Curriculum Study (ISCS) Level One curriculum into the classes of ISCS Institute participants. Participants were compared with a control group on the basis of results obtained from the Classroom Activity Checklist, Student Inventory, Scientific Attitude Inventory, Self-Reliance Test, and the Subject Preference Ranking. Twelve hypotheses were tested. Some of the ISCS objectives were not met by Level One of the program, which might make it difficult to achieve the objectives of the other two ISCS levels. (CP)

FINAL REPORT OF THE NSF-CCSS PROJECT FOR ISCS TEACHERS HELD AT THE UNIVERSITY OF KANSAS, 1971-72.

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Introduction

In the summer of 1971, a five week NSF-CCSS Summer Institute was conducted at the University of Kansas. The purpose of the institute was to prepare thirty-five junior high teachers to teach the Intermediate Science Curriculum Study program (ISCS). These teachers then would implement ISCS Level One materials in their classes. In addition to these participants, five college science educators were included so that the nature of the ISCS program might be introduced as a part of the pre-service education of prospective teachers.

Twenty-two unified school districts, out of a possible 314 school districts in Kansas, participated in this cooperative endeavor. A total of thirty individual junior high schools were represented. A summary of the results of a post-institute participant questionnaire completed by 29 teachers indicated they had taught a total of 114 ISCS Level One classes with 3030 students, and 14 sections of Level Two with 343 students. The average participant then taught 4.4 sections of ISCS with 26.4 students after participating in the NSF-CCSS institute.

The projected number of additional ISCS classes to be taught in the cooperating school districts in 1972-73 included: Level One - 54 sections, Level Two - 89 sections,

and Level Three - 21 sections. These figures don't include one cooperating school district which will introduce some ISCS for the first time in 14 junior highs.

A very conservative estimate would suggest that next year the total number of sections of ISCS taught in the 22 cooperating school districts will be over twice as large as the 1971-72 school year. This estimate is based on maintaining the 1971-72 sections being taught and adding in the projected sections.

One of the goals of the CCSS Institute at the University of Kansas was to provide pilot ISCS programs in 22 school districts in Kansas. These pilot programs made it possible for the school districts to assess the feasibility of the program first hand as well as to have local leadership available in the event the program was expanded. The unanimous affirmative response of the 29 participants to the question of teaching ISCS again if given the opportunity lends credence to the value of the ISCS program.

It would be presumptious to assume that no other adoption factors have entered in. Certainly there are teachers in Kansas who have received ISCS training elsewhere. However, in 1971-72, very few ISCS teachers outside our project were active in Kansas

The manner in which the teachers will be trained to handle the projected ISCS classes in 1972-73 is somewhat unclear. Certainly a number will attend various NSF Institutes. Some workshops of various duration are being planned, many of which involve our institute participants as resource people. It would seem from personal communication

with the participants that many of the smaller school districts expanding to ISCS Level Two and Three have relied on the CCSS participants to work informally with the other science teachers assigned to teach ISCS this next year.

The remainder of this report includes a description of the institute activities, academic year activities and ISCS research studies. The bulk of the report, however, consists of an evaluation of the effect of introducing the ISCS Level One curriculum in the classes of the institute participants. The project director is indebted to Jerry Nieft and LaMonte Lauridsen for their assistance in collecting and analyzing the research data presented in this report.

Institute Activities

The basic daily schedule of the Institute called for a ninety minute ISCS laboratory session followed by a 75 minute lecture--discussion on the science concepts within the ISCS curriculum. A one hour period in the afternoon was used to work with the four ISCS Teacher Education Modules then available. A demonstration class of 20 junior high students was also taught in the afternoon by Mr. Ron Schwatken, assisted by small teams of teacher participants. The staff included Dr. Bill LaShier, director; Dr. Robert James, project coordinator; Dr. Clark Bricker, associate director; and Mr. Herb Simmons, laboratory assistant and video-tape operator.

Attitude Survey. An evaluation was made of the participants' attitudes toward the six major areas emphasized during the summer institute. The Attitude Survey was a 12 item measure which tapped the participants' attitudes

concerning the degree of interest and the degree of usefulness of the following six activities: (1) working through all the Level One ISCS laboratory activities, (2) presentations on related science concepts, (3) demonstration class of ISCS students, (4) ISCS Teacher Education Modules, (5) group discussions of teaching strategies, and (6) evaluation design and achievement tests.

The responses of the participants are given in Table 1. Each of the 12 items were statistically treated using the Binomial Test to determine if there was a significant difference between the observed frequencies of responses and the frequencies one might expect based on the three possible responses, each receiving one third of the tallies. The interpretation of the results indicated that overall, the opportunity to work through the ISCS laboratory activities was rated the most interesting and most useful segment of the Institute. The science background presentations were rated as the most interesting single activity, but the activity was judged less useful than the ISCS laboratory activities. The small group discussions and the evaluation tests were ranked in the middle as far as usefulness and interest. The use of the teacher education modules and the demonstration class were judged overall as less interesting and useful when compared with the four other aspects of the program.

TABLE 1

NSF INSTITUTE ATTITUDE SURVEY

The purpose of this brief attitude measure is to asses what aspects of the summer institute were of particular value.

I. The opportunity to work through the ISCS activities was:
(1) not interesting, (2) interesting, (3) very interesting
0 11 23

II. For me, the ISCS laboratory activities will:
(1) not be useful, (2) be useful, (3) be very useful
1 6 27

III. The science background presentations were:
(1) not interesting, (2) interesting, (3) very interesting
0 9 25

IV. From my viewpoint, the science presentations will:
(1) not be useful, (2) be useful, (3) be very useful
4 16 14

V. The demonstration class of students was:
(1) not interesting, (2) interesting, (3) very interesting
6 24 4

VI. I feel that the demonstration class was:
(1) not useful, (2) useful, (3) very useful
12 20 2

VII. The Teacher Education Modules on Organization, Evaluation, Rational and Work were:
(1) not interesting, (2) interesting, (3) very interesting
6 21 7

VIII. For me, the modules will:
(1) not be useful, (2) be useful, (3) be very useful
6 21 7

IX. The small group discussions of teaching strategies were:
(1) not interesting, (2) interesting, (3) very interesting
4 20 10

X. From my point of view, the small group discussions will:
(1) not be useful, (2) be useful, (3) be very useful
5 24 5

XI. The evaluation design and achievement tests to be used this year are:
(1) not interesting, (2) interesting, (3) very interesting
5 20 9

XII. For me, the evaluation design and tests will:
(1) not be useful, (2) be useful, (3) be very useful
4 20 10

Academic Year Activities

During the 1971-72 school year, nine half-day inservice meetings were scheduled. In general, these meetings were held in the junior high schools of the participants. Four meetings were scheduled to coincide with meetings of the Kansas Association of Teachers of Science and with the regional meeting of the AETS in Wichita, Kansas. The inservice meetings were used to discuss problems confronting the group, introduce new ISCS Teacher Education Modules, discuss Level Three materials, and collect feedback from the evaluation program. A description of the inservice meetings is included in the appendix. The schedule of meeting sites was as follows:

#	Day	Date	Location	Chairman
1	Sat. AM	Sept. 25	East Jr. High 1210 East 8th Topeka, Kansas	John Hirsch
2	Sat.	Oct. 16	Kansas State Teachers College Emporia, Kansas	Bill LaShier (w/K-NEA)
3	Fri. PM	Nov. 5	West Jr. High 2700 Harvard Rd. Lawrence, Kansas	Stan Mullenix (w/K-NEA)
4	Sat. AM	Dec. 4	Union Valley School Hutchinson, Kansas	Dean Hinshaw Kenneth McCloskey John Showalter
5	Fri. PM	Jan. 7	Wilbur Jr. High Wichita, Kansas	Bill Ring (w/AETS)

#	Day	Date	Location	Chairman
6	Sat. AM	Feb. 12	Junction City Jr. High Junction City, Kansas	Donna Mall Bob James
7	Fri. PM	Mar. 24	Area ISCS presentations by participants in Shawnee Mission, Manhattan, Hutchinson, Pittsburg, and Goodland.	Bill LaShier Bob James Paepke, Burkholder, Ross, Franks, and Donna Mall
8-9	Fri. PM Sat. Sun. AM	Apr. 21 Apr. 22 Apr. 23	KATS KAMP Rock Springs 4-H Camp Junction City, Ks.	Bob James Bill LaShier

Studies Pertaining to the ISCS Program

Seven studies have been conducted which investigated various effects of the ISCS program. Betsy A. Conlon (1970) conducted a study in which she investigated the effect of providing students enrolled in Level One of the ISCS program with written statements of the objectives of the course. She provided the objectives to a group of students enrolled in Level One, and she withheld them from another group of Level One students. Using the students' scores on the self-test questions as her criterion measure, she attempted to detect any differences between the performances of the two groups of students. She found no significant difference between the performance of the two groups of students on the self-tests. Conlon suggested that a possible explanation of the results of her study is that the objectives of instruction are implicit in the questions and activities of the ISCS program.

Ronald N. Giese (1970) conducted a study in which he investigated the effect of a formal training program in a

process oriented approach to science teaching on certain characteristics of teachers who were planning to teach ISCS. He attempted to detect changes in teachers' knowledge of the processes of science and in certain attitudes toward science. On the basis of his study, Giese concluded that the training program did not produce a statistically significant change in the understanding of the participants in the processes of science. Also, he found that the participants in the training program experienced no change in their attitudes toward science. Moreover, he found that personality traits generally were not predictors of whether or not a participant would exhibit the behaviors which are in keeping with the ISCS model of teaching.

David H. Dasenbrock (1970) conducted an investigation into the difference between student performance in a Level One ISCS classroom which was taught in the ordinary fashion and student performance in a classroom in which Level One was taught using computer assisted instruction. Dasenbrock attempted to detect any similarities or differences which exist in the error rates and in the types of incorrect student responses of students in the two types of classes. Questions found in the regular ISCS format and in the computer assisted instruction version of ISCS were categorized into the following eight areas: (1) graphic skills, (2) interpreting data tables and non-graphic data, (3) identification and control of variables, (4) prediction, hypothesis formation, and hypothesis testing, (5) application of a principle or concept, (6) measurement, (7) operational definitions, and (8) none of the above. Scores on the achievement tests found in the ISCS

program were used as the criterion measure. Dasenbrock found that he was unable to reject the general hypothesis that student performance in the computer assisted classroom is the same as in the regular ISCS classroom. Hence, he concluded that computer assisted instruction is an appropriate technique to use in curriculum revision efforts.

Thomas G. Teates (1970) conducted a study in which he compared the performance of students who had completed three years of the ISCS program with other ninth grade students who had had no ISCS experience with respect to their respective abilities to perform certain Piaget-type tasks. His purpose was to determine the extent to which students in ISCS and non-ISCS courses have attained formal operational behavior. He used photographic slides to test the students in each group as to their ability to conserve mass, weight, volume, length, and area. Teates found no significant difference between the ability of students in the ISCS program and those who were not in performing the tasks. The findings of this study led Teates to conclude that the ISCS program does not significantly accelerate the ability of students to conserve such entities as mass, volume, weight, area, etc.

Homer D. Luttrell (1971) conducted a study in which he attempted to determine if the use of supplementary audio-tapes by ISCS students with low reading ability enhanced their performance on the ISCS achievement tests. He also attempted to detect any effect the tapes might have on their ability in mathematics and in reading. Furthermore, he studied the effect the tapes had on the time students with low reading ability required to complete a specified instructional

sequence. Using analysis of covariance to adjust the final scores according to initial performance levels, he found that the audio-tapes made no significant difference in the students' ability to score well on the ISCS achievement tests. Moreover, the audio-tapes made no significant difference in the mathematics and reading abilities of the students. Furthermore, he found that the audio-tapes made no significant difference in the time required for the students to complete a given section of the ISCS program.

Robert L. Vickery (1968) investigated the effects of the ISCS Level One materials on teacher behavior. The study compared the teacher behavior of teachers using a statewide adopted textbook with the classroom behavior of teachers using Level One ISCS materials for the first time. Using a three-dimensional behavior classification scheme, Vickery attempted to determine if different teaching strategies are used with the ISCS materials than with other materials. The three dimensions of the classification scheme involved the following continua: (1) individualized--group, (2) laboratory--non-laboratory, and (3) verbal--non-verbal. The study supported the general hypothesis that teacher behavior is modified by the provision of appropriate instructional materials. Vickery found a significant difference between the teaching behaviors of the two groups of teachers in every category that reflected individualized and laboratory centered instruction, and each difference was in the direction of increased use of those procedures.

In a study conducted by the Riverside, California, school system which was designed to evaluate ISCS as well as

six other junior high school science projects, A. N. Gentry (1969), project director, reported some interesting findings. The study was designed to detect changes in science achievement, in thinking skills, and in interest in science among seventh grade students who had been classified according to scholastic ability, socio-economic standing, sex, and whether or not they had Spanish surnames.

The findings of this study indicated that students in the ISCS classes made a significant mean gain ($p < .01$) in science achievement as measured by the STEP Science Test. Similar findings were reported for the classes using the IDP, ESCP, MPS, and IPS programs, however. The study indicated that students in all of the categories used to classify students made significant mean gains on the STEP Science Test if they were enrolled in the ISCS program. This finding was also reported for students enrolled in IDP and ESCP classes. An interesting finding of this study was that ISCS students in the low socio-economic subgroup produced a significantly greater mean gain ($p < .01$) on the STEP Science Test than did students in the not low socio-economic subgroup. This result was not reported for any of the other curriculum programs.

Interest in science was measured with an instrument which asked each student to indicate his level of interest by choosing one of four classifications ranging from very interested to not interested. The ISCS students involved in the study indicated that on the average they were interested in science at both the beginning and the end of the year. However, the posttest results were sufficiently lower than

the pretest results so that a significant decrease ($p < .01$) in interest in science was detected. A significant decrease in science interest was experienced by those students enrolled in ESCP and TSM classes as well.

Gentry summarized the impressions of the Level One ISCS teachers involved in the study as to the strengths and weaknesses of the program. The two statements which are most relevant to the study reported here were listed under the heading of major strengths. It was the concensus of opinion of the teachers that the ISCS program "enables students to be more self-reliant--they learn to solve their own problems (p. 37)" and that the program "encourages development of scientific attitudes (p. 37)."

Evaluation

Introduction

Four basic questions were investigated for the purpose of revealing relationships and differences in the responses of students in ISCS classes and students in control classes. These four questions included: (1) Were there correlations among the testing instruments used in the study? (2) What differences were observed in the classroom activities and student perceived teacher attributes of the ISCS teachers in a pre-test, post-test design? (3) What is the relative effectiveness of the variables employed in this study in discriminating between the ISCS group and the control group? (4) What differences existed among the variables in the study between high and low achievers in ISCS classes?

Experimental Design

In the spring of 1971, two instruments were administered to students in the classrooms of 18 teachers slated to participate in the subsequent NSF institute. A control group of six teachers also administered these instruments which included the Classroom Activity Checklist and the Student Inventory. Both of these instruments were again administered in the spring of 1972 in the classes taught by the teachers involved in the pre-test. The purpose of this separate sample pre-test, post-test, control group design was to determine the effect of ISCS on classroom practices and student perception of teacher attributes.

Certain assumptions were made in using this independent sample design. The first assumption was that seventh grade students in the 1971 school year would not differ significantly from those in the seventh grade the following year. The second assumption was that students could accurately report on both the practices that took place in their classroom and their teacher's attributes. The third assumption was that a random selection of 100 students for each group would be representative of the larger sample groups.

A second pre- and post-test design was set up to assess the effectiveness of the ISCS program with respect to the development of scientific attitudes and self-reliance. The design required that both the ISCS and control groups be administered the Scientific Attitude Inventory, the Self-Reliance Test, and the Subject Preference Ranking as pre-tests and again as post-tests. The pretesting took place early in September of 1971, and the posttesting occurred

late in March of 1972. The students in 15 ISCS classrooms and eight control or non-ISCS classrooms were included in this phase of the study. The data from this phase of the study was statistically treated using the technique of discriminant analysis.

An additional aspect of the research strategy involved the development and administration of ISCS chapter achievement tests in the classes of the experimental group of ISCS teachers. The results of these tests provided measures of achievement and progress of students in the program.

Test Instruments

Classroom Activity Checklist. This instrument was used to determine what kinds of activities were taking place in the classroom. This is a true or false type of instrument which provides information about the nature of classroom activities from the students' perspective. This instrument is a modification of the Biology Classroom Activities Checklist (BCAC) which was developed by Kochendorfer and Lee (1967). The Biology Classroom Activities Checklist contains 64 items.

The CAC instrument in the present study included 32 items from the BCAC instrument along with six items that reflected additional aspects of the ISCS practices. Originally 44 items were submitted to eight experienced ISCS teachers to determine whether each statement of classroom practices would contribute positively or negatively to achieving the ISCS objectives. Six of the 44 original statements were discarded on the basis of fewer than six out of eight judges agreeing. Twenty-nine of the items received complete agreement by all the judges.

The scoring of the CAC involved totaling the number of positive practices (N=24) marked true and the number of negative statements (N=14) marked false on each of the five sections of the CAC. The five sections of the CAC included practices related to: (1) role of the teacher in the classroom, (2) student classroom participation, (3) use of the textbook, (4) design and use of tests, and (5) laboratory activities.

An item analysis of the responses of ISCS students contrasted with non-ISCS students is included in the appendix. One hundred students from each of the two groups were selected at random from post-test scores obtained in eight ISCS classrooms and nine control classrooms. The preferred response for scoring each item is indicated by an F (false) or a T (true).

Student Inventory. This inventory was developed by Reed (1961) and modified for this study. This instrument is of the Likert-type and contains 36 items. The items are uniformly distributed into three categories, with each category designed to measure a different aspect of a teacher's personal traits as seen from the perspective of the students. The characteristics measured are: (1) teacher warmth, (2) teacher demand, and (3) the ability of the teacher to develop intrinsic motivation in students. With regard to warmth, Reed designed questions to measure the pupil's perceptions of teacher behavior directed toward the reduction of interpersonal tension between the teacher and pupil. Reed suggested such synonyms for warmth as affection, affiliation, consideration, kindness, friendliness, sympathy,

responsiveness, and geniality. A typical question for measuring warmth is the following:

3. I am made to feel at ease during class ...
(1) not at all (2) a little (3) somewhat
(4) much (5) very much

In terms of measuring demand, the student is asked about teacher standards for quantity, promptness, correctness, neatness, depth, thoroughness, honesty, attention, and orderliness. A representative question from the demand category is the following:

24. Our teacher demands that we be orderly during laboratory periods ...
(1) not nearly strongly enough (2) almost strongly enough (3) just strongly enough (4) somewhat too strongly (5) much too strongly

The questions concerning intrinsic motivation attempt to measure pupil motivations for learning that have been internalized. The teacher is supposed to present the material so that the student appreciates the relationships between what he is learning and his own needs and interests. A question exemplary of this classification in the instrument is the following:

9. The teacher points out relationships between our science work and out-of-school events ...
(1) almost never (2) few times (3) sometimes
(4) often (5) very often

In total there are thirty-six questions on the Student Inventory, twelve each for the three categories. The three categories of questions are randomly shuffled. Each question is set up on a Likert scale with five gradations in the answer. The Student Inventory was scored so that a high score of sixty (five multiplied by the twelve items) would be the limit for each category. Thus, the higher the score on each

category, the more warm, demanding, or intrinsically motivating the student perceives his teacher. Reed found the reliabilities for warmth and motivation categories to be between .88 and .93. The reliability for demand was somewhat smaller, .78 to .80.

Scientific Attitude Inventory. Moore and Sutman (1970) published a Scientific Attitude Inventory of sixty items designed to measure three intellectual and three emotional attitudes toward science. Each of the six categories had statements framed to represent the positive and negative aspects of each attitude. The two intellectual and one emotional categories chosen for use in the present study are listed below.

1A The laws and/or theories of science are approximations of truth and are subject to change.
1B The laws and/or theories of science represent unchangeable truths discovered through science.

2A Observation of natural phenomena is the basis of scientific explanation. Science is limited in that it can only answer questions about natural phenomena and sometimes it is not able to do that.
2B The basis of scientific explanation is in authority. Science deals with all problems and it can provide correct answers to all questions.

6A Being a scientist or working in a job requiring scientific knowledge and thinking would be a very interesting and rewarding life's work. I would like to do scientific work.
6B Being a scientist or working in a job requiring scientific knowledge and thinking would be dull and uninteresting; it is only for highly intelligent people who are willing to spend most of their time at work. I would not like to do scientific work. (pp. 86-87)

The "A" category represents a positive statement, and the "B" category represents a negative statement of the same general scientific attitude.

A typical statement measuring attitudes in category number one is:

25. A useful scientific theory may not be entirely correct, but it is the best idea scientists have been able to think up.

Representative of category number two is the following:

30. Scientists believe that they can find explanations for what they observe by looking at natural phenomena.

And for category six this item is typical:

21. I would enjoy studying science and using this knowledge in some scientific field.

In total there are five questions of the positive type for each category and five questions of the negative type for each category, making thirty items. A Likert scale of one to four was used for the answers, with "one" indicating strong agreement with the statement and "four" indicating strong disagreement. In writing the program to score the instrument, the positive scale was transgenerated so that a high total score would indicate strong agreement with the positive statements of scientific attitudes; hence, a large score would indicate a good agreement with the type of attitudes ISCS wants to foster.

The reliability coefficient was calculated according to the test-retest method of Winer and was found to be 0.934 for Moore and Sutman's data. By comparing the pre-test and post-test means for each group with theoretically predicted results, the authors of the inventory concluded that they also had good construct validity.

The original SAI instrument contains 60 items evenly distributed into six categories. Each category purportedly measures a different facet of scientific attitude. Only

three categories, or 30 items, were used in this present study. The three categories of scientific attitude assessed were: (1) the approximations to truth of scientific laws, (2) the empirical nature of science, and (3) the desirability of science as a vocation.

The Self-Reliance Test was developed by Lauridsen (1972), institute participant. The instrument was developed in order to have an easily administered tool for assessing the view students have of their ability to encounter and cope with new situations. The instrument is of the Likert-type, and it contains 20 items. The respondent is given four choices to each of the items in the instrument.

The Subject Preference Ranking is a five item instrument in which the respondent is asked to rank in order his preferences for five classroom subjects. The subjects to be ranked are: (1) English, (2) mathematics, (3) physical education, (4) science, and (5) social studies.

Achievement Tests. To check the cognitive achievement of ISCS students at regular intervals throughout their course of study, a series of ten achievement tests was constructed. The basis for the questions was a set of behavioral objectives compiled by the Intermediate Science Curriculum Study (1969). The behavioral objectives were divided into entering and terminal behaviors for each chapter. The following verbs are indicative of the types of objectives: identify, distinguish, construct, name, order, describe, apply (a rule), state (a rule), demonstrate, interpret, predict, calculate, and measure. As Jerry Nieft, NSF participant, constructed the items for each test, an attempt was made to write questions.

of varying difficulty and representative of the knowledge, comprehension, application, analysis, and synthesis categories of Bloom's taxonomy (1956). The questions were a synthesis of several sources besides the behavioral objectives of ISCS. The examinations published in Triezenberg's (1970) monograph were consulted, as well as a set of examinations obtained from two experienced ISCS teachers in the summer institute which began this study. The remainder of the questions were composed from scratch.

In order to improve on the validity of the achievement tests for junior high students, all of the members of the ISCS summer institute in Kansas for 1971 took the tests as they themselves worked through the experiments and chapters of Level One. Constructive comments were made on each question, and from these comments the tests were revised, with some questions deleted, some vocabulary changed, and some questions entirely altered in format. In final form, there resulted one test to be taken after the completion of every two chapters in the book. Because of the varied content of the chapters, the length of the achievement tests varied from twenty-four to thirty-two items. The achievement tests in their final form were mimeographed and given to the teachers to use during the year. An answer key was provided, as well as a record sheet on which to keep the scores for each test. Each test was to be given to an individual as soon as he finished the material. Therefore, in addition to the achievement score, a measure of the rate of progress for the individual could be obtained by noting the fraction of the total material he had completed at the end of the

first semester. That is, each individual earned an achievement score, progress score, and achievement-progress index calculated as follows:

$$\text{Achievement} = \frac{\text{total number of correct responses on all tests}}{\text{total number of items on all tests taken}}$$

$$\text{Progress} = \frac{\text{number of tests taken}}{10}$$

$$\text{Achievement-Progress Index} = \text{Achievement} + \text{Progress} = 2.00 \text{ for maximum value}$$

Results

The twelve hypotheses of this study may be categorized according to the type of design utilized. Hypothesis One is characterized by a correlation matrix of all but the Self-Reliance Measure. Hypotheses Two and Three relate to the pre-test - post-test separate sample control group design. This design allows a comparison of ISCS teachers before and after attendance at a summer institute. Hypotheses Four through Nine represent a pre-test - post-test situation in which the hypotheses deal successively with a discriminant analysis of the pre-test scores of the ISCS and control groups; post-test scores of ISCS and control group; pre-test and post-test of control; pre-test - post-test of ISCS group; post-test Student Inventory scores of ISCS and control; and post-test scores on CAC scores of ISCS and control groups. Hypotheses Ten, Eleven, and Twelve represent an analysis of the difference in mean scores of the top one-third and bottom one-third of the ISCS students as classified by achievement and progress.

> Hypothesis One. Using post-test ISCS data, there are no significant correlations among the variables of achievement, progress, achievement-progress index,

three kinds of scientific attitudes, subject preference, and student perceptions of teacher warmth, demand, and use of intrinsic motivation.

Keeping in mind Campbell and Stanley's (1963) remarks concerning the fact that a high correlation means that the credibility of a relationship has only been strengthened because it has survived a chance of disconfirmation, fifteen significant correlations are obtained from the ten by ten matrix of variables used in the study. Table 2 lists all those correlations which were significant at the .01 level. These correlations represent Pearson "r" coefficients. Such coefficients denote some degree of relationship between two variables, although the strength of the relationship is not linearly related to "r" (Guilford, 1965).

Student achievement on ISCS Level One behavioral objectives was significantly correlated with the student-progress index, with teacher warmth and demand, and with the two science attitudes on the Scientific Attitude Inventory which deal with science as approximations to truth and the empirical nature of science.

A multiple correlation between student achievement, teacher warmth, and teacher demand indicated that a better prediction of student achievement could be obtained by using teacher warmth and demand together as predictors.

The progress measure on students was only correlated significantly with the combination achievement-progress index.

Teacher warmth was significantly correlated with all three science attitudes measured by the Scientific Attitude Inventory: science as an approximate discipline, science as an empirical discipline, and science as a desirable career.

TABLE 2

SIGNIFICANT CORRELATIONS

Variable	Pearson "r" df=105-2=103 $r_{.01}$=.254
1. Achievement	r_{13}=.6625 r_{14}=.3651 r_{15}=-.2672 r_{17}=.3366
2. Progress	r_{23}=.6776
3. Ach-Prog Index	r_{37}=.3608 r_{38}=.3788
4. Tchr Warmth	r_{46}=.5873 r_{47}=.2703 r_{48}*=.2496 r_{49}=.3632
5. Tchr Demand	r_{56}=.2839
6. Tchr's Use of Motivation	
7. Sci Attitude - Sci as Approx to Truth	r_{78}=.4148
8. Sci Attitude - Sci as Empirical	r_{18}=.3667
9. Sci Attitude - Sci as a Career	
10. Sci as Preferred Sch Subj	$r_{9,10}$**=-.4811
Multiple Correlation	$R^2_{1.45}$=.2027 $R^2_{9.1,10}$=.2345 $R_{1.45}$=.451 $R_{9.1,10}$=.483 (r_{45}=-.0032)*** r_{81}=-.0175 *** $r_{1,10}$=.1034

*$r_{.05}$=.195

**Negative Correlation Resulting from Inverted Scale

***Required in the Computation of the Multiple Correlation

Within the Student Inventory itself, teacher warmth and teacher use of intrinsic motivation were significantly correlated, as were teacher demand and teacher use of intrinsic motivation.

Within the Scientific Attitude Inventory the two attitudes dealing with the approximate and empirical natures of science were correlated significantly.

Hypothesis Two. Pre-test - Post-test Separate Sample Control Group Design for the Student Inventory.

There is no significant difference between the gain scores on the Student Inventory for teachers who implement ISCS materials during the study and the gain scores on the Student Inventory for teachers who continue teaching a non-ISCS course.

The purpose of null Hypothesis Two is to determine if ISCS Level One, as compared to non-ISCS courses, has a differential effect upon students' perceptions of their teacher, as measured by the Student Inventory (WDM). A two by two factorial design is used to test Hypothesis Two. The main question is whether the gain score for the experimental group is significantly different from the gain score for the control group. This difference is tested by the significance of the interaction between the main effects of pre-test - post-test and experimental-control. The necessity for this type of analysis arises because of the use of different sample groups for the pre-tests and post-tests.

Null Hypothesis Two could not be rejected at the .05 level of confidence for a multivariate analysis of variance for all three sections of the Student Inventory (WDM). A comparison of the pre-test and post-test means for both the experimental and control groups on the Student Inventory (Table 3) revealed that the post-test means are lower than

the pre-test means for teacher warmth, demand, and motivation. These negative gains were not significant at the .05 level, however.

TABLE 3

STUDENT INVENTORY MEANS FOR HYPOTHESIS TWO

		Experimental	Control
Pre-test	W	40.35	39.40
	D	34.14	32.46
	M	34.51	33.73
Post-test	W	39.39	36.98
	D	31.68	32.36
	M	33.11	31.88

Hypothesis Three. Separate-Sample Pre-test - Post-test Control Group Design for the Classroom Activity Checklist.

There is no significant difference between the gain scores on the Classroom Activity Checklist for classrooms which implement ISCS materials during the study and the gain scores on the Classroom Activity Checklist for classrooms which continue a non-ISCS course.

The purpose of this null hypothesis is to determine if ISCS Level One, as compared to other junior high programs, has a differential effect upon student-perceived classroom activity. A two by two factorial design is required to test the significance of the difference between gain scores for experimental and control groups on the Classroom Activity Checklist. This difference in gain scores is tested by the interaction of main effects for the design (Table 4).

This Null Hypothesis was rejected at the .01 level of confidence on a multivariate analysis of variance across all five sections of the CAC. After treating each section separately, it was found that the treatment variance resulted only from sections "A" and "B" of the CAC. Section "A" measured the "role of the teacher", and section "B" measured the "student participation in the classroom". A multivariate analysis of covariance indicated that section "B" contributed the most to overall treatment variance, while section "A" contributed a smaller portion of the traatment variance.

TABLE 4

CLASSROOM ACTIVITY CHECKLIST MEANS
FOR HYPOTHESIS THREE

		Experimental	Control
	A	4.33	4.10
	B	4.51	4.50
Pre-test	C	2.69	2.52
	D	3.54	2.88
	E	8.18	7.46
	A	5.36	4.26
	B	5.21	4.15
Post-test	C	3.07	2.53
	D	4.34	3.36
	E	9.22	7.64

Hypothesis Four. The pre-test scores of the ISCS and control groups will not produce a discriminant function, containing the variables associated with the Scientific Attitude Inventory, the Self-Reliance Test, and the Subject Preference Ranking, which is significant at the .05 level of probability.

Hypothesis Five. The post-test scores of the ISCS and control groups will not produce a discriminant function, containing the variables associated with the Scientific Attitude Inventory, the Self-Reliance Test, and the Subject Preference Ranking, which is significant at the .05 level of probability.

Hypothesis Six. The pre-test and post-test scores of the control group will not produce a discriminant function, containing the variables associated with the Scientific Attitude Inventory, the Self-Reliance Test, and the Subject Preference Ranking, which is significant at the .05 level of probability.

Hypothesis Seven. The pre-test and post-test scores of the ISCS group will not produce a discriminant function, containing the variables associated with the Scientific Attitude Inventory, the Self-Reliance Test, and the Subject Preference Ranking, which is significant at the .05 level of probability.

Hypothesis Eight. The post-test scores of the ISCS and control groups will not produce a discriminant function, containing the variables associated with the Student Inventory, which is significant at the .05 level of probability.

Hypothesis Nine. The post-test scores of the ISCS and control groups will not produce a discriminant function, containing the variables associated with the Classroom Activities Checklist, which is significant at the .05 level of probability.

Hypotheses four through nine are tested by the technique of discriminant analysis. The rationale and procedures associated with discriminant analysis are discussed very clearly by Tatsuoka (1970). In his early remarks, Tatsuoka presents arguments and examples which indicate the nature of the danger of drawing inappropriate conclusions from an analysis of variance of data which is composed of variables which are highly correlated with one another. Basically, the difficulty is associated with the fact that

if one of a set of highly correlated variables is found to be significantly different for two groups by analysis of variance techniques, then the other variables in that set will tend to produce evidence that the groups are significantly different with respect to them as well. Indeed, it may be true that the groups which produced the data differ significantly on all of the variables involved in the study. However, one cannot know if this is the case because the significant differences have arisen to some extent because of the correlations which existed between the variables employed. Analysis of variance techniques do not allow one to make a judgment as to the reason for the significant findings. Discriminant analysis procedures avoid this difficulty by taking into account the covariances which exist between the variables. By discounting or partialling out the effects of the correlations which exist between the variables, discriminant analysis provides a way to determine, with greater assurance, the nature of any differences which may exist between groups.

The analysis of the data in hypothesis four is illustrative of the general procedure used in the other five discriminant analysis hypotheses. A random selection of 100 student data cards was taken from the ISCS pre-test data cards available. Likewise, a random selection of 100 student data cards was taken from the control cards which were available from the pre-test. Each student data card contained the total scores earned by the respondent on the Scientific Attitude Inventory, the Self-Reliance Test, and the Subject Preference Ranking. Because the Scientific

Attitude Inventory consisted of three subtests, each data card contained five total scores. These two sets of 100 cards each were used with the BMD07M discriminant analysis program to calculate a discriminant function for the ISCS and control pre-test scores. Only one discriminant function is possible in the analyses performed in this study.

Hypothesis Four. The pre-test data obtained from the Scientific Attitude Inventory, the Self-Reliance Test, and the Subject Preference Ranking produced a discriminant function which indicated that the ISCS and control groups were not significantly different with respect to these five measures at the .05 level of probability. In fact, the resultant discriminant function was not significant at the .20 level of probability. Hence, the conclusion was drawn that the ISCS and control groups were not significantly different with respect to the five measures employed in the pretesting. The mean scores are listed in Table 5.

TABLE 5

MEAN SCORES AND STANDARD DEVIATIONS OBTAINED FROM THE BATTERY OF INSTRUMENTS ADMINISTERED AS PRE-TESTS TO THE ISCS AND CONTROL GROUPS

Test	ISCS $\bar{X}$	Control $\bar{X}$	ISCS S.D.	Control S.D.
One	61.97	60.63	6.81	5.64
Two	27.22	26.95	3.34	2.84
Three	31.64	31.37	3.81	3.66
Four	29.03	27.57	6.72	4.97
Five	2.63	2.81	1.30	1.37

With a maximum score of four possible on each of the 20 items contained in the Self-Reliance Test, the highest possible score on this instrument was 80. Each of the three subtests contained in the Scientific Attitude Inventory has ten statements for which a maximum score of four can be earned on each. Hence, the maximum score for Tests Two, Three, and Four in the above table is 40. The mean scores for Test Five, the Subject Preference Ranking, indicates that both groups, on the average, ranked science between second and third place in listing five classroom subjects in order of their preference.

Hypothesis Five. The post-test data obtained with the same instruments employed in the pretesting generated a discriminant function which indicated that the ISCS and control groups were not significantly different at the .20 level of probability, with respect to the five measures employed. However, the discriminant function generated in this analysis included the variable associated with the attitude related to the nature of scientific laws. Calculation of the scaled weights of the variables included in the discriminant function which resulted from this analysis indicated that this variable was one of the most important in detecting differences between the ISCS and control groups on the post-test (Table 6). The analysis of the pre-test data did not allow this variable to be included in the resultant discriminant function. These findings suggested that the ISCS program may do more to enhance the attitude related to the nature of scientific laws than the mixture of non-ISCS programs employed by the control group teachers.

TABLE 6

MEAN SCORES AND STANDARD DEVIATIONS OBTAINED FROM THE BATTERY OF INSTRUMENTS ADMINISTERED AS POST-TESTS TO THE ISCS AND CONTROL GROUPS

Test	ISCS $\bar{X}$	Control $\bar{X}$	ISCS S.D.	Control S.D.
One	62.76	61.11	7.01	6.82
Two	28.44	27.58	3.42	3.88
Three	32.08	31.49	3.71	3.88
Four	27.15	25.87	6.84	7.02
Five	3.04	3.16	1.33	1.36

Again, Test One refers to the Self-Reliance Test, Tests Two, Three, and Four refer to the three subtests contained in the Scientific Attitude Inventory, and Test Five refers to the Subject Preference Ranking. As before, the maximum score possible on the Self-Reliance Test was 80. The highest possible score on each of the three subtests contained in the Scientific Attitude Inventory was 40, and the mean score for the Subject Preference Ranking reflected the fact that, on the average, students in both groups ranked science as less than their third choice of classroom subjects.

Hypothesis Six. A discriminant analysis in which the control pre-test and post-test data obtained with the instruments mentioned above was conducted in order to determine the effects of the control treatment on the five variables employed in this phase of the study. This analysis produced a discriminant function which indicated that the pre-test and post-test data for the control group was not significantly

different at the .10 level of probability. Calculation of the scaled weights of the variables included in the resultant discriminant function revealed that the change from the pre-test to the post-test in the data associated with the test which measured the attitude related to the nature of scientific laws was the second most important factor in detecting the difference in the data from the two testings. In other words, the control group experienced a change in the attitude related to the nature of scientific laws, but the increase in this attitude was not sufficient, when coupled with the other variables in the discriminant function, to produce a significant discriminant function at the .05 level of probability.

Hypothesis Seven. The pre-test and post-test data obtained from the battery of instruments involved in the pre-test - post-test phase of this study for the ISCS group was subjected to discriminant analysis in order to determine whether or not the changes which had occurred in the ISCS and control groups were similar. This analysis produced a discriminant function which indicated that the pre-test and post-test data for the ISCS group was significantly different at the .05 level of probability. In fact, the resultant discriminant function was significant at the .02 level of probability. The scaled weights calculated from this data indicated that the variable associated with the attitude related to the nature of scientific laws was more than twice as effective as the next most effective variable in detecting the differences between the pre-test and post-test data from the ISCS group. This finding indicated that Level One of

the ISCS program does much more to enhance the attitude associated with the nature of scientific laws than any of the other factors investigated in this phase of the study.

Hypothesis Eight. Discriminant analysis of the post-test data collected from the ISCS and control groups with the three subtests included in the Student Inventory generated a discriminant function which indicated that the two groups were not significantly different with respect to these three variables at the .05 level of probability. The resultant discriminant function was significant, however, at the .10 level of probability. Calculation of the scaled weights of the three variables included in this discriminant function revealed that the variable associated with the students' view of the warmth of their teacher was over twice as effective in detecting differences between the two groups as the next most effective variable. This finding suggested that the students in the ISCS group tended to view their science teacher as being a warmer person than did the students in the control group.

Hypothesis Nine. The Classroom Activity Checklist was administered to the ISCS and control groups as a post-test. The data collected from this instrument was subjected to discriminant analysis. The discriminant function generated in this analysis indicated that the ISCS and control groups were significantly different with respect to the five variables included in this instrument. The level of significance was beyond the .001 level of probability. The scaled weights calculated for the five variables included in this discriminant function revealed that the variables associated

with student classroom participation and with the design and use of tests were the most effective in discriminating between the two groups. A somewhat surprising finding was that the variable associated with the nature and use of laboratory activities was by far the least effective in detecting the difference between the ISCS and control groups.

> Hypothesis Ten. When a random sampling of junior high students taking Level One ISCS materials is trichotomized on the achievement-progress index, no significant difference between the top and bottom one-third of the students is observed on the student-perceived, teacher variables of warmth, demand, and use of intrinsic motivation.
>
> Hypothesis Eleven. When a random sampling of junior high students taking Level One ISCS materials is trichotomized on the achievement-progress index, no significant difference between the top and bottom one-third of the students is observed on the student-perceived, classroom variables of teacher role, student participation, use of textbook and references, examinations, and laboratory activities.
>
> Hypothesis Twelve. When a random sampling of junior high students taking Level One ISCS materials is trichotomized on the achievement-progress index, no significant difference between the top and bottom one-third of the students is observed, after the pre-test scores are subtracted out as a covariate, for three kinds of science attitudes.

In this design only the post-test scores of the Student Inventory (WDM), Classroom Activity Checklist (CAC), and Scientific Attitude Inventory (SAI) were used as criterion measures. These post-test scores were randomly sampled from the population and divided into three groups: top, middle, and bottom one-thirds in the achievement-progress index. There were fifty students in each group. This represents a sample of 150 out of 600 students for whom all data was available. Figures 1, 2, and 3 contrast the scores of the top and bottom group.

FIGURE 1

GRAPH OF STUDENT INVENTORY MEANS FOR THE TOP AND BOTTOM ONE-THIRD ACHIEVEMENT GROUPS

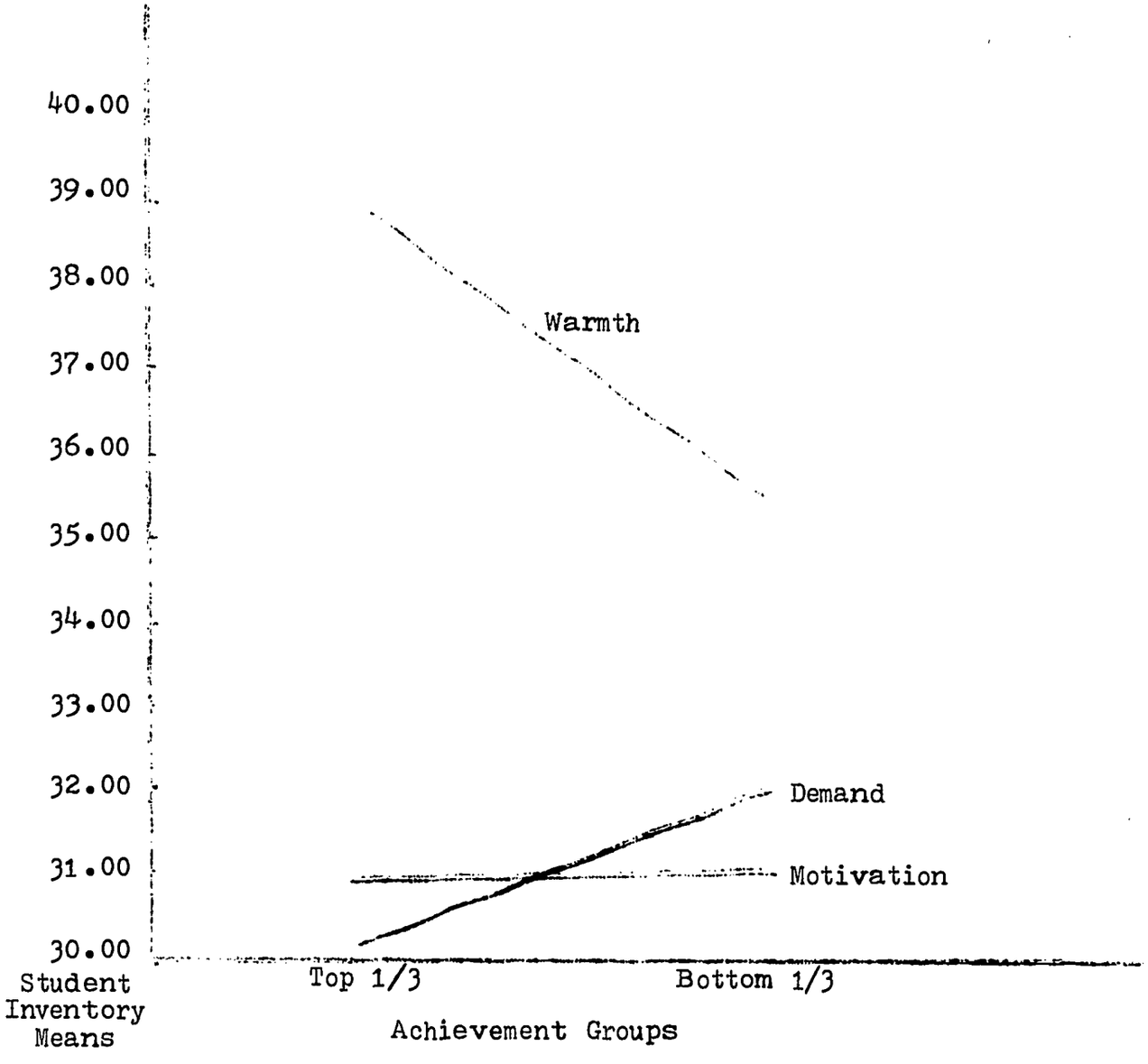


FIGURE 2

GRAPH OF CAC MEANS FOR TOP AND BOTTOM ONE-THIRD ACHIEVEMENT GROUPS

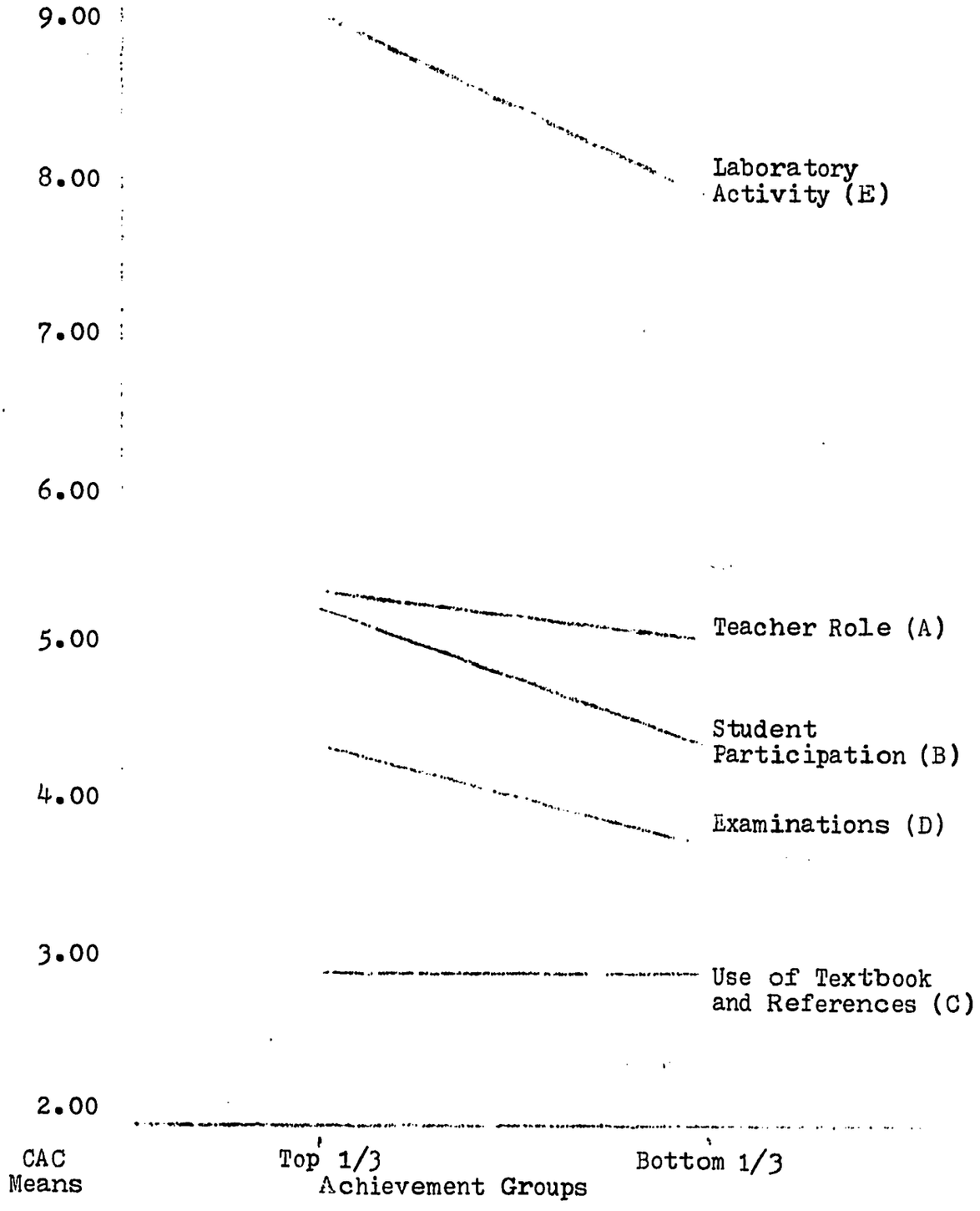
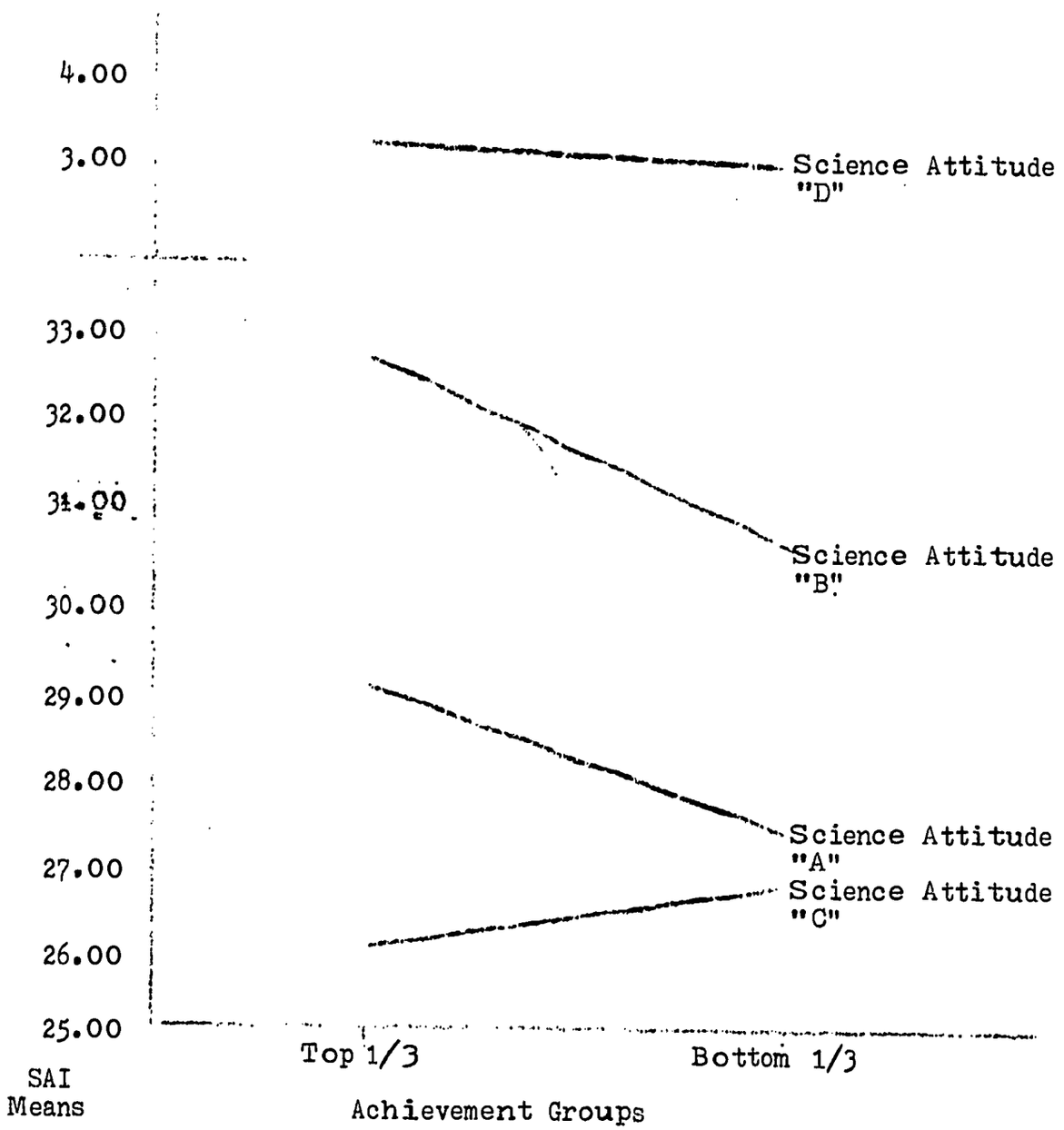


FIGURE 3

GRAPH OF SAI MEANS FOR TOP AND BOTTOM
ONE-THIRD ACHIEVEMENT GROUPS



An analysis of variance between the top and bottom one-third of the students across the variables of the WDM and CAC was effected with the UCLA biomedical program BMD01V. An analysis of covariance using the pre-test scores as a covariate was effected for the top and bottom one-third student samples on the SAI. The pre-tests were used as a covariate because it is logical to assume that students will enter a class with preconceived attitudes which could affect the variance in the post-test scores. In order to obtain a "t" for testing significance of differences, it was possible to take the square root of the F ratio because the degrees of freedom between groups is one.

The purpose of this particular design was to note any differences between high and low achievers in their attitudes toward science and in the way they perceive their teachers and classrooms. It should be noted that this design is corroborative of the correlation matrix design with respect to the variables the two designs have in common.

Null Hypothesis Ten could not be rejected for any of the three teacher variables of the Student Inventory at the .05 level of confidence. However, high ISCS achievers perceived their teachers as more warm and less demanding than low achievers, although the difference was not significant. The scale which measured teacher use of intrinsic motivation showed negligible difference in means for high and low achievers.

Null Hypothesis Eleven could not be rejected for sections "A" and "C" of the CAC at the .05 level. It was rejected at the .05 level of confidence for sections "D"

and "E" and at the .01 level of confidence for section "B". The five sections of the CAC measure the following variables: (A) role of the teacher in the classroom, (B) student participation in the classroom, (C) use of the textbook and references, (D) design and use of examinations, and (E) laboratory activity.

Null Hypothesis Twelve was rejected at the .05 level of confidence for section "A" of the SAI and at the .01 level of confidence for section "B" of the SAI. Hypothesis Twelve was accepted for sections "C" and "D" of the SAI. The four sections of the SAI measure the following student attitudes: (A) science as an approximation to truth, (B) science as an empirical discipline, (C) science as a career choice, and (D) science as a preferred school subject. The means for the top and bottom thirds of the ISCS sample population indicated that the high achievers scored higher on sections "A" and "B" of the SAI than did the low achievers.

Conclusions

Student Inventory. ISCS Level One materials are designed to release the classroom teacher from the authoritarian role of lecturer, demonstrator, and central classroom figure. The teacher is supposed to become a resource person who interacts intimately with each student individually in the course of his self-paced study. It is logical to assume that the ISCS teacher's new role would affect the students' perceptions of that teacher more during the course of the year than would the more traditional role of a non-ISCS teacher. However, the gain scores for ISCS and non-ISCS teachers during the school year were not significantly

different on the variables of teacher warmth, demand, and use of intrinsic motivation.

In addition it would be expected that the gain scores on the Student Inventory (WDM) would be positive, at least for ISCS teachers, in going from pre-test to post-test. On the contrary, both experimental and control teachers received negative gain scores on the Student Inventory. The mean scores for the experimental ISCS teachers, however, were initially higher than those for control teachers and remained higher on the post-test comparison.

The Student Inventory developed 10 years ago may no longer be in tune with the classroom strategies presently employed in ISCS classrooms. An examination of the warmth scale items suggests the set of most durable items. The weighed scoring of the demand scale, with its emphasis on teacher imposed standards of promptness, correctness and orderliness may be in conflict with the day to day practices in ISCS classrooms. The intrinsic motivation scale probes, in part, the role of the teacher in relating the science taught to events outside the classroom. This facet of instruction may not be obvious, particularly in ISCS classes taught by a teacher for the first time.

No special explanation can be made for the negative gain scores for experimental and control teachers. Perhaps, because a separate-sample design was used, the nature of the student population changed between the spring of 1971 and the spring of 1972. The limited nature of the control group might also have affected the negative gain score trend.

Correlations. For the post-test data of the ISCS experimental group, significant positive correlations were obtained between teacher warmth and the variables of student achievement, two student attitudes regarding the approximate and empirical natures of science, and student choice of science as a career. Teacher demand and use of intrinsic motivation were not significantly correlated with these student variables. The implication of the correlations is that an ISCS teacher with a warm, accepting personality can foster beneficial growth in student achievement and science attitudes. It should be realized, however, that significant correlations do not indicate the linear strength of a relationship and that the implication or hypothesis is strengthened only because it has survived a chance of disconfirmation.

Classroom Activity Checklist. ISCS Level One is designed to allow the student to do many experiments as a vehicle in arriving at meaningful concepts. The activity centered ISCS program encourages students to work through the materials and teach themselves. If one were to measure the classroom activity of ISCS and non-ISCS classes against the activity of an "ideal" ISCS classroom, one would expect the gain scores for the ISCS classes during the year to be significantly different from the gain scores for non-ISCS classes. This expectation was fulfilled in two sections of the Classroom Activity Checklist: (A) role of the teacher in the classroom and (B) student participation in the classroom. The gain scores were also in a direction consonant with ISCS philosophy.

The three sections of the CAC which did not yield significant differences in gain scores for experimental and control groups were (C) textbook and reference use, (D) design and use of examinations, and (E) laboratory activity. The lack of significant differences for sections "C" and "D" could be attributed to the fact that these two areas are more directly under the influence of the teacher; in other words, they are not teacher-proof. Therefore, ISCS teachers could have interferred with ISCS philosophy regarding sections "C" and "D" because of past teaching experiences and inclinations.

It is surprising that section "E" of the CAC did not yield significantly different gains between ISCS and non-ISCS classes. ISCS is more laboratory-centered than most other junior high programs. The explanation for this confounding result probably lies in the character of the control population. The control teachers taught in an area of Kansas which has rather innovative school districts. This special character of the control population could have obliterated the effect of the treatment in the portion of the design measuring laboratory activity.

Attitudinal Measures. Several interesting findings arose from the analyses conducted in this study. From the perspective of the ISCS objectives, the most positive finding was related to the significant positive increase in the attitude associated with the nature of scientific laws, as experienced by the students in the ISCS group. A comparable enhancement of this attitude was not experienced by the students in the control group. This difference in the growth

experienced by the students in the two groups with respect to this attitude cannot, however, be legitimately attributed to the use of laboratory activities by the ISCS program. The discriminant analysis of the data collected from the Classroom Activity Checklist indicated that the two groups of students viewed laboratory activities as being used very similarly in the two types of classrooms.

If the cause for the difference in growth of this attitude in the two groups of students is reflected by the responses given to the instruments included in the Student Inventory and the Classroom Activity Checklist, rather than by some other unmeasured factor, then the factors which most likely contributed to this difference are associated with the factors of student classroom participation, design and use of tests, and teacher warmth. Of course, the combination of these factors may have been necessary in order to produce the difference in the growth of this attitude, but this investigator feels that the difference in the level of student participation in the two types of classrooms may have been the most important single factor. It seems reasonable to believe that active participation in science activities would be an important contributor toward the enhancement of an attitude associated with the nature of scientific laws. Without this personal involvement, the understanding and appreciation of the nature of scientific laws possessed by the student would probably not change.

On the other side of the ledger, the findings of this study do not indicate that Level One of the ISCS program fosters a positive growth in some other important areas. The

pre-test and post-test data collected through use of the instrument designed to measure the scientific attitude associated with the limitations of science indicate that the ISCS students experienced no appreciable change in this regard. A similar situation was reflected in the control group. Nonetheless, if an appropriate attitude toward the limitations of science is desirable, and since the ISCS program purports to have as one of its objectives the enhancement of scientific attitudes, then it must be concluded that Level One of the ISCS program fails to meet its objective in regard to this attitude.

Moreover, the pre-test and post-test data gathered through administration of the instrument designed to measure the scientific attitude associated with the desirability of science as a vocation indicates that the students in the ISCS group experienced negative growth with respect to this attitude. It is true that the students in the control group also experienced a similar decline with respect to this attitude. Again, however, this finding suggests that Level One of the ISCS program failed to meet its objective at this point. It may well be that concentrated exposure to laboratory activities does not make young people feel that they would like to continue activities of that sort as part of their life's work.

The pre-test and post-test results from the Subject Preference Ranking indicated that both groups ranked science lower in their preferential ranking at the end of the year than they did at the beginning of the year. It may be reasonable to assume that the enthusiasm and liking that

students have for a given classroom subject will diminish through the course of an academic year, but this finding indicates that a subject or subjects which were initially ranked below science in the preferential listing were ranked above science after a year's experience with the classes. This means that the science offerings did not manage to maintain, let alone improve, the relative appeal that science has for students. This is not an encouraging finding. With the increasing impact which science will continue to have on the lives of citizens in this society, it seems important to develop science curricula which will foster a desire to learn and know more about science. If the preferential ranking students gave to science is an indication of their intention to enroll in additional science courses in the future, then it is clear that neither the treatment experienced by the ISCS group nor the treatment experienced by the control group fostered a positive attitude toward further study of science.

If this interpretation is valid, then this finding indicates that the ISCS objective of producing avid consumers of science is not attained by Level One of the program.

The data collected through administration of the Self-Reliance Test as a pre-test and as a post-test to the ISCS and control groups indicated that this dimension of a student's personal qualities may well be firmly extablished by the time he enters the seventh grade. Comparison of the pre-test and post-test means for the respective groups reveals that little change occurred in either group. One of the objectives of the ISCS program is to develop students who

are autonomous learners. It seems reasonable to believe that a direct relationship exists between the self-reliance an individual possesses and his ability to be an autonomous learner. If this is indeed the case, then it seems reasonable to conclude that Level One of the ISCS program cannot be expected to appreciably alter a student's ability to learn autonomously.

ISCS Achievement Levels. The purpose of Hypothesis Ten was to consider any differences between the way high and low ISCS achievers perceive their teacher on the Student Inventory. That is, does a student who is doing well see his teacher differently in terms of warmth, demand, and motivation as compared to a student who is doing poorly?

It is evident that the high achievers in ISCS Level One give their teacher a higher mean score on warmth than the low achievers (38.98 versus 35.56). However, the "t" of 1.86 fails to be significant at the .05 level. The Pearson "r" for achievement and warmth is .3651, which is significant at the .01 level. The reason for the discrepancy in significance between the two tests arises from the fact that the correlation coefficient rests upon more information because it retains the middle one-third of the achievement trichotomy.

There is a negative relationship between the way high and low ISCS achievers view their teacher on the demand variable; the low achiever perceives his teacher as more demanding than the high achiever. The "t" test fails to be significant at the .05 level. However, the Pearson "r" between achievement and teacher demand is -.2672, which

is significant at the .01 level. Again, the correlation is significant because it is based upon more information than the "t" test.

Evidently high and low ISCS achievers do not perceive their teachers differently on the intrinsic motivation scale of the Student Inventory. The difference in means for intrinsic motivation is minute, and the "t" test is quite small and insignificant. Under Hypothesis One, no significant correlation is observed between student achievement and teacher use of intrinsic motivation.

In summary, null Hypothesis Ten is accepted for all three variables in the Student Inventory. However, if the information from the middle one-third achievement group is included, as in the correlations of Hypothesis Two, significant relationships between achievement and the variables of warmth and demand are observed. The fact that the "t" tests failed indicates that these relationships, while significant according to the Pearson "r" coefficient, are not strong enough to survive a trichotomization on achievement.

When a comparison of the perceptions of classroom activity was made between high and low achievers on ISCS behavioral objectives in Hypothesis Eleven, a significant difference was obtained for the classroom variables (B) student participation in the classroom, (D) design and use of examinations, and (E) laboratory activities. The high achievers in ISCS behavioral objectives perceive the classroom in a manner more consonant to the "ideal" ISCS classroom than do the low achievers. This difference in perspective

may result from a better overall understanding of the philosophy and purpose underlying ISCS.

The purpose of Hypothesis Twelve was to test any difference in the science attitudes that high and low ISCS achievers hold at the end of the school year, after the variance for science attitudes held at the beginning of the year is removed as a covariate.

From the information obtained from the analysis of covariance, it is evident that null Hypothesis Twelve can be rejected at the .05 level for section "A" of the SAI and at the .01 level for section "B" of the SAI.

Section "A" of the SAI relates to the student considering science as an approximation to truth and subject to change. The analysis of covariance for section "A" gives an "F" ratio of 6.447, and a graph of the means for section "A" indicates that the high achievers have the higher mean. Hence, high achieving ISCS students have a significantly better conception of science as approximate and changeable than do low ISCS achievers. Likewise, the high achieving ISCS student had a significantly better grasp of "B", science as empirical, or based on natural phenomena, than did the low achievers.

Limitations of the Study

Four major considerations need to be kept in mind as the conclusions of this study are reviewed. First of all, the nature of the control group must be recognized as one considers those conclusions which are related to the relative effectiveness of Level One of the ISCS program and the programs employed in the control group. The control group

data reflects a mix of non-ISCS approaches to teaching science. Consequently, it is impossible to clearly identify the nature of the experiences associated with the control group treatment. It should be kept in mind that the majority of the students in the control group attended suburban schools which are noted for their progressive and excellent educational programs. This fact makes it reasonable to believe that the educational experiences of the majority of the students in the control group were of high quality. That is, the control treatment was not necessarily what one normally calls a traditional, textbook-oriented experience, as supported by the report of laboratory activities by the control group.

The second factor is that even though this study suggests that some of the objectives of the ISCS program are not met by Level One of the program and that this fact may make it difficult for the other two levels to attain them, it is possible that the cumulative effect of the three year sequence is such that those objectives will be met.

The third factor which may have affected the findings of this study is related to the timing of the posttesting. Discussions with individual ISCS teachers indicated that the posttesting occurred at a time when many of their students were at a point in the Level One program which is not as appealing to the student as are the other portions of the course. This temporary reduction of enthusiasm for the ISCS program could have had an adverse effect upon the responses of the students in the ISCS group.

The fourth factor which must be considered as the conclusions of this study are contemplated is associated with the testing procedure. The administration of the instruments was carried out by the teachers rather than by the investigators. Although uniform written instructions were provided for the administration of the tests, there was undoubtedly variation in testing conditions. The findings of this study were confounded to the extent that this lack of uniformity in testing affected the data.

Recommendations

This study suggests several interesting and important questions which should be investigated. The differential effect of Level One of the ISCS program upon the scientific attitudes of students of high, average, and low self-reliance should be investigated.

A longitudinal study encompassing the entire three-year sequence of the ISCS program should be conducted. A study of this duration will be required before the true effects of the ISCS program upon scientific attitudes and self-reliance can be assessed.

The effect upon student responses to the Student Inventory when a teacher changes from a non-ISCS approach to science teaching to the self-pacing, individualized approach of the ISCS program should be investigated. It is possible that when a teacher has the opportunity to assume a new role in the classroom, students will see him very differently as a person.

Research designed to ascertain specifically those classroom practices and teacher characteristics which serve to foster desirable growth in scientific attitudes is needed. It is hoped that the study reported here suggests likely relationships between these variables.

Until science educators have established which classroom practices and teacher characteristics are appropriate for the enhancement of positive scientific attitudes, attempts at educating students for a science-influenced society will continue to rely on intuitive and philosophical considerations alone. Moreover, these relationships must be established if teacher training programs are going to prepare teachers to teach science in such a way that young people will be prepared to make decisions as adults in the science-oriented society of which they will be a part.

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End of the Year Comments of ISCS Teachers

1. Offered an opportunity to see students as they really are. Lazy, aggressive, quiet, fast, slow, interested, etc.
2. Created an almost impossible means of evaluation while getting students off to a "good" motivating start (first of year.)
3. Provided me opportunity to implement material outside the book for the motivated student.
4. Afforded me a chance to discuss the ISCS program of (individualizing) science to my collegues.

I feel that without the NSF Institute training, I would not be teaching ISCS Science this coming year. In the school district where I work, the science teachers who have attended an ISCS institute have stayed on the job, the others have quit and moved to other school districts.

A revised edition of Level I would be an improvement.
The Level II teachers feel that the students keep there interest up through most of the course. The textbooks are better written.

I think the ISCS program I taught this year allowed me to be the most effective teacher I have ever been. I felt comfortable teaching it and the students were really "turned on" by it. What more need I say?
The kids didn't allow me the five-minute break between classes (I didn't even get a cup of coffee!). They were standing at the door waiting to get into the lab before the previous group could get out of the lab.
By judicious grouping I was able to have some capable student and a slower student in each grouping of four. Of course, this was not a hard and fast situation. By the end of the year I had teams of one, two, three, four and even five, working at their own pace and level of ability.
The more capable students finally got the attention they so seldom get. For the first time we weren't geared to mediocrity but were allowing some students to literally soar to the heights of achievement. Ten of these better students completed the course and spent from one, two, three, even four weeks doing an "independent study". WOW! did they think they were GREAT. One student, wanting to do a comparative study of the protein values of foods started out this way: "Mrs. Boesker, what is the OPERATIONAL DEFINITION of protein?" Isn't that just fantastic?
Three seventh grade boys worked with ESS Optics, but because of the scientific inquiry they had developed during the ISCS program, went into optics so deeply the principal of our building became involved.

This year I purposely refrained from total group explanations almost altogether so as to fit me more closely into the ISCS plan. I feel that I could have done a better job with a few of the concepts if I had used a few total-group situations at strategic points. Next year I'm going to do my own thing in my own way (as I did the first year), and I think I will feel a little better satisfied at the end of the year. I have also experimented with my classes in regard to setting some time limits. I have found time limits to be helpful in urging some pupils to use time more wisely. I shall see that the limits

are generous, but I plan to set some limits next year. For most of my pupils, one evening after 3:30 is a real pepper-upper!

We plan a one week workshop Aug. 14 and 5 Sat. meetings for the coming year. We will have about 50 teachers teaching ISCS next year. I plan to help in the workshop as a resource person. Teachers throughout the year came to our school and based upon what they observed decided for or against teaching ISCS for the coming year. Most are trying it. All but 2 schools.

Probably the best comment about ISCS is the student's involvement in the work. For the most part all students like that about ISCS.
Mentioning certain ideas over and over again was the major item students disliked about ISCS.

As a whole I was very pleased with the whole program. There are a few things I miss teaching with the ISCS program but it has many good additions which make up for them.
I would enjoy teaching ISCS next year and even if I didn't teach it I think it would influence me to change the way in which I would conduct a typical classroom.

In an evaluation by students--after the grades were already out, 74 of the 80 students thought they'd like to have Level II in the eighth grade. Also, 64 students thought they'd learned more & remembered the info better with ISCS than with the other lecture courses. 13 thought they learned more from lecture & 3 thought it was about the same.
We are sold on ISCS in Hays & felt that your institute was the greatest thing that happened in science to help us--EVER!

I was responsible for Level II (3 sections) and Level I (1 section) this year, and will again handle a similar responsibility next year. I feel Level II was a tremendous success based on what the students learned as well as their grades. Parents and the Board of Education were impressed with the quality of education their children received from ISCS instruction. During open house and similar visits, they could see what the students did during class time and had nothing but praise for the program. My year was enjoyable and unhampered by accidents or disciplinary problems. All of my students finished the book leaving time for individual projects in all fields of science. As a result of the ISCS program, I will have a larger room for next year to handle more students who wish to take Level II. Before, we had to beg students to take science; now we have had to expand our facilities and hope this will be sufficient to handle the many who now want to take science. I feel the NSF institute at KU last summer was very beneficial not only in helping me implement the Levels I and II programs effectively, but also helped me as an individual in preparing the programs the way in which they were meant to be taught.

I really enjoyed teaching Level I of ISCS this last year. The part which I feel is the best is self-pacing where a student can work at his own speed plus the student is doing the

experimenting. Not a demonstration. There were some students who just poked along, but I feel it was the fault of the teacher and plans are already underway to take care of that problem. In Summary: It's GREAT!

The program's philosophy is fine but the equipment in the electricity chapters is frustrating. Most of the time it doesn't work in a depending manner--the girls aren't too fond of this area so you can see what it does to them. The student batteries cause more trouble--too much time spent in charging batteries--cleaning them--waiting around and getting into trouble. The program does keep the slower students happy but they don't emerge from this experience with better grades. It's very difficult to evaluate the learning process. Some areas seem to be easier for the students to grasp the concepts. The last chapters (8-21) seem to keep the students happier because everything works better equipment wise. This program doesn't have all the answers but it is much better than our previous program.

I feel Level I is somewhat limited as to the content and concepts presented. Level II is a very thorough presentation of elementary chemistry and does an outstanding job of developing for the student a particle model of matter. The ISCS program enables the student to investigate scientific phenomena by doing.

If a student becomes disinterested, it is almost impossible to get them moving again. Lacking incentive of the pressure type seems to be the problem. I was unable to determine whether the students are actually gaining the science concepts. Most capable students will complete the course before the year's end unless breaks are taken.