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AN ASSESSMENT OF INTRODUCTORY PHYSICAL SCIENCE USING THE TEST ON UNDERSTANDING SCIENCE

by
George Ronald Stangl

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of the requirements for the degree of
Doctor of Philosophy
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in the University of Michigan
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ABSTRACT

AN ASSESSMENT OF INTRODUCTORY PHYSICAL SCIENCE USING THE TEST ON UNDERSTANDING SCIENCE

by

George Ronald Stangl

Chairman: Burton E. Voss

Introductory Physical Science (IPS) is a highly structured course having a prescribed sequence of experiments and procedures. The purpose of this study was to determine the suitability of a highly structured course (IPS) for all eighth grade students in a suburban school. Taking into consideration the mental abilities of the students, the major measure for the evaluation of the course was to study the degree of teacher commitment to the objectives of IPS and determine if this influenced the students' mastery of IPS content and their perception of science as measured by the Test on Understanding Science (TOUS).

The course objectives are stated as follows: (1) to give a feeling for the kind of human effort that is involved in the pursuit of science, (2) to drive home the point that science is phenomena first and the names come later, (3) to get data from nature itself, (4) to correlate and generalize observations, (5) to construct models or theories which can be manipulated logically and which will raise new questions, and (6) to teach the handling of errors.

Twelve teachers and one randomly selected class per teacher provided a sample of three hundred students out of a population of twelve hundred eighth grade midwestern General Science students. Pre and posttests were administered to all twelve classes. The tests were a summary IPS Achievement Test and the Test on Understanding Science (TOUS) Jx.

A panel of five classroom teachers who were experts in the philosophy and objectives of IPS were asked to respond to a Classroom Activity Checklist (CAC). Their responses served to create a model of an ideal IPS teacher. The CAC was administered to the twelve classes in this study at the end of the school year, thereby enabling the ranking of the teachers against the constructed ideal.

Analyses were carried out to investigate what influence the degree to which a teacher approached the ideal IPS teacher had on his students' achievement and understanding of science.

The general academic ability of the students was obtained from their scores on the Verbal Reasoning and Numerical Ability portions of the system-wide administered Differential Aptitude Tests (DAT). This ability measure was used as a covariate to investigate the influence of the student's ability on his success in the mastery of IPS content and the understanding of science.

A positive relationship was discovered between the degree to which a teacher accepted and practiced the

philosophy and objectives of IPS and the success his students had in the course. No influence could be attributed to this "IPS-ness" in regard to the students' understanding of science. The student's general academic ability had some significance to his success in IPS and to his understanding of science but was more critical to his mastery of IPS content.

It was concluded that IPS is not flexible enough to be successfully presented to the wide range of student abilities found in a normal public school system. Also, IPS did not produce any significant change in students' perception of the nature of science as measured by the Test on Understanding Science (TOUS) Jx.

ACKNOWLEDGMENTS

The writer is especially grateful to the chairman of his doctoral committee, Professor Burton E. Voss, who provided instruction and assistance in the most difficult stages of this study.

Cooperation from many of the writer's teaching colleagues made it possible to conduct this investigation.

The study would not have been completed without two understanding children and a wife who spent some of the longest hours of her life proofreading and typing this thesis.

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CHAPTER I

INTRODUCTION

It has been stated by George B. Stern (16) that, "It has become increasingly clear that we need to know more about what we (educators) do and how this affects the student, regardless of the reasons which might be given as to why we do them."

This study is an attempt to ascertain what success eighth grade students in a suburban school district are achieving in Introductory Physical Science (IPS). Is IPS meeting its objectives for most of these students? What students or teachers are achieving the desired objectives of IPS?

General Science Programs in Junior High School

General Science is a relatively recent addition to the junior high school curriculum. It was introduced into a few schools around the turn of the century. Widespread adoptions occurred between 1915 and 1930 (3). By 1932 it had become a standard offering of the ninth grade curriculum in a majority of school systems across the country. As the growth and development of junior high schools was occurring, the extension of General Science into the

seventh and eighth grades was being encouraged.

General Science was envisioned as a natural part of the junior high school curriculum because of the attendance patterns and general philosophy of the role of junior high schools. Hunter (7) states that during 1908 in New York City, forty-three percent of the enrolled pupils had left school by the end of the tenth year. The formal science courses of the time were, in part, responsible for the high drop-out rate.

It was apparent that a need for a different type of science course existed. Educators wanted a course that was suited for those students who would elect no more science, a course that would help them understand and use the things being introduced into the mainstream of their daily lives by a growing mechanized society. Also voiced was the concern that this course should permit growth and development of interests by those who would continue on to the more formal science courses. Thus General Science was introduced into the curriculum as part of a general trend to humanize the secondary school curriculum, and it found its home in the general philosophy and goals of the early junior high schools.

While General Science was a label, the content of this course varied widely. Some teachers presented samplings of the various specialized sciences loosely tied together. These samplings were of both the exploratory and introductory type and offered little value to those students who

were not going on in scientific fields. Some teachers emphasized the practical applications such as how to repair a lamp, fix a leaky faucet, or choose a proper diet. Formally trained science teachers considered these do-it-yourself courses to be a "hodge-podge" of little value.

A study conducted in 1930 showed that some science teachers felt General Science needed broader goals. The teachers in this study were thinking in terms of the development of interest, desirable attitudes, and certain general skills (8), and most were thinking in terms of giving an understanding and an interest in the environment. It is significant that few considered General Science to have any responsibility toward helping boys and girls adjust to their social groups or to explore their capabilities. General Science teachers, generally, were thinking as science specialists, not as educators.

In 1932 there appeared the Yearbook of the National Society for the Study of Education, a publication that was to have a strong effect on General Science (13). It proposed a program based on the major concepts of science and listed thirty-eight major generalizations to be used as objectives for science instruction throughout the entire sequence of elementary, junior, and senior high school science.

Structuring a science program around major concepts makes possible a highly organized and well-integrated outline which is extremely logical from the adult point of

view. This suggested structure was, thus, quickly accepted by administrators who liked clearly defined objectives and well-developed sequences. The proposals of the Yearbook dominated the thinking of science educators for the next two decades and still influence curriculum changes today.

There were objections to the Thirty-first Yearbook proposals. Hunter said, "Intellectual objectives hold complete domination over practical ones." (8)

Only recently have we seen a trend away from generalization toward discovery, but there is great debate about what is to be discovered. Is it to be the same generalizations of the 1930's or the principles of the kinetic molecular theory or the laws of nature?

General Science has become activity-centered and less time given to reading. Still prevalent is the trend to use General Science as a preparatory class for the more formal science courses of senior high school.

Structure of Science Curriculum

The science curriculum of the school district has a kindergarten through twelfth grade structure. The first eight years of this structure are prescribed. Selected units of study are presented to the students every year or in alternate years; some units appear on a three year cycle. Before the adoption of Introductory Physical Science (IPS) into the eighth grade, seventh and eighth grade General Science was made up of the same units presented in the

lower grades. The units were presented again in greater depth by teachers with more academic training in these special content areas. Starting in ninth grade, depending on a student's goals and skills, students could have as little as one year or as much as four years more of science education.

Thus the seventh and eighth grade science courses attempt to serve as both a terminal in the prescribed sequence and a transition point between a generally descriptive mode of science and a quantitative mode of science.

Rationale for Adoption of Introductory Physical Science

The junior high science teachers adopted Introductory Physical Science (IPS) as the course of study for eighth grade General Science in September, 1968. Pedagogically, among the reasons for selecting IPS was the fact that with the explosion of knowledge in the various scientific disciplines, much of what was being taught was out-dated before a student graduated from high school. As a result of attempting to teach the rudiments of many different disciplines, the processes of science were often slighted. Laboratory exercises, as a mode of instruction, were often discarded because of their inefficient use of time in teaching a large body of content.

Other reasons given for the selection of IPS over other approaches to a general physical science program

were (1) it was a relatively inexpensive program in terms of capital outlay, (2) it was a highly structured course providing support for teachers who might have weak academic preparation or little experience in teaching; i.e., first year teachers, and (3) it could be taught in classrooms that presently had no special facilities such as running water.

For two years prior to the formal adoption of this course, two teachers in the school system had been using IPS in their classrooms. These pilot studies provided positive feedback to the rest of the science staff. IPS was superior to the old methods mainly because of the active participation of students in the processes of science as a daily activity, not as an occasional laboratory exercise. Also, the content mastered in IPS appeared to be highly relevant to those students who continued on with the more challenging science courses.

A conscious shift in emphasis was sought with the selection of IPS as the required eighth grade science course. Processes of science were now to have top priority with content mastery being supportive to these skills.

Structure of Introductory Physical Science

Introductory Physical Science (IPS) was developed under the direction of Dr. Uri Haber-Schaim. The initial objective of IPS appears to have been one of preparing students for the new physical science courses such as Physical

Science Study Committee and Chemical Bond Approach. Coupled with this goal was the director's realization that IPS must also be able to stand on its own as a terminal course.

> Thus we must have a program to serve two purposes: on the one hand to be a sound foundation for future physics, chemistry, and perhaps biology courses; and on the other hand to furnish sufficient nourishment in the essence, the spirit, and the substance of physical science to be a good terminal course for those who will not study physical science later on. (6)

Dr. Haber-Schaim goes on to state the following course objectives:

> ...to give a feeling for the kind of human effort that is involved in the development of science.
> ...to put across the point that the root of all science is phenomena and that names come later.
> ...to get information from nature itself.
> ...to correlate and generalize observations.
> ...to construct models or theories which can be manipulated logically and which will raise new questions.
> ...to teach the handling of errors. (6)

The structure of the course and general operating procedures are clearly expressed in the Teacher's Guide to Introductory Physical Science (9).

1. Introductory Physical Science was constructed on the theory that, whenever possible, the student should learn physical science in the laboratory and that his ability to understand the discoveries of others depends on his having real experiences himself. The laboratory, therefore, is the integral and dominant part of the course. Instructions in the IPS textbook are minimal and call attention to important points by asking questions.

2. Instructors are not to answer questions but are to have discussions that help the students find their own answers.

3. Experiments have been sequentialized and are to be studied in the prescribed order, because this points out the building of concepts as a product of organized investigation. Also, topics and techniques from early chapters are used throughout the year.

4. Pre-laboratory and post-laboratory discussions are extremely important. The authors of the course feel that in order to interpret the results of an experiment and understand the implications of the results, a student must understand why he is doing an experiment before he does it. Post-labs should pool information often to form a histogram. This pooling of data is critical to the development of the true nature of scientific truth. Possible sources of errors are to be discussed.

5. When and if experiments are repeated, it is particularly important not to give away the expected results. Experiments are designed to be performed by two students. A data notebook must be kept by each student.

6. The text contains a large selection of problems. There are easy, moderate, and complex problems. Fifty to eighty percent of the problems are judged by the authors to be appropriate.

7. The instructor is told to avoid the temptation of judging questions "right" or "wrong". Rather, he is to ask

for the reasoning behind the answers.

8. This course presupposes only standard facility with arithmetic. Some experience in ratios is desirable.

9. The authors have developed four objective achievement tests to measure the comprehension of the course by students.

Need for Assessment

> One way to assess the impact of the new programs is to determine whether the stated goals of the project have been achieved.... It is difficult to determine the extent to which stated objectives have been achieved and even more difficult to assess contributions to the general objectives of education. (19)

Though difficult, a determination to what extent the stated goals of the Introductory Physical Science (IPS) course have been achieved is the aim of this study. Assessment is needed because the required involvement of all students in the IPS program demands that its objectives be within the grasp of a high percentage of the students. To require a year's attendance in a course that is appropriate for only a portion of the student population or whose philosophy and objectives are not actually accepted by a large percentage of the teachers would seem to demand some corrective measures to make the course relevant to the population and efforts to affect a change in the curriculum.

Assessment is needed because IPS has not been evaluated in terms of its expected success with a wide range of student abilities at the eighth grade level and/or the

willingness of teachers to carry out the prescribed program. Assessment is necessary to provide the administration with better data on which to base its decisions about the continuation and/or modification of the IPS program in this school district.

The Problem

The purpose of this study was to determine the suitability of a highly structured course (IPS) for all eighth grade students in a suburban school. Taking into consideration the mental abilities of the students, the major measure for the evaluation of the course was to study the degree of teacher commitment to the objectives of IPS and determine if this influenced the student's mastery of IPS content and his perception of science as measured by the Test on Understanding Science. Inherent to this study was the highly structural nature of IPS.

Hypotheses

The following hypotheses were tested:

1. There is no significant difference in the understanding of science between eighth grade students who have been taught by teachers who more closely approach a constructed ideal IPS teacher and eighth grade students taught by teachers who are ranked farther from the ideal IPS teacher.

2. There is no significant difference in achievement scores between eighth grade students taught by teachers who more closely approach a constructed ideal IPS teacher and eighth grade students taught by teachers who are ranked farther from the ideal IPS teacher.

The following subhypotheses were tested:

1. There is no significant difference in the understanding of science between eighth grade students taught by the top quartile of IPS teachers and those eighth grade students taught by the bottom quartile of IPS teachers.
2. There is no significant difference in the post IPS achievement scores between eighth grade students taught by the top quartile of IPS teachers and those eighth grade students taught by the bottom quartile of IPS teachers.
3. There is no positive and direct correlation between the Test on Understanding Science posttest scores and the Differential Aptitude Tests' scores of these eighth grade students.
4. There is no positive and direct correlation between IPS Achievement Test posttest scores and the Differential Aptitude Tests' scores of these eighth grade students.

Plan of the Study

The general plan of this study was to determine and use the degree to which teachers taught a prescribed science course to students having a wide range of general intelligence and to see what effects these two variables (degree of IPS behavior by teachers and student skill) had on students' understanding of science and mastery of the course content.

First and foremost, Introductory Physical Science (IPS) is a science course that professes to teach process skills involving observation, correlation, generalization, and interpretation of phenomena and/or data. Also sought is an attitudinal change in the students, involving their understanding of the development of science. Attempts to evaluate such objectives that are not made specific by behavioral definitions are frought with problems.

Secondly, what teachers are teaching the course? The careful selection and training usually found in pilot programs insures their early success. This should be a concern for any school system that adopts these programs. It has been pointed out by Davis (5) that a school system can change programs, but teacher behavior does not easily change. Another study by Yager (20), looking at the effect of the teachers, found statistically significant differences in students' understanding of science when taught by different teachers. The instrument Yager used was the

Test on Understanding Science (TOUS) Jx.

Thirdly, the students themselves present an important variable; with obvious variance in skill and ability are their various degrees of interest. Stone and Church (17) have written that far too often upon entering school, children find topics proposed for their edification that bear little relationship to the immediate curiosities they arrived with.

Twelve classes of eighth grade students in IPS took two pretests within the first four weeks of school. One pretest was the TOUS Jx, used to measure the students' understanding of science. The other was the IPS Achievement Test, constructed from unit tests published by the authors of this course.

Shortly after the pretests, the students took the Differential Aptitude Tests (DAT). The combined scores of the Verbal Reasoning and the Numerical Ability portions were used as a general intelligence indicator.

Four weeks before the end of the school year, the pretests were re-administered as posttests. In addition a questionnaire called the Classroom Activity Checklist (CAC) was administered to all classes to get a measure of the students' perception of their teacher's instructional and procedural behavior during the year.

Before its use in this study, the CAC had been submitted to a panel of experts in IPS in order that they could mark those activities that should and should not be

found in an ideal IPS course. The teachers in this study were then rated in regards to a constructed ideal IPS teacher. This was done by using their students' responses to the Classroom Activity Checklist.

Statistical analysis was used to compare students taught by highly rated teachers and students taught by lowly rated teachers. The comparisons were done for both understanding of science and mastery of course content.

The students' general intelligence was used in an analysis of covariance over the same areas.

Basic Assumption

This study assumes that a student's ability and the degree to which his teacher teaches a course will be the primary factors affecting the student's performance on tests attempting to measure his understanding of science and mastery of course content.

CHAPTER II

REVIEW OF RELATED LITERATURE

Evaluation studies of Introductory Physical Science (IPS) are not found in the normal publications of science education.

Development of IPS

One source of information having a statement of the course objectives prior to its construction is a paper entitled Introductory Physical Science, Objectives and Content of the Course, by Uri Haber-Schaim, Director, Introductory Physical Science Program (6). This paper was adapted from a lecture given at Florida State University, Tallahassee. The paper, which lists no publisher or date of publication, is the most definitive statement of the course and its development presently available.

IPS started as an outline in the spring of 1963. It was initially funded by Educational Service, Inc. Later that year it received funding from the National Science Foundation.

The first eight chapters were used by ten teachers in 1963-64. Through their feedback a revision was written and

used in 1964-65 and 1965-66 by "about sixty teachers and about 2,300 students covering a wide range of ability and background." (6)

Educational Testing Service Analysis

In the publication Introductory Physical Science, Physical Science II, a Progress Report, Raymond E. Thompson (18) of the Educational Testing Service reports on the development and analysis of the IPS Achievement Tests (Series A, B, and C). This analysis provides some important insights into IPS:

1. The data presented in Table 1 presents summary data for two test series. Series A results are thought to be of typical students. Series C represents a sample of lower-ability students.

2. In the 1965-66 school year 1,005 ninth grade IPS students and 400 eighth grade IPS students took the School and College Abilities Test (SCAT), Survey Form, a test of verbal and mathematical ability. The results of Table 2 make it clear that these students were more scholastically able, on the average, than typical junior high school students in the nation.

3. The student's grade level and SCAT score were used to form six sub-groups for each test in Series A. For the ninth graders, a percentile score on the SCAT of 80 or higher placed a student in the high sub-group; a percentile score of 30 or lower placed the student in the low

sub-group. For the eighth graders, a percentile score on the SCAT of 70 or higher placed the student in the high sub-group; a percentile score of 30 or lower placed the student in the low sub-group. See Table 3.

TABLE 1

MEASURE OF PERFORMANCE ON IPS ACHIEVEMENT TESTS

Test	1	2	3	4
Series A				
Number of Students	1,818	1,632	1,170	370
School Year	1964-65	1964-65	1965-66	1965-66
Chapters Covered	1-3	4-6	7-9	10-11
Number of Questions	26	30	30	30
Mean Score	13.5	17.1	16.6	15.4
Standard Deviation	4.9	5.6	6.4	6.1
Reliability	.80	.81	.87	.83
Series C				
Number of Students	425	400	165	320
School Year	1967-68	1967-68	1967-68	1967-68
Chapters Covered	1-3	4-5	6-7	9-11
Number of Questions	25	25	25	22
Mean Score	13.3	13.5	14.9	9.2
Standard Deviation	4.6	4.5	5.2	4.7
Reliability	.77	.74	.83	.81

TABLE 2

SCHOLASTIC ABILITY OF IPS STUDENTS IN THE 1965-66 SCHOOL YEAR

Grade Level	SCAT Converted Score	Approximate Percentile in This IPS Group	Approximate Percentile in National Sample
9th	308	90	97
	302	75	93
	297	50	90
	290	25	70
	282	10	50
8th	306	90	98
	301	75	97
	295	50	93
	285	25	75
	276	10	40

TABLE 3

PERFORMANCE ON IPS TESTS (SERIES A) BY GRADE LEVEL AND SCHOLASTIC ABILITY

	Test 1		Test 2		Test 3		Test 4	
Grade & Scholastic Ability	n	Mean Score	n	Mean Score	n	Mean Score	n	Mean Score
9th High	189	18.9	206	23.8	137	23.6	73	20.0
9th Middle	398	15.3	433	19.7	291	18.3	113	15.1
9th Low	288	11.3	310	14.3	227	12.0	42	11.2
8th High	82	16.8	57	21.5	34	20.0	38	19.0
8th Middle	110	13.4	81	16.2	43	15.0	26	16.3
8th Low	104	9.7	56	13.1	51	8.6	4	19.0

4. Table 3 indicates that the higher the grade level and the higher the scholastic ability of the student, the higher his performance on the IPS tests can be expected. There are only two exceptions, these being in the middle and low sub-groups of eighth graders on Test 4. These two mean scores are based on sample sizes of 26 and 4, respectively, and should probably be questioned.

5. The Series C IPS test was designed for lower-ability students; but Thompson's data, Table 4, shows that even the students utilized in this sample were more able than national averages.

TABLE 4

SCHOLASTIC ABILITY OF IPS LOWER-ABILITY NINTH GRADERS IN 1967-68 SCHOOL YEAR

SCAT Converted Score	Approximate Percentile in This IPS Group	Approximate Percentile in National Sample
295	90	93
289	75	85
283	50	70
275	25	59
267	10	25

The data from the Educational Testing Service suggests that students used in the developmental stages of the IPS program were of high ability and far removed from a typical junior high school. This would mean that initial success of the course with students in the developmental stages might be highly dependent upon the verbal and mathematical skill of the students.

The above information was not published at the time the school system in this study selected IPS for its required eighth grade science course. One can only speculate if the school system would have adopted this course had Thompson's data been available.

Biological Sciences Curriculum Study: Example of Evaluation

One new science course has been subjected to more systematic evaluation than the others (2). Biological Sciences Curriculum Study (BSCS) has many similarities to IPS. BSCS is process orientated with secondary emphasis on content mastery. The BSCS 1961-62 evaluation program, carried out by the Psychological Corporation, provides many insights to variables considered important in such modern science programs.

The basic evaluation design consisted of BSCS teachers and their students compared with non-BSCS teachers and their students. BSCS teachers were designated as those who had received special training in a particular version of BSCS

there are three versions: yellow, green, and blue -- and were presently teaching that version.

The School and College Abilities Test (SCAT), Form 2B, Parts I and II, was given to give an index of general intelligence to all students in the study. Two other tests were specifically constructed for this evaluation. The Impact Test "...was designed to measure understanding of scientific principles and scientific reasoning capacity." (2) The BSCS Achievement Test Comprehensive Final, a measure of specific knowledge of the course materials, was the second. In addition the Cooperative Biology Test, Form Y, considered to be a conventional biology test, was given.

In comparing the BSCS groups with the control groups on the Impact Test, the control groups showed a slight superiority over all BSCS groups.

The BSCS students did better than the control students on the BSCS Comprehensive Final. This was expected.

The control groups did better than the BSCS groups on the Cooperative Biology Test. This was expected.

An attempt was made to assess the effect of BSCS instruction on the attitudes and opinions of students toward science and scientists. The Test on Understanding Science (TOUS) and an attitudinal scale developed at Purdue University were used. A third technique used was a semantic differential instrument employing fifteen bipolar adjectives on ten concepts. Both the TOUS and the Purdue scale revealed negligible differences between the BSCS and the

control groups. The semantic differential results were not available.

In looking at school and teacher characteristics as related to the BSCS Comprehensive Final, only four factors showed statistically significant correlations: nature and amount of laboratory facilities ($r = .07$), teachers' salaries ($r = .17$), percent of the school's graduates going on to college ($r = .24$), and average size of BSCS classes ($r = -.09$). The only direct check of teacher behavior in this evaluation was one visit by a BSCS consultant; that is, an experienced BSCS teacher.

This review has shown the need for further assessment of science courses. Specifically, assessment of the influence of new courses on students' mastery of content and understanding of science is needed.

CHAPTER III

PROCEDURES

This chapter is mainly descriptive in nature and includes the procedures and instruments employed in the study. Specifically included are the sample, the selection of the teachers, the determining of student abilities, the measuring of the degree to which Introductory Physical Science (IPS) was taught, the criteria instruments, the administration of instruments, and the statistical procedures employed.

The Sample

The data for this study were gathered in a suburban school system in southeastern Michigan. Permission to gather data was obtained from the school system's research department. Building principals were then contacted and their permission to carry out the study was also obtained.

Teacher Sample

During the first week of the school year, the researcher spoke to the entire junior high school science staff and asked for volunteers. It was explained that this

would be a study to determine the effectiveness of the IPS program in influencing students' achievement in and understanding of science.

Twelve teachers, four females and eight males, volunteered -- three from each of the four junior high schools in the system. A general description of the teachers involved in the study is presented in Table 5. It is interesting to note the presence of the four females in the top half of the ranking. Also, those teachers with the least experience in teaching occupy the top third of the ranking. Those who attended an IPS Institute are found in the middle of the ranking. There is one exception here, and this individual was ranked high by her students on the Classroom Activity Checklist.

Each teacher submitted a schedule of his or her classes; one class per teacher was randomly selected by the researcher. Because of students transferring in and out of the system and in and out of the selected classrooms and because of absences on days when instruments were administered, the number of students who were present for both the pre and posttests was often less than the actual enrollment for each selected class.

Student Abilities

The abilities of the eighth grade IPS students in the sample were determined by administering a battery of Differential Aptitude Tests (DAT). This battery consists

TABLE 5

TEACHER DATA

Teacher Rank	1	2	3	4	5	6	7	8	9	10	11	12
Years of Experience	8	2	2	3	9	12	16	19	9	20	20	17
Degree	MA	MA	BS	BS	BA	MAT	MS	MS	MS	MS	MS	MS
Attended IPS Institute	no	no	yes	no	yes	yes	yes	yes	yes	no	no	no
No. Years Taught IPS Prior to Study	1	0	0	0	2	3	2	2	2	1	2	1
No. Semester Hours of Physical Sci. Educ.	45	10	30	35	30	45	30	12	75	25	45	30
Sex	M	F	F	F	F	M	M	M	M	M	M	M

of tests called Verbal Reasoning, Numerical Ability, Abstract Reasoning, Clerical Speed and Accuracy, Mechanical Reasoning, Space Relations, Language Usage I - Spelling, and Language Usage II - Grammar. The combination of Verbal Reasoning and Numerical Ability tests alone will tap the same general area as most intelligence or general mental ability tests. Some typical correlation co-efficients between the Differential Aptitude Tests (DAT) and familiar intelligence tests are reported in the fourth edition Manual for the Differential Aptitude Tests, Forms L and M (1). See Table 6.

TABLE 6

COEFFICIENTS OF CORRELATION BETWEEN THE DAT, FORMS L AND M, AND INTELLIGENCE TESTS

Test	Sex	Verbal Reasoning + Numerical Ability
California Test of Mental Maturity (1957 Short Form Junior High Level) Total I.Q.	M	.75
	F	.84
Otis Quick-Scoring Mental Ability Tests (Form Gamma FM)	M	.85
	F	.81
School and College Ability Tests (Form 2A) Total	M	.90
	F	.89

The following are brief descriptions of the areas measured by the Differential Aptitude Tests.

Verbal Reasoning: a measure of ability to understand concepts framed in words.

Numerical Ability: tests understanding of numerical relationships and facility in handling numerical concepts.

Abstract Reasoning: a non-verbal measure of the student's reasoning ability.

Clerical Speed and Accuracy: measures speed of response to a simple perceptual task.

Mechanical Reasoning: a pictoral presentation of a mechanical situation together with a simply worded question.

Space Relations: the ability to visualize a constructed object from a picture of a pattern and the ability to imagine how an object would appear if rotated in various ways.

Language Usage - Spelling and Grammar: All spelling words are selected from the lists in Gate's Spelling Difficulties in 3876 Words, 1937. The grammar section is intended to measure the student's ability to distinguish between good and bad grammar, punctuation, and word usage.

The Differential Aptitude Tests were administered uniformly to the entire eighth grade of each junior high school by the counseling staff.

The Degree to Which Introductory Physical Science Was Taught

To assess any influence of Introductory Physical Science (IPS) in any specific area, it was necessary to determine to what degree IPS was being taught to the students. The official adoption by a Board of Education of a new course of study to replace another does not guarantee a

change will, in fact, take place in the classrooms. New textbooks, new equipment, and special training sessions all can and often do occur, but what actually happens in the classroom is difficult and usually expensive to ascertain.

Information about what actually takes place in the classroom can come from three sources: the teacher, an observer, and the pupils. Singularly and in combination, these are the only sources of what is happening in the classroom. Teachers' self-observations tend to move toward what they perceive as the "correct response". The presence of an observer is known to affect teacher behavior (15). The use of electronic observation involves high equipment cost and personnel expenditures to evaluate the obtained electronic data.

Students' responses would provide the broadest base of information that would center most closely to what actually does happen in the classroom. No one should deny that the students' perception of what did and does take place is the "truth" they carry from the classroom. Not enough attention is given to what the students perceive as happening in class. Students represent a pool of observers, ever present, and equipped with various degrees of speaking and writing skills that should be tapped as a vital information source of what has been happening in the classroom. Thus, an integral part of this study was an attempt to develop an instrument that would aid in determining what has been happening in IPS classes.

Criteria Instruments

The following instruments were used to measure the influence of Introductory Physical Science (IPS) in their respective areas and were administered by the researcher.

Test on Understanding Science (TOUS)

The Test on Understanding Science (TOUS) was developed at the Harvard University Graduate School of Education. It is an attempt by William W. Cooley and Leo E. Klopfer to try and measure certain perceptions of students about science. These perceptions include an understanding of the nature of scientific inquiry, of science as an institution, and of scientists as people. It is a paper and pencil, objective type test with four alternative, multiple-choice items. Three areas are sought to be tested:

Area I	Understanding about the scientific enterprise (18 items)
Area II	Understanding about scientists (18 items)
Area III	Understanding about methods and aims of science (24 items)

As the authors state in the Manual for Administering, Scoring, and Interpreting Scores, Form W, 1961, "...the most obvious use of this instrument is in the direct testing of high school students to determine to what extent a realistic understanding of science and scientists has been obtained as a result of taking science courses."

Reliability of the TOUS as determined by the Kuder-

Richardson Formula 20 has been given as:

Scale	Reliability
Area I	.58
Area II	.52
Area III	.58
Total	.76

The standard error of measurement for the total score is 3.45.

A form suitable for junior high school students, TOUS Jx, has been developed and was used by the researcher. In this study a Kuder-Richardson Formula 20 of .81 and a standard error of 3.03 was calculated for this instrument.

Introductory Physical Science Achievement Test

The authors of IPS have developed a set of four objective type achievement tests which they feel are consistent with its objectives. A single comprehensive test was constructed from these tests by the researcher for this study. See Appendix B.

Reliability of this instrument as determined by the Kuder-Richardson Formula 20 procedure was .67. The standard error was 2.43.

Classroom Activity Checklist (CAC)

The researcher constructed and administered to the students a series of statements. These statements were designed to ascertain what activities had been engaged in in the class during the school year. The activities listed included both those practices the authors of the IPS course

feel are required and are desirable for the successful presentation of the course. Also included were those practices that have been deemed useful in teaching a laboratory-centered course. This CAC can be found in the Appendix C.

The initial form of the CAC was submitted to a panel of IPS experts who were familiar with its philosophy, objectives, and methods. They judged each statement and rated it as they thought the answer should be rated if the student had been taught by an ideal IPS teacher. All of these experts are themselves classroom teachers who have attended an Introductory Physical Science Institute and who have taught IPS.

From this preliminary form, only those statements that had total agreement by all five judges were used in the final form of the CAC.

The CAC was the last instrument to be administered to the students in this study.

Class averages were determined for the number of incorrect responses and for the number of neutral responses. From these data the teachers in the study were ranked. Primary consideration was given to the number of incorrect responses; where these scores were identical or very close, secondary consideration was given to the number of neutral responses to rank the teachers. See Table 5.

Those teachers who had the fewest incorrect responses and/or neutral responses were ranked higher; that is, they

were more closely aligned with the IPS ideal teacher than teachers with many incorrect and/or neutral responses.

A reliability coefficient of .81 and a standard error of 3.45 were determined by using the Kuder-Richardson Formula 20.

In spite of the criticisms of questionnaire research, the questionnaire is still the most extensively used research instrument in the behavior sciences. There are many reasons why this is so, not the least being the relative ease of questionnaire construction, the efficiency of data collection, and the specificity of the instrument for the problem at hand. (10)

Administration of the Instruments

The pre-IPS Achievement Test was administered to all classes first and followed within a two to three week period by the pre-TOUS Jx. These same two instruments were administered as posttests four weeks before the close of school. The CAC was administered during the last two weeks of school.

This testing schedule provided a maximum time between pre and posttests.

During the school year the researcher obtained the Verbal Reasoning and Numerical Ability scores and their combined total score from the eight grade counselor at each junior high school.

Statistical Procedures

Variables taken into account in the analysis of data were the student's general ability and the degree to which his teacher approached an ideal teacher model. These variables were investigated to see what effect they had on the student's understanding of science and his mastery of course content. Analyses of variance were used to test for significant differences among the classes in terms of student abilities, understanding of science, and mastery of course content. Analyses of covariance were used to statistically remove the influence of the student's abilities on his understanding of science and mastery of course content.

The analysis of data was carried out using the IBM 360 computer in the Computing Center at the University of Michigan. Data cards were punched and verified by the researcher.

CHAPTER IV

ANALYSIS AND INTERPRETATION OF THE DATA

The analysis of the data is presented under five main headings: (1) ranking of the teachers, (2) analysis of the Test on Understanding Science (TOUS), (3) analysis of the Introductory Physical Science Achievement Test, (4) additional analysis, and (5) teacher attitudes.

Ranking of Teachers

The twelve teachers in this study were ranked according to the degree they approached a constructed "ideal" Introductory Physical Science (IPS) teacher. The data were provided by the student ratings on the CAC. Those teachers who had the fewest incorrect responses and/or neutral responses given by their students were ranked higher; that is, they were more closely aligned with the "ideal" IPS teacher than were teachers whose students gave many incorrect and/or neutral responses. See Table 7.

Analysis of TOUS Scores

In the analysis of the Test on Understanding Science

(TOUS), first to be investigated were the differences between the selected classes in terms of their general academic ability. The DAT score was the indicator of this ability. Further analyses dealt with the IPS pre and posttest scores.

TABLE 7

RANKING OF TEACHERS USING THE CLASSROOM ACTIVITY CHECKLIST (CAC)

Teacher Ranking	n	Incorrect Responses Mean	Neutral Responses Mean
1	22	12.4	17.0
2	23	13.5	15.4
3	17	13.8	19.5
4	25	13.9	14.4
5	21	14.1	15.6
6	21	14.7	16.2
7	24	17.8	12.7
8	23	18.2	18.8
9	17	19.7	16.1
10	22	19.7	18.9
11	24	21.1	15.6
12	13	29.0	9.6

Analysis of DAT Scores Associated with the Test on Understanding Science (TOUS)

An examination of Table 8 shows a range from 45.64 to 29.14 for class means on the Differential Aptitude Tests

TABLE 8

DAT SCORES FOR ALL CLASSES RESPONDING TO THE POST TOUS TEST

Teacher	n	Mean	SD
1	22	45.64	22.78
2	21	29.14	22.15
3	24	28.92	19.62
4	23	35.70	20.60
5	25	35.12	24.12
6	24	38.38	20.31
7	26	40.08	14.09
8	25	31.96	19.71
9	22	39.27	19.81
10	24	31.33	24.15
11	27	35.56	17.11
12	18	31.72	18.08

(DAT). The large standard deviation for all classes would suggest that the classes are homogeneous when regarding this ability measure.

The analysis of variance between the class means for the DAT, Table 9, is not statistically significant at the 0.05 level. This would indicate no significant differences exist between classes in regard to ability.

TABLE 9

ANALYSIS OF VARIANCE OF DAT SCORES OF STUDENTS RESPONDING TO THE POST TOUS TEST

Source of Variation	df	Sum of Squares	Mean Square	F Ratio[a]
Between Groups	11	6185.07	562.28	1.36
Within Groups	269	111439.41	414.28	
Total	280	117624.48		

[a] $F_{11,269}$ at 0.05 = 1.75

Analysis of Data Concerning the TOUS Pretest and Posttest Scores

The analysis of variance between class means on the pre TOUS produced an F of 1.75 which is significant at the 0.05 level. See Table 10. When the same test was used as a posttest, an F of 0.96 was found. Using an 0.05 significant level, the null hypothesis is not rejected. See Tables 11 and 12.

The students were more clustered together in their perception of science after the course than before. This shows that, generally, the degree to which a teacher was committed to teaching IPS had little effect on the students' perception of science as measured by the TOUS instrument. Table 13 shows that there were slight gains in seven

TABLE 10

ANALYSIS OF VARIANCE OF TOUS PRETEST CLASS MEAN SCORES

Source of Variation	df	Sum of Squares	Mean Square	F Ratio[a]
Between Groups	11	1109.54	100.87	1.75
Within Groups	232	13393.66	57.73	
Total	243	14503.20		

[a] $F_{11,232}$ at 0.05 = 1.75

TABLE 11

TOUS MEAN POSTTEST SCORES FOR ALL CLASSES

Teacher	n	Mean	SD
1	22	19.68	8.41
2	21	20.52	7.89
3	24	20.58	6.83
4	23	20.00	6.69
5	25	20.32	6.14
6	24	22.21	7.99
7	26	20.65	8.37
8	25	21.48	6.50
9	22	22.50	7.08
10	24	19.08	6.53
11	27	20.15	6.20
12	18	16.61	5.08

TABLE 12

ANALYSIS OF VARIANCE OF TOUS POSTTEST CLASS MEAN SCORES

Source of Variation	df	Sum of Squares	Mean Square	F Ratio[a]
Between Groups	11	524.33	47.67	0.96
Within Groups	269	13400.39	49.82	
Total	280	13924.72		

[a] $F_{11,269}$ at 0.05 = 1.75

class means between the pre and posttest, this leaves five classes where there was a small decrease in the class mean score. This seems to indicate that IPS is not uniquely suited to improving students' understanding of science.

Teachers who were rated farther down the scale than their collegues had posttest scores that were equal to or greater than their higher rated collegues. The lack of marked increases in posttest scores over pretest scores raises a serious question about the validity of IPS as a factor in improving students' understanding of science as measured by the TOUS instrument.

TABLE 13

COMPARISON OF TOUS PRETEST AND POSTTEST SCORES

Teacher	n	Tous Pretest Score	Tous Posttest Score	Gain or Loss in Posttest Score
1	22	24.45	19.68	-
2	21	18.75	20.52	+
3	24	16.74	20.58	+
4	23	17.10	20.00	+
5	25	21.57	20.32	-
6	24	21.71	22.21	+
7	26	21.31	20.65	-
8	25	18.86	21.48	+
9	22	21.29	22.50	+
10	24	20.83	19.08	-
11	27	19.04	20.15	+
12	18	18.06	16.61	-

Analysis of Covariance of Post TOUS Scores

Analysis of covariance was carried out to statistically remove differences that might exist between the classes in terms of their ability. It is possible that one class or classes might, by chance, have an above average sample of students; and therefore, any effect attributed to teaching behavior and teaching philosophy could be the result of this chance combination of students.

Analysis of covariance of the TOUS posttest scores, with the student's DAT score as the single covariate, confirms that the differences among the adjusted scores are not statistically significant. See Table 14.

These findings fail to reject the null hypothesis of no class differences ascribable to the differences in the degree to which a teacher taught IPS. Chance alone could have produced the differences among the posttest scores.

Analysis of Variance of TOUS Posttest Scores Between the First and Fourth Quartile of Ranked Teachers

Analysis of variance between those students taught by the top three teachers, the first quartile, and those students taught by the teachers in the fourth quartile shows no statistically significant differences in the students' TOUS posttest scores. See Table 15. Therefore, the null hypothesis regarding differences between these selected groups is accepted.

TABLE 14

ANALYSIS OF VARIANCE AND COVARIANCE OF TOUS POSTTEST SCORES ADJUSTING FOR DAT SCORES[a]

Tchr	n	DAT Score Mean	DAT Score F	TOUS Posttest Mean	TOUS Posttest F	Adj. Posttest Mean	Adj. Posttest F
1	22	45.64	1.36	19.68	0.96	18.02	1.27[b]
2	21	29.14		20.52		21.51	
3	24	28.92		20.58		21.61	
4	23	35.70		20.00		19.94	
5	25	35.12		20.32		20.35	
6	24	38.38		22.21		21.71	
7	26	40.08		20.65		19.88	
8	25	31.96		21.48		22.02	
9	22	39.27		22.50		21.86	
10	24	31.33		19.08		19.72	
11	27	35.56		20.15		20.11	
12	18	31.72		16.61		17.19	

[a]Correlation between DAT scores and TOUS posttest scores = .453.

[b]$F_{11,268}$ at 0.05 = 1.75

TABLE 15

ANALYSIS OF VARIANCE OF TOUS POSTTEST SCORES BETWEEN THE FIRST AND FOURTH QUARTILE OF RANKED TEACHERS

Source of Variation	df	Sum of Squares	Mean Square	F Ratio[a]
Between Groups	1	67.93	67.93	1.43
Within Groups	134	6371.72	47.55	
Total	135	6439.65		

[a] $F_{1,134}$ at 0.05 = 3.84

Analysis of IPS Achievement Test Scores

In the analysis of the IPS test, first to be investigated were the differences between the selected classes in terms of their academic ability. The DAT score was the indicator of this ability. The next analyses dealt with the pre and posttest IPS scores.

Analysis of DAT Scores Associated with the IPS Achievement Test

An examination of Table 16 shows a range from 47.55 to 35.73 for the class means on the DAT. The large standard deviation for each class supports the belief that the classes are homogeneous when regarding this aptitude

TABLE 16

DAT SCORES FOR ALL CLASSES RESPONDING TO THE POST IPS TEST

Teacher	n	Mean	SD
1	20	47.55	18.74
2	16	36.19	16.56
3	16	36.76	13.94
4	22	39.00	16.71
5	21	41.81	20.11
6	18	42.44	13.07
7	28	39.57	10.02
8	20	36.70	14.96
9	21	40.95	18.23
10	18	42.44	17.31
11	19	39.41	11.94
12	15	35.73	19.20

measure.

The analysis of variance between the class means for the DAT, Table 17, is not statistically significant at the 0.05 level. This would indicate no significant differences exist between classes in terms of this ability measure.

TABLE 17

ANALYSIS OF VARIANCE OF DAT CLASS MEAN SCORES

Source of Variation	df	Sum of Squares	Mean Square	F Ratio[a]
Between Groups	11	2368.57	215.32	.80
Within Groups	222	59712.08	268.97	
Total	233	62080.65		

[a] $F_{11,233}$ at 0.05 = 1.75

Analysis of Data Concerning the IPS Pretest and Posttest Scores

An analysis of variance between class means on the IPS pretest produced an F of 1.08 which is not statistically significant at the 0.05 level. See Table 18. When the same instrument was administered as a posttest, an F of 3.26 was generated which was statistically significant at the 0.01 level. This result supports the contention that the degree to which a teacher was committed to IPS

TABLE 18

ANALYSIS OF VARIANCE OF IPS PRETEST CLASS MEAN SCORES

Source of Variation	df	Sum of Squares	Mean Square	F Ratio[a]
Between Groups	11	154.91	14.08	1.08
Within Groups	222	2893.07	13.03	
Total	233	3047.98		

[a] $F_{11,222}$ at 0.05 = 1.75

influenced the achievement of his or her students. See Tables 19 and 20.

Analysis of Covariance of Post IPS Achievement Test Scores

An analysis of covariance was used. The student's DAT score was the covariate. See Table 21. This analysis of covariance produced an F of 3.72. This still is significant at the 0.01 level.

The analysis of covariance confirms the belief that mean ability differences between all the classes are not statistically significant.

TABLE 19

IPS MEAN POSTTEST SCORES FOR ALL CLASSES

Teacher	n	Mean	SD
1	22	14.05	4.31
2	22	9.81	4.03
3	22	9.47	3.26
4	27	10.41	4.57
5	24	11.67	5.70
6	20	11.00	4.88
7	28	8.50	3.03
8	25	8.48	4.06
9	22	10.14	3.70
10	22	9.14	5.16
11	21	9.43	3.55
12	17	8.59	3.04

TABLE 20

ANALYSIS OF VARIANCE OF IPS POSTTEST CLASS MEAN SCORES

Source of Variation	df	Sum of Squares	Mean Square	F Ratio[a]
Between Groups	11	636.27	57.84	3.26
Within Groups	260	4613.00	17.74	
Total	271	5249.27		

[a] $F_{11,260}$ at 0.01 = 2.18

TABLE 21

ANALYSIS OF VARIANCE AND COVARIANCE OF IPS POSTTEST SCORES ADJUSTING FOR DAT SCORES[a]

Tchr	n	DAT Score Mean	DAT Score F	IPS Posttest Mean	IPS Posttest F	Adj. Posttest Mean	Adj. Posttest F
1	22	47.55	.80	14.50	3.26	13.42	3.72[b]
2	22	36.19		10.12		10.69	
3	22	36.76		9.12		9.59	
4	27	39.00		11.23		11.38	
5	24	41.81		12.29		12.03	
6	20	42.44		10.72		10.38	
7	28	39.57		8.50		8.57	
8	25	36.70		9.10		9.58	
9	22	40.95		10.19		10.06	
10	22	42.44		8.89		8.54	
11	21	39.41		8.89		8.98	
12	17	35.73		8.93		9.55	

[a]Correlation between DAT scores and IPS posttest scores = .459

[b]$F_{11,221}$ at 0.01 = 2.32

Analysis of Variance of IPS Posttest Scores Between the First and Fourth Quartile of Ranked Teachers

Analysis of variance between those students taught by teachers ranked in the first quartile, the top three, and those students taught by teachers ranked in the fourth quartile, the bottom three, was executed. See Table 22. The resulting F is significant at the 0.05 level and, therefore, the null hypothesis regarding these selected groups is rejected. This result further supports the hypothesis that the degree to which a teacher was committed to the philosophy and procedures of IPS influenced the academic achievement of his or her students.

TABLE 22

ANALYSIS OF VARIANCE OF IPS POSTTEST SCORES BETWEEN THE FIRST AND FOURTH QUARTILE OF RANKED TEACHERS

Source of Variation	df	Sum of Squares	Mean Square	F Ratio[a]
Between Groups	1	200.54	200.55	11.61
Within Groups	103	1779.30	17.27	
Total	104	1979.84	217.82	

[a] $F_{1,104}$ at 0.05 = 4.00

Additional Analysis

A Post t Test

In a further attempt to explore the possibility that the difference between class performances might be more an expression of differences between student abilities than the degree to which the course was taught, a post t test was utilized. The three classes having the highest DAT average were pooled into one group. The three classes having the lowest DAT average were pooled into another group. A t test was used, comparing the IPS Achievement posttest scores of these two constructed groups. The results in Table 23 show that a significant statistical difference can be found between these two groups.

TABLE 23

t-TEST FOR SIGNIFICANCE OF DIFFERENCES IN MEAN IPS POSTTEST SCORES BETWEEN THREE HIGHEST DAT CLASSES AND THREE LOWEST DAT CLASSES

Group	Class Mean on Post IPS	df	t[a]
3 Top DAT Classes	11.40	64	3.05
3 Lowest DAT Classes	8.97	63	

[a] t_{121} at 0.05 = 1.65

These results indicate some influence of the student's academic ability on his IPS posttest score. The comparison of extremes in a range of scores is normally expected to produce statistical significance.

Analysis of Correlation Between the DAT and Posttest Scores of the TOUS and IPS Test

Rank correlation analysis was utilized to explore the subhypotheses dealing with any relationship existing between the students' abilities and their posttest scores on the IPS and TOUS tests.

An r =.50 with a standard error of .07 was calculated for the relationship between the students' DAT scores and their IPS posttest scores. This indicates a positive and direct relationship between these two variables.

An r =.57 and a standard error of .06 was determined for the rank correlation between the students' DAT scores and their TOUS posttest scores. This also shows the same degree of positive and direct correlation between these variables.

Therefore, the subhypothesis stating that a direct and positive correlation exists between high ability and low ability students and their success, as expressed in their posttest scores on the IPS and TOUS tests, is not rejected. These findings are not unexpected. In the case of the TOUS test, one would hope to achieve changes in a student's understanding of science without being so limited by

the student's general ability.

Teacher Attitudes Toward IPS

The attitudes of the teachers toward the IPS course were assessed in informal discussions held during the school year and at those times when the various test instruments were being administered to the classes. These attitudes fell into three general areas.

First, there were teachers who felt the course was excellent and who felt their students were engaged in an outstanding, interesting, stimulating class. It is interesting to note that at the end of the year when the CAC was administered to the classes, the teachers with this attitude were ranked as the top four teachers. This was not unexpected.

Secondly, there were those teachers who supported the strong activity-centered nature of the course but questioned the choice of activities selected by the authors of IPS. These teachers felt the mathematical skill demanded and the degree of sophistication needed to interpret data were well beyond the range of most of their students. Often students had to be told what they had "discovered" or else they did not understand the purpose of the experiments.

Thirdly, the last group of teachers did, in fact, not teach IPS; they used the equipment and selected or created laboratory exercises they felt were worthwhile. These teachers had the same feelings about the appropriateness of

the course for their students as the second group of teachers but differed in that they made little or no effort to teach IPS as structured by its authors. As one would suspect, the teachers who made little or no effort to teach IPS were ranked in the last four positions of the twelve teachers by their own students on the CAC.

CHAPTER V

SUMMARY, RESULTS, AND RECOMMENDATIONS

Summary of Procedures

This study was undertaken to assess the influence of a specific required science course, Introductory Physical Science (IPS), on eighth grade students. Considered as important input variables were the nature of the course, the degree to which the course was taught, and the general ability of the students. Only two criteria were investigated, the students' achievement and their understanding of the nature of science.

The population in the study consisted of the 1200 students in the eighth grade in four junior high schools in a midwest school system during the school year of 1969-70. The sample size was 300 students.

Twelve teachers volunteered for the study and one class was randomly selected for each teacher. These twelve selected classes were administered three instruments: a pre and posttest measuring achievement, a pre and posttest measuring students' perception of the nature of science, and an instrument used to rank the teachers as to the degree

to which they taught the prescribed course.

Statistical analyses were then carried out. Investigated were the influence of the degree to which the philosophy and objectives of IPS were used in the classroom and the general academic ability of the students.

Results

The following results can be drawn from this study:

1. The major hypothesis stating no differences in understanding science between students taught by teachers whose classroom practices were more closely aligned with the philosophy and objectives of the IPS course and students taught by teachers who were farther removed from the philosophy of the IPS course was not rejected. No significant difference in students' understanding of the nature of science was detected.

2. The major hypothesis stating no differences in achievement scores of students taught by teachers closely aligned with the IPS course and students taught by teachers not as closely aligned was rejected. Significant differences were detected between class means for the IPS post-test scores.

3. The subhypothesis regarding the comparison of extremes; i.e., the top quartile with the bottom quartile of teachers and their students, was not rejected for the Test on Understanding Science (TOUS). No significant differences were detected.

4. The subhypothesis regarding the comparison of the top quartile with the bottom quartile of teachers and their students was rejected at the .01 level for the IPS posttest scores. A significant difference was detected between these selected quartiles. This further inforced the influence of the degree to which a teacher accepted and practiced the philosophy and objectives of the IPS course.

5. The subhypothesis regarding a direct and positive relationship between a student's DAT scores and his TOUS and IPS posttest scores was accepted with r's of .57 and .50 being generated from the data.

Recommendations

The following recommendations are submitted:

1. Assessment of IPS should be continued, coupled with efforts to improve students' achievement and understanding of the nature of science.

2. An effort should be made to devise an instrument or method of assessing students' understanding of science that is not limiting to students with low literary skills.

3. The IPS posttest class mean scores in this study are below those figures found in Ray Thompson's data. This suggests that with this school system and its more normal student population, missing more than half the questions on the IPS Achievement Test is closer to this test's true norm. Assuming these posttest scores are true indicators of academic achievement, the degree of this achievement is

so low as to question the present structure of the eighth grade science curriculum.

It might be better to offer this highly structural course only for those students who are presently in the top two levels of the mathematics' program in this school system. It is also suggested that if such a plan is followed, only those teachers who want to teach IPS and, in fact, will teach IPS be asked to teach this course.

For those students not in IPS, a companion course could be offered in which science would be presented as a mode of understanding the physical world of the eighth grade student. This course could be activity-centered and inquiry-directed but with much less emphasis on the gathering of quantative data and the interpretation of this data. It could be a series of topics covering a range of ideas that, hopefully, would be linked together by some common physical phenomena; i.e., kinetic molecular theory, conservation of energy, conservation of matter, action and reaction, et cetera.

This freedom of presentation of material would allow teachers to respond to the various levels of student ability in their classes and not try to raise all of their students to the heights of abstraction found in IPS.

IPS is too highly structured and operates at such a high level of abstraction as to be meaningless to a large portion of such a diverse student population as is found in this school system.

APPENDIXES

APPENDIX A

TEST ON UNDERSTANDING SCIENCE

T O U S

JX

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xxx xxxxxxxxxxxxxxxxxxxxxxxxxx
xxx TEST ON UNDERSTANDING SCIENCE xxxxxxxxxxxxxxxxxxxxxxxxxx
xxx xxxxxxxxxxxxxxxxxxxxxxxxxx
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DIRECTIONS: Each of the questions or incomplete statements in this test is followed by four suggested answers. You are to choose the one BEST answer.

Here is a sample.

0. The main reason for doing experiments in science is to

A. use laboratory equipment.
B. find things out.
C. learn about nature.
D. discover what scientists do.

Choose the one BEST answer to this sample question. On the separate answer sheet, find row number "0" and circle the letter of the answer you have chosen.

Your answers for all the test questions should be marked in this manner on the answer sheet. Be sure to circle the letter for the one BEST answer on the row with the same number as the question. DO NOT WRITE ANYTHING IN THIS TEST BOOKLET.

PLEASE DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

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RECORD YOUR ANSWERS ON THE ANSWER SHEET

1. Which of the following is the best list of what scientists study?

   (A) atoms, molecules, energy
   (B) matter, energy, living things
   (C) national defense, rockets, space
   (D) living things, disease, matter

2. Which of the following is the most important need of science?

   (A) more money and equipment
   (B) well-trained assistants
   (C) better working conditions
   (D) people with new ideas

3. A scientist predicted that an experiment would come out a certain way. He observed a different result when he did the experiment. What would he most likely say to himself?

   (A) "I shouldn't have made a prediction before trying this out."
   (B) "If I do the experiment again, it will come out the way I predicted."
   (C) "If I had better equipment for this experiment, I would get the right results."
   (D) "Something is wrong either with my observation, my equipment, or my prediction."

4. If you were to meet a scientist on the street, he would probably look like

   (A) a rather odd sort of person.
   (B) a quiet, thoughtful man.
   (C) anyone else you might meet.
   (D) an intelligent, young man.

5. The newest microscopes make it possible for scientists to study small objects and also to

   (A) discover the meaning of life.
   (B) explore many new problems.
   (C) observe atoms in motion.
   (D) see that germs cause disease.

RECORD YOUR ANSWERS ON YOUR ANSWER SHEET

6. Today, the education of American scientists who teach and do research at colleges and universities generally

   (A) is completed after four years of college.
   (B) includes a period of practical training in some industry.
   (C) is completed after two years of college or technical school.
   (D) includes long study in universities after finishing college.

7. Today's scientists can solve more complex problems than the scientists of the past chiefly because today's scientists

   (A) know that the ideas of earlier scientists were wrong.
   (B) have more imagination than earlier scientists.
   (C) build on the achievements of earlier scientists.
   (D) are more intelligent than earlier scientists.

8. When a scientist completes his work on a new scientific theory, we know that he has

   (A) uncovered one of the laws of nature.
   (B) moved mankind closer to absolute truth.
   (C) discovered new evidence from experiments.
   (D) developed new ideas and understandings.

9. The design of a space rocket is chiefly a problem of

   (A) the application of science, because the designer must have special training and skills.
   (B) science, because the design must be developed by experiment.
   (C) the application of science, because it leads to the production of a practical device.
   (D) science, because it calls for being clever and having new ideas.

10. Scientists would consider any major hypothesis to be

   (A) a temporary explanation.
   (B) a changeless truth.
   (C) a final explanation.
   (D) a temporary truth.

11. The people and government of the United States influence scientific activity

(A) very little, because scientists are quite isolated from the rest of society.
(B) a little, because some people must be willing to become scientists and the government pays them.
(C) a great deal, because most scientists work for the government and follow its instructions.
(D) a great deal, because the kind of education available in the nation depends on what most people want.

12. Most important scientific ideas are developed today through

(A) a long investigation by a scientist working alone.
(B) a group of scientific experts deciding what to investigate.
(C) work and thinking carried on by many scientists.
(D) team-work between scientists and government.

13. Betty is planning an experiment to learn something about the role of potassium in the growth of a certain plant. She decides to grow one group of these plants in soil containing nitrogen and phosphorus, but lacking potassium. A second group of these plants, serving as a "control", should be grown in soil containing

(A) potassium only.
(B) nitrogen, phosphorus, and potassium.
(C) nitrogen and potassium, but no phosphorus.
(D) nitrogen and phosphorus, but no potassium.

14. Which of the following is the best statement about science?

(A) Science is the result of human thinking and action.
(B) Science is the result of careful planning.
(C) Science is produced by living and non-living things.
(D) Science is produced by experiments.

15. When much new evidence that <u>does not fit</u> a scientific theory appears, scientists usually will ask themselves:

(A) Shall we throw out the theory and begin again, since the evidence is against it?
(B) Can we change the evidence a little so that it will fit the theory?
(C) Shall we keep the theory as it is, since this new evidence doesn't help it?
(D) Can we change the theory a little so that this new evidence will fit it?

16. The chief purpose of the science of botany is to

(A) tell us what plants grow best in various kinds of soil.
(B) explain how plants grow and reproduce.
(C) develop new drugs and medicines from plants.
(D) help farmers grow bigger plants and produce more food.

17. Mary likes science. At first, she did not like to write down all the details of her experiments. If Mary decides to become a scientist, however, this training will help her to

(A) be patient in doing her experiments.
(B) make more accurate laboratory reports.
(C) develop theories from experiments.
(D) look for the reasons why things happen.

18. When scientists in America work on a major research project today, the laboratory equipment they need usually is supplied and built by

(A) the scientists themselves.
(B) other scientists.
(C) a scientific society or association.
(D) people who are not scientists.

19. Scientists are often said to be extremely hard-working and dedicated. <u>This is true of</u>

(A) successful people in most professions.
(B) scientists, but not other professional people.
(C) other professional people, but not scientists.
(D) more scientists than other professional people.

20. After a scientist has found the solution to a research problem, he usually

(A) seeks a practical application for his discovery.
(B) feels that the issue is settled once and for all.
(C) cannot easily find a new problem to work on.
(D) finds that the study has opened up new problems.

21. A scientist is open-minded if he

(A) thinks up many new experiments to perform.
(B) tries to open up new fields of research.
(C) listens to ideas unfavorable to his research.
(D) talks openly about his ideas.

22. Scientists have many goals in doing scientific work, but their principle aim is to

(A) prove what has already been discovered about the physical world.
(B) express natural phenomena in terms of principles and theories.
(C) discover, collect, and classify facts about living and non-living things.
(D) provide the people of the world with the means for leading better lives.

23. When a scientist reads a report of a new scientific discovery, he probably will

(A) not fully believe the report until he has checked the work himself.
(B) believe the report without asking too many questions about it.
(C) not fully believe the report until he has obtained more information.
(D) believe the report because it describes a scientific discovery.

24. Scientists serve mankind in many ways. Which of the following sentences best describes their special contribution?

(A) Scientists make improved products for better living.
(B) Scientists show us the goals we should try to reach.
(C) Scientists give us knowledge about nature.
(D) Scientists give skilled service and advice to others.

25. In regard to intelligence, most scientists

(A) have about average intelligence.
(B) are born with a special scientific curiosity.
(C) become intelligent after scientific training.
(D) have more than average intelligence.

26. Ralph said: "Scientists do experiments to ask questions of nature." By this Ralph means that experiments and tests are used in science to

(A) prove that nature works in a regular manner.
(B) learn by trying things, making mistakes, and then trying again.
(C) try out the ideas of scientists.
(D) inquire into the mystery of creation.

27. A research scientist is most likely to make important discoveries by

(A) obtaining enough money to carry out his experiments.
(B) thinking up ideas and trying experiments to test them.
(C) doing research in a very well-equipped laboratory.
(D) making many observations and reporting his results.

28. Many essays have been written about the meaning of life. Today, any serious essay on the meaning of life probably would

(A) be written by a scientist who has studied living things.
(B) include what scientists have learned about life.
(C) include a proof of the scientific theory of evolution.
(D) contain little or nothing on the scientists' ideas about life.

29. A scientist learns about a new theory that has been suggested. Will the scientist accept this theory or not? He will decide on the basis of

(A) whether or not the theory is true.
(B) the experimental evidence supporting the theory.
(C) his personal ideas and the evidence supporting the theory.
(D) whether or not the theory can be put into mathematical form.

30. Bill always does well in school, likes to build model airplanes, and is a practical joker. Frank makes high grades in mathematics, likes to read books, and plays baseball. Janet is a serious, intelligent girl and a good dancer. Who do you predict could become a scientist?

(A) Bill
(B) Frank
(C) Janet
(D) Any one of the three.

31. Most scientists consider scientific theories to be

(A) changeless truths.
(B) explanations that may be revised.
(C) final explanations.
(D) descriptions of the world as it really is.

32. In trying to decide whether or not to go to a new movie, a scientist would probably ask himself?

(A) "Does the film use experimental techniques?"
(B) "Is there cause and effect in the plot?"
(C) "Will I like this film?"
(D) "Is the plot factual and accurate?"

33. When a scientist makes a hypothesis about an experiment, he

(A) makes a guess about what will happen next.
(B) describes how the experiment should be done.
(C) suggests how to make careful measurements.
(D) gives an explanation for the experiment.

34. Scientists most often make important advances in research by

(A) trial and error experimentation.
(B) planning and experimenting.
(C) difficult laboratory work.
(D) observing and measuring.

35. A scientific law describes

(A) rules which scientists must obey.
(B) relationships between natural events.
(C) directions for doing experiments.
(D) predictions about how things happen.

36. A young man who wants to have a career in science would be able to find a job as a scientist

(A) only in the United States or Russia
(B) only in countries in America and Europe.
(C) in most countries of the world.
(D) only in countries with large industries.

37. A scientific theory should

(A) give final answers for scientific problems.
(B) suggest directions for making useful things.
(C) tie together and explain many natural events.
(D) describe the world as most scientists see it.

38. Which of the following sentences about science is best?

(A) Modern science is too advanced to use past discoveries.
(B) Modern science is more practical than ever before.
(C) Modern science is the result of useful inventions.
(D) Modern science is based on the science of the past.

39. Since science is now expanding so rapidly, you could correctly predict that

(A) scientists will develop new ideas.
(B) there may soon be little left for scientists to discover.
(C) machines will plan research projects.
(D) the expansion of science cannot be stopped.

40. Some scientists specialize in developing new scientific theories. In doing this kind of work, these scientists might hardly ever

(A) perform any experiments.
(B) consider the theories of other scientists.
(C) consider experimental evidence.
(D) share their theories with other scientists.

41. Today, some scientists are employed in industry to do research on the properties of metals. The research these scientists carry out would usually

(A) add to scientific knowledge but have little or no practical value.
(B) add to scientific knowledge and help the industrial applications of science.
(C) have many practical applications in industry but add little or nothing to scientific knowledge.
(D) have many industrial applications and help scientific knowledge to become permanent truth.

42. Scientists are often said to have certain "scientific attitudes." These may be best observed when a scientist is

(A) working on his research.
(B) moving into a new laboratory.
(C) doing most anything.
(D) with his family and friends.

43. Smith, a research scientist, reads a report of an experiment by Mrs. Jones, who is doing research in the same scientific field as Smith. In his own experiments, Smith has found out some important information that was not mentioned in Mrs. Jones' report. In this situation, which of the following would Smith be <u>LEAST LIKELY</u> to do?

(A) Tell Mrs. Jones the information in a letter or by phone.
(B) Issue a statement to the press about the omissions in Mrs. Jones' report.
(C) Rush a report of his experiments to a scientific journal.
(D) Announce his findings at the next meeting of a scientific society.

44. When he has a day off, a scientist would probably <u>NOT</u> like to

(A) spend time with his family.
(B) go to his laboratory.
(C) spend some time on his hobby.
(D) go to a friend's party.

45. Which of the following statements about scientific theories is NOT correct?

(A) A scientific theory gives a description of the world as it really is.
(B) A scientist may reject a scientific theory if he has doubts about it.
(C) When there is some evidence against a scientific theory, scientists may still accept it.
(D) A scientific theory gives an explanation of many natural events.

This is the end of the test. If you finish before time is called, please go back and check your answers.

TEST ON UNDERSTANDING SCIENCE TOUS Jx

ANSWER SHEET

Name_____ Date_____
Last First MI

School_____ Class & Teacher_____

Male or Female (circle one)

Sample: O. A B C D

1. A B C D
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38. A B C D
39. A B C D
40. A B C D
41. A B C D
42. A B C D
43. A B C D
44. A B C D
45. A B C D

APPENDIX B

INTRODUCTORY PHYSICAL SCIENCE ACHIEVEMENT TEST

IPS ACHIEVEMENT TEST

Directions:

Each of the questions is followed by five suggested answers. You select the correct answer and mark your choice on the answer sheet.

DO NOT WRITE ON THIS TEST BOOKLET.

USE SCRAP PAPER FOR YOUR CALCULATIONS OR THE ANSWER SHEET.....DON'T WRITE IN THIS BOOKLET.

Draw a circle around the letter that represents your choice on the answer sheet.

PLEASE DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

1. When $20.0 cm^3$ of dry sand is added to a graduated cylinder containing water, the level of the liquid rises $12.5 cm^3$. The volume of air in the sand is

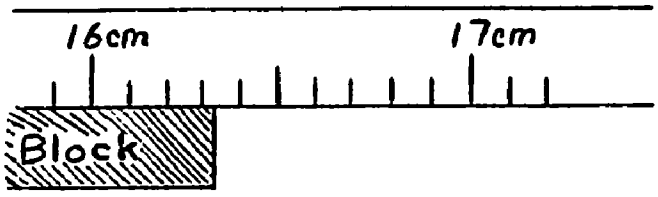
   (A) $7.5\ cm^3$
   (B) $12.5\ cm^3$
   (C) $20.0\ cm^3$
   (D) $27.5\ cm^3$
   (E) $32.5\ cm^3$

2. When water is heated above room temperature, which of the following is always true?

   (A) The volume of water remains the same, but the density increases.
   (B) The volume of the water decreases, and so does the density.
   (C) The volume of the water increases, and so does the density.
   (D) The volume of the water increases, but the density remains the same.
   (E) The volume of the water increases, but the density decreases.

3. The position of the end of the block shown in the figure below corresponds to a scale reading of

   (A) 16.3 cm
   (B) 16.300 cm
   (C) 16.325 cm
   (D) 16.33 cm
   (E) 16.35 cm



4. All the following statements are correct. Which one is a law of nature?

   (A) One inch equals 2.54 cm.
   (B) The density of a substance is its mass per unit volume.
   (C) The boiling point of water is 100° C.
   (D) The change in length of a 50 cm aluminum rod is 0.0092 cm when it is heated from 20° C to 100° C.
   (E) All gases expand when heated at constant pressure.

5. Which of the following is <u>not</u> a characteristic property of a solid substance?

   (A) Elasticity
   (B) Mass
   (C) Mass of a unitavolume
   (D) Thermal expansion of a unit length
   (E) Melting point

6. The freezing point of a substance

   (A) has no relation to its melting point.
   (B) is always lower than its melting point.
   (C) is always equal to its melting point.
   (D) is always higher than its melting point.
   (E) depends on the mass of the sample whose freezing point is measured.

7. Which statement about volume is <u>incorrect</u>?

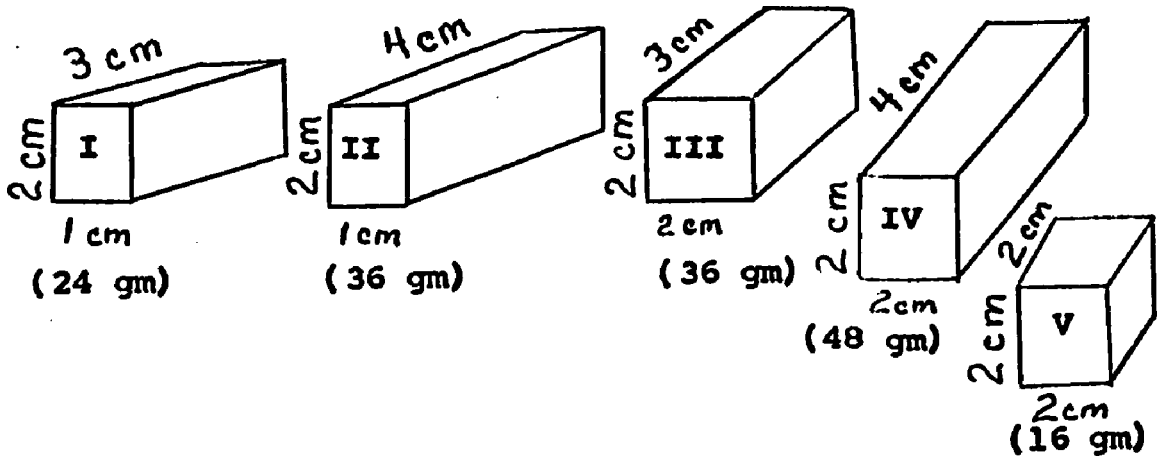
   (A) The volume of an object is the amount of space it takes up.
   (B) The volume of a solid that does not dissolve in water can be found by the displacement of water.
   (C) Whenever substances are changed in some way, their total volume is conserved.
   (D) The volume of a rectangular box is measured in terms of unit cubes.
   (E) The volume of a sphere is measured in terms of unit cubes.

8. The easiest way to get rid of the mud in a sample of muddy water is to

   (A) filter the water.
   (B) distill the water.
   (C) use chromatography.
   (D) use fractional crystallization.
   (E) use soap.

9. If in Question 8 we wanted to be sure that the water was free of dissolved substances as well, we would

   (A) filter the water.
   (B) distill the water.
   (C) use chromatography.
   (D) use fractional crystallization.
   (E) use soap.



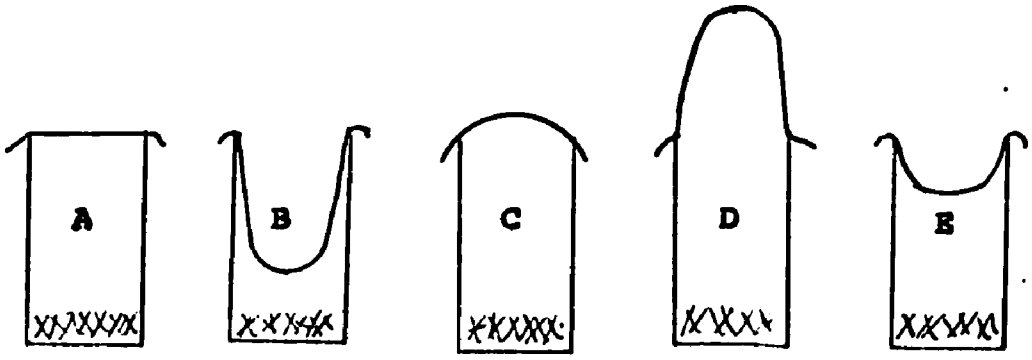
10. One of the above blocks is dropped into a graduated cylinder containing water and sinks to the bottom. The water level changes from 20 cm^3 to 26 cm^3. This must be block

(A) I
(B) II
(C) III
(D) IV
(E) V

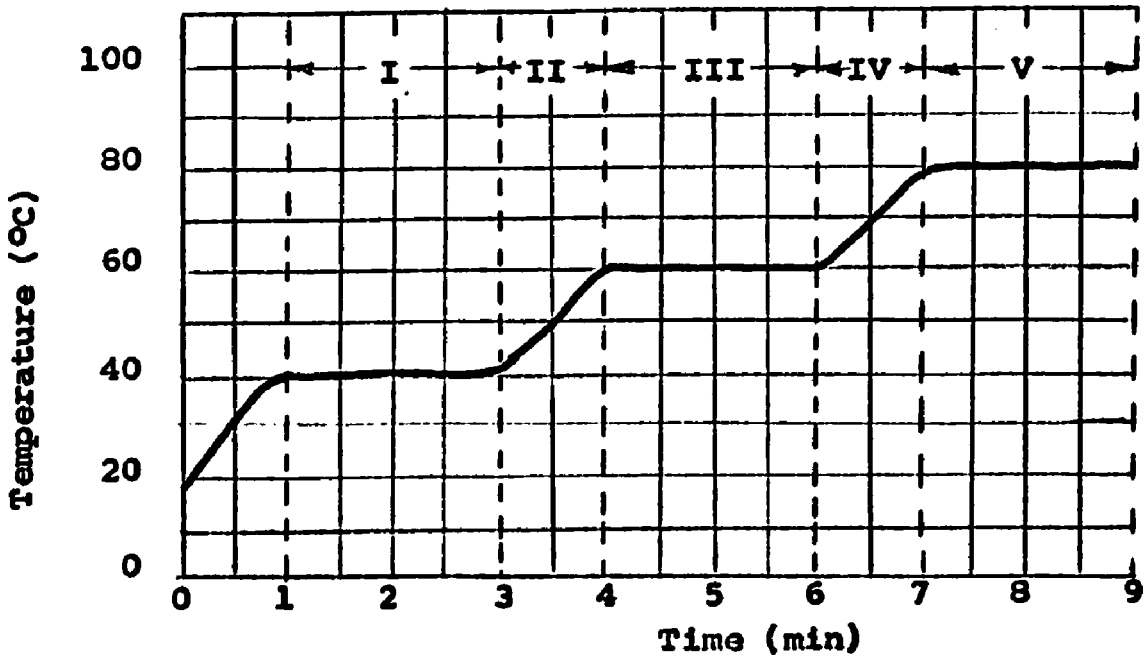
11. Which of the above blocks could be made of the same material?

(A) I and II
(B) II and III
(C) I and IV
(D) III and IV
(E) II and IV

12. You put some moist steel wool in a jar and cover it tightly with a sheet of rubber fastened to the mouth of the jar. If you know that moist steel wool combines with oxygen, which of the shapes below would you expect the rubber sheet to have after a day?



For Questions 13-15: A plot of temperature as a function of time during a distillation experiment is shown in the graph below:



13. The number of pure substances in the liquid which can be identified from the graph is

(A) 1
(B) 2
(C) 3
(D) 4
(E) 5

14. Liquid collected during the time interval II boils at

(A) 40°C
(B) 50°C
(C) 60°C
(D) above 60°C
(E) has no fixed boiling temperature

15. To separate the substances in the liquid, it is best to change the collecting test tubes at

(A) 2, 5, and 8 minutes.
(B) 3, 4, 6, and 7 minutes.
(C) 1, 4, and 7 minutes.
(D) 3, 6, and 9 minutes.
(E) a different set of times from those given.

16. A student dissolves as much as he can of a certain solid in 10 cm^3 of water in a beaker. The solid has a solubility of 80 g/100 cm^3 of water. The solution is then allowed to evaporate until only 5 cm^3 of liquid remains. If the contents of the beaker are now filtered, what mass of solid should he expect to find on the dried filter paper? (All operations take place at the same temperature.)

(A) 0 g
(B) 4 g
(C) 8 g
(D) 16 g
(E) 80 g

17. A certain gas does not burn, is about as dense as air, does not affect limewater, and does not support combustion. The gas might be

(A) nitrogen
(B) oxygen
(C) carbon dioxide
(D) hydrogen
(E) methane

18. When pure substance X is heated, pure substances Y and Z are produced. Which of the following is <u>false</u>?

(A) The ratio of the mass of X to the mass of Y produced is constant.
(B) The ratio of the mass of Y to the mass of Z is constant.
(C) Y and Z must be elements.
(D) The ratio of the mass of Z produced to the mass of X is constant.
(E) The rate at which the reaction takes place depends on the temperature.

19. When water is decomposed by electrolysis, the ratio of the volume of hydrogen produced to the volume of oxygen produced

(A) depends on how long the apparatus was connected to the battery.
(B) depends on how much sulfuric acid was added to the water.
(C) depends on how much water was used.
(D) depends on the temperature of the water.
(E) does not depend on any of the above.

For Questions 20-22:

The Table shows the results of tests on five samples of matter.

Sample	Separated into Fractions by Distillation	Separated into Fractions by Fractional Crystallization	Separated into Components by Electrolysis	Radioactive
1	yes	-	-	yes
2	no	no	no	yes
3	-	yes	yes	no
4	no	no	yes	yes
5	no	yes	yes	no

20. Which samples probably contain only a pure element?

(A) 1 only
(B) 2 only
(C) 4 only
(D) Both 1 and 2
(E) Both 1 and 4

21. Which sample is probably a single compound?

(A) 1
(B) 2
(C) 3
(D) 4
(E) 5

22. Which samples are definitely mixtures?

(A) 1, 2, and 3
(B) 1, 3, and 5
(C) 2, 3, and 5
(D) 1, 2, 3, and 5
(E) 3, 4, and 5

23. A Geiger counter registered a background count of 8 counts/min. When a piece of radioactive material was placed 25 cm from the probe, the counter registered 44 counts/min. The number of counts/min. due to the radioactive material was

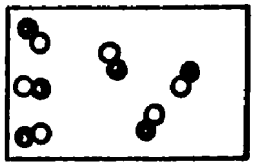
(A) 36
(B) 44
(C) 52
(D) $44/8$
(E) $36/25^2$

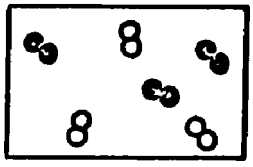
24. The elements X and Y form two compounds whose formulas are XY and X_2Y. The mass of X that reacts with 100 g of Y to form X_2Y is

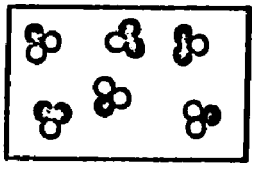
(A) 200 g
(B) 50 g
(C) 5 g
(D) 2 g
(E) impossible to determine from the information given.

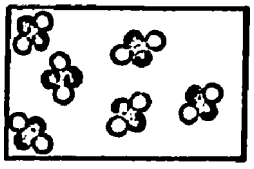
25. In the diagrams below, atoms of element X are represented by black balls and atoms of element Y by white balls. Which of the diagrams show possible arrangements of atoms in molecules of a gas whose simplest formula is XY?

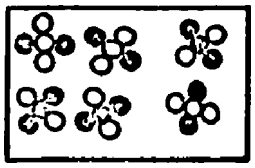
(A) I only
(B) II only
(C) IV only
(D) I and IV
(E) II and V











26. Equal masses of elements X and Y react to form a compound. Which of the following conclusions can be properly drawn on the basis of these data?

(A) The atoms of X and Y have equal masses.
(B) The atoms of X and Y have different masses.
(C) The number of atoms of element X in the compound equals the number of atoms of element Y in the compound.
(D) The number of atoms of element X in the compound is different from the number of atoms of element Y in the compound.
(E) None of the above.

For Questions 27 and 28:

A single layer of seeds completely covers the bottom of a square tin pan that is 20 cm on a side. When the seeds are poured into a graduated cylinder, they fill it to the 40 cm^3 mark.

27. The diameter of one of the seeds is about

(A) 0.01 cm
(B) 0.1 cm
(C) 0.5 cm
(D) 1 cm
(E) 2 cm

28. The total number of seeds in the pan is about

(A) 40
(B) 400
(C) 1.6×10^3
(D) 4.0×10^4
(E) 1.6×10^7

29. One cm^3 of blue dye is thoroughly mixed with 99 cm^3 of water. One cm^3 of this solution is then mixed with 9 cm^3 of water. The fraction of dye in the second solution is

(A) 1/1,000
(B) 1/110
(C) 1/10
(D) 1/100
(E) 2/1,000

30. According to the atomic model, atoms are in motion

(A) in gases only.
(B) in gases and liquids only.
(C) in gases, liquids, and solids.
(D) only when there is a temperature difference.
(E) only when diffusion takes place.

31. All of the following depend on molecular motion EXCEPT

(A) diffusion of copper sulfate into water.
(B) pressure exerted by a gas.
(C) difference in density for different solids.
(D) evaporation of water.
(E) compressibility of gases.

IPS ACHIEVEMENT TEST

Answer Sheet

Name_____ Date_____
Last First MI

School_____ Teacher & Class_____

Male or Female (circle one)

1. A B C D E
2. A B C D E
3. A B C D E
4. A B C D E
5. A B C D E
6. A B C D E
7. A B C D E
8. A B C D E
9. A B C D E
10. A B C D E
11. A B C D E
12. A B C D E
13. A B C D E
14. A B C D E
15. A B C D E
16. A B C D E
17. A B C D E
18. A B C D E
19. A B C D E
20. A B C D E
21. A B C D E
22. A B C D E
23. A B C D E
24. A B C D E
25. A B C D E
26. A B C D E
27. A B C D E
28. A B C D E
29. A B C D E
30. A B C D E
31. A B C D E

APPENDIX C

CLASSROOM ACTIVITY CHECKLIST

CLASSROOM ACTIVITY CHECKLIST

(These instructions, example, and questions are to be read to the students. Students need only handle and mark an answer sheet.)

The purpose of this checklist is to find out how well students know what is going on in their science classes. Each statement describes some classroom activity. The activities are not judged as either good or bad. This checklist is not a test and is not going to be used to grade you (the student) or the teacher.

SAMPLE QUESTION: ON ANSWER SHEET:

My teacher takes class attendance. (1) (2) (3) (4) (5)

KEY: ALWAYS (1) OFTEN (2) SOMETIMES (3) SELDOM (4) NEVER (5)

If the statement describes what always happens in class, mark the number (1) with an X. If the statement describes something that happens often, mark the number (2) with an X. The number (3) should be marked if the activity happens sometimes and the number (4) is marked if you think that the mentioned activity seldom takes place in class. The number (5) is to be marked if the activity never takes place.

REMEMBER:

1. The purpose of the checklist is to determine how well you know what is going on in your classroom.
2. All statements should be answered on the answer sheet by placing an X on the number that most nearly describes the statement.

1. We have classroom demonstrations done by students.
2. We begin an experiment by first reading the entire section including the captions in the IPS book.
3. We are required to outline parts of the text.
4. Much of our class time is spent in listening to our teacher talk about science.
5. Our teacher insists that we write in our notebook the final conclusions that we arrived at after each experiment.
6. My teacher admits mistakes when he makes them.
7. The teacher answers our questions about the laboratory work by asking us questions.
8. Textbook problems are assigned after an experiment is completed.
9. We use only one textbook in this class.
10. If there is a discussion among students, the teacher tells us who is right.
11. We spend more than 1/2 of our time doing laboratory work.
12. Students are called on to present their solutions to problems and to defend them.
13. We see movies and filmstrips in science class.
14. We are asked to make graphs.
15. Complete sentences and correct spelling are expected in science class.
16. During an experiment we record our data at the time we make the observations.
17. Our tests include many questions about things we have learned in our laboratory sessions.
18. We are asked to explain the meaning of certain parts of the text.
19. We are asked for the reasoning behind our answers.

20. We discuss what we have observed in the laboratory within a day or two after we finish each experiment.

21. Our teacher gives open-notebook quizzes over work done in the laboratory.

22. During an experiment each student keeps a record in his notebook of what he observes.

23. The movies, filmstrips, and slides we see pertain to the subject we are studying or have studied in class.

24. I like science class.

25. Our science tests ask us to define words.

26. After every experiment we compare the data we have collected with the data of other individuals or groups.

27. When we forget how to do things, our teacher tells us what we have forgotten.

28. Our science teacher grades the data in our notebooks on neatness.

29. On tests we are expected to use facts and information that we have learned at different times in this course.

30. Our teacher asks questions about what facts or evidence support the statements that are made in the book.

31. We are required to copy the purpose, materials, and procedure used in our experiments from the IPS book.

32. We stick to the subject we are studying.

33. We have tests in this class.

34. We have quizzes in this class.

35. We use the IPS book.

36. My teacher asks questions that make us remember things we studied in earlier chapters.

37. My job is to copy down what the teacher tells us or writes on the board.

38. I have a chance to look at and figure out my own conclusions from the lab work before it is discussed in class.

39. We use different science books in class.

40. We are expected to write out the meanings of words.

41. Before laboratory experiments are done, we discuss and determine the purpose of the experiment.

42. The experiments are done by the teacher or students while the rest of us watch.

43. During laboratory sessions I work with only one partner.

44. Students ask the teacher to tell them what they are suppose to do.

45. Students who finish the experiments before us (in this class or another class) give away the answers to the experiment.

46. We do experiments before we read or discuss what they are about.

47. Our teacher is grading papers or doing some other personal work while we are working in the laboratory.

48. We talk about the different kinds of evidence that are behind a scientist's conclusion.

49. Reading the books and the teacher's talking are about the only way we spend our time in science class.

50. When we have laboratory work to do, I work alone.

51. We know the answer to the laboratory experiments before we do them.

52. We started with Chapter I and went straight through the IPS book.

53. Questions asked in this class have more than one answer.

54. We hand in work every day to be graded.

55. Math is used in science class.

56. Students are asked to read aloud.

57. We are expected to write the answer to all the questions asked of us during an experiment by the IPS book.

58. Some students work ahead in the laboratory and do other experiments.

59. We have classroom demonstrations done by the teacher.

60. We discuss the problems faced by scientists in the discovery of a scientific principle or law.

61. We skip around to different parts of the IPS book.

62. Science tests ask us to figure out answers to new problems.

63. If I don't agree with the teacher, he wants me to say so.

64. Our entire class does the same experiment at the same time.

65. Our teacher tells us step by step what to do in the lab.

66. Class time is spent in answering questions that are taken from the book or that the teacher has made up for us.

67. Science tests give us data and ask us to draw conclusions from this data.

68. We have demonstrations done by students.

69. Our tests and quizzes have questions about the movies, filmstrips, and slides we have seen.

70. We spend more than half of our time in this class reading or discussing science.

CLASSROOM ACTIVITY CHECKLIST

Answer Sheet

Name_____ Date_____
Last First MI

School_____ Class & Teacher_____

Male or Female (circle one)

KEY: ALWAYS (1) OFTEN (2) SOMETIMES (3) SELDOM (4) NEVER (5)

Sample: 0. 1 2 3 4 5

1.	1	2	3	4	5
2.	1	2	3	4	5
3.	1	2	3	4	5
4.	1	2	3	4	5
5.	1	2	3	4	5
6.	1	2	3	4	5
7.	1	2	3	4	5
8.	1	2	3	4	5
9.	1	2	3	4	5
10.	1	2	3	4	5
11.	1	2	3	4	5
12.	1	2	3	4	5
13.	1	2	3	4	5
14.	1	2	3	4	5
15.	1	2	3	4	5
16.	1	2	3	4	5
17.	1	2	3	4	5
18.	1	2	3	4	5
19.	1	2	3	4	5
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24.	1	2	3	4	5
25.	1	2	3	4	5
26.	1	2	3	4	5
27.	1	2	3	4	5
28.	1	2	3	4	5
29.	1	2	3	4	5
30.	1	2	3	4	5
31.	1	2	3	4	5
32.	1	2	3	4	5
33.	1	2	3	4	5
34.	1	2	3	4	5
35.	1	2	3	4	5
36.	1	2	3	4	5
37.	1	2	3	4	5
38.	1	2	3	4	5
39.	1	2	3	4	5
40.	1	2	3	4	5
41.	1	2	3	4	5
42.	1	2	3	4	5
43.	1	2	3	4	5
44.	1	2	3	4	5
45.	1	2	3	4	5
46.	1	2	3	4	5
47.	1	2	3	4	5
48.	1	2	3	4	5
49.	1	2	3	4	5
50.	1	2	3	4	5
51.	1	2	3	4	5
52.	1	2	3	4	5
53.	1	2	3	4	5
54.	1	2	3	4	5
55.	1	2	3	4	5
56.	1	2	3	4	5
57.	1	2	3	4	5
58.	1	2	3	4	5
59.	1	2	3	4	5
60.	1	2	3	4	5
61.	1	2	3	4	5
62.	1	2	3	4	5
63.	1	2	3	4	5
64.	1	2	3	4	5
65.	1	2	3	4	5
66.	1	2	3	4	5
67.	1	2	3	4	5
68.	1	2	3	4	5
69.	1	2	3	4	5
70.	1	2	3	4	5

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