

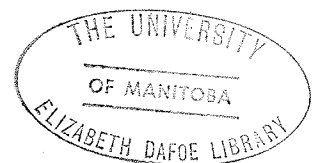
TEAM LEARNING:
THE EFFECT OF HOMOGENEOUS VS. HETEROGENEOUS PAIRING

A Thesis
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Master of Education

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ABSTRACT

The primary purpose of this investigation was to examine the effects of differential pairing of grade ten students on their achievement in Introductory Physical Science.

A random sample of 135 Fort Garry grade ten pupils, stratified on the basis of sex and scores on the Kuhlmann-Anderson Test, Form H, was selected for the study. These subjects were paired to form the four treatment groups - high ability subjects paired with high ability subjects, high ability subjects paired with low ability subjects, low ability subjects paired with high ability subjects, and low ability subjects paired with low ability subjects.

Acquisition and retention of factual information, application of knowledge, and changes in attitude, were measured. T-tests were employed to test for significance of mean differences between treatment groups.

Retention scores favored heterogeneous pairs of high and low ability subjects. Mean score differences of application measures favored the high ability subjects of homogeneous pairs, but not at a significant level. Method of pairing had no significant effect on attitude of subjects toward any of the variables tested.

Several conclusions appear warranted on the basis of the findings:

1. Retention of acquired information is affected by the method of pairing. High ability subjects who were paired with low ability subjects retained significantly more information than did high ability subjects of homogeneous pairs;
2. Any differences in attitude arising as a result of the pairing were not significant;
3. Homogeneous pairs, it would appear, do at least as well as heterogeneous pairs.

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CHAPTER I

STATEMENT OF THE PROBLEM

The Problem

The purpose of this study was to investigate the differential effects on rate of acquisition, retention, and application of scientific knowledge as a result of two methods of student-pairing in a team learning situation at the lower secondary level. Further, the study was designed to determine possible affective modifications as a result of differential pairing. More specifically, the questions of major interest were:

1. Does homogeneous pairing in a grade ten Introductory Physical Science (IPS) program enhance
 - (a) acquisition of factual information,
 - (b) retention of factual information,
 - (c) application of information,as opposed to heterogeneous pairing?
2. Do students in a Grade ten Introductory Physical Science program exhibit significant differences in attitude as a result of method of pairing?

Significance of the Problem

In the last decade there has been continued growth

in the use of social contacts among students as an aid in the learning process. Open classrooms, seminars, workshops, discussion and study groups utilize the group-concept of learning. Attention has centred increasingly upon the development of the individual in a social setting. A recent innovation in the field of group work is paired learning. Under this system, classes are divided into teams. The members of each team study together and work on joint assignments. Discussions are carried on within each pair, but testing is done individually.

Historically, research in team learning has developed in two phases: phase I, which concentrated on comparisons of students working in pairs with students working alone; phase II, which investigated the best method of pairing. In phase I the question of interest was, "How does paired learning compare with individual learning?"

According to Travers and Myers (1966) individual learning is more efficient when the task is rote learning. Dick (1963) and Heimer (1962) stated that paired learning was advantageous in algebra; Harms (1966) found that students of English gained as a result of paired learning.

Since several experiments have been completed which

indicate that, in certain subject fields, students working in pairs learn at least as much as students working alone, it seems both reasonable and efficacious that phase II research investigate the best method of pairing. Some research has already been conducted in this area, stimulated, in part, by the findings of phase I research, and, in part, by new courses which lend themselves readily to this approach. Most of these investigations have been confined to subjects involved in programmed learning units. However, team learning is not restricted to programmed learning; it is also being adopted in regular classrooms and laboratories. The findings of this study may be helpful in determining which type of pairing will be most beneficial to the student in regular classroom and laboratory situations.

In Grade ten Introductory Physical Science (IPS) classes, students are paired because experiments frequently require that several activities be carried on concurrently. In addition, the expenditure for apparatus is reduced considerably by having student pairs work together.

The writer was teaching the IPS course to two Grade ten classes during the school term 1967-68. Students were paired according to their own preferences. Some of the teams worked efficiently, while others

seemed to encounter various problems. It seems reasonable that if students work together on an experiment, that follow-up work and related tasks could be effected in a more efficient manner if they continued working together. A natural consequence is the need for determining the type of pairing that will result in optimum efficiency. Further, if one subscribes to the responsibility of the school of generating attitudes that will stimulate interest, and thus continued learning, beyond the confines of the school situation, one must recognize the need for some information regarding the degree to which classroom organization, such as learning in teams, can contribute to the formation of such attitudes.

Method of the Study

During the 1968-69 term, the subjects for the experiment were grade ten students at Vincent Massey Collegiate, Fort Garry. The sample consisted of 140 students. The socio-economic status of the community served by this school is middle to upper-middle class.

The subject was Introductory Physical Science. The course was supplemented with certain mathematical concepts and skills. The general experimental setting was as follows: about ninety percent of the time was spent in the laboratory with students working in single-

sexed pairs. The school operated on a ten-day cycle with six fifty-minute periods a day. Each class had eight periods of IPS per cycle. The experiment was conducted over a fifteen-week period.

Initially, students in each class were stratified on the basis of sex, then ranked according to the scores achieved on the Kuhlmann-Anderson Test (Form H). The actual pairing followed a slight variation of the procedure adopted by Hartley and Cook (1967). Students were encouraged to work together on as many tasks as possible. Only the testing was done on an individual basis.

The tests used included (1) The Kuhlmann-Anderson Test (Form H) used to pair subjects on the basis of ability (2) chapter tests (3) attitude scale (devised by the investigator using Osgood's Semantic Differential Scale as a model) (4) a final examination given at the end of the experimental period covering all the material taken during the experimental period.

Apart from grouping dictated by course selection, students were randomly assigned to classes. Of the seven classes taking IPS, four were selected at random for the experiment. Two teachers were involved, each teaching two of the experimental groups. Teacher

assignment to the experimental groups was done on a random basis. Instructional procedure was not changed for the experimental groups. The only variable was the method of pairing.

Definition of Terms

Throughout the study some terms are used so frequently, others in a special sense, that a brief explanation at this point seems desirable.

Team Learning - "learning" is used in the broad conventional sense; "Team" refers to a pair of students. "Team learning" and "Paired learning" are used interchangeably.

Station - the part of a laboratory table used by a pair of students.

High ability Student - Both sexes in each class were ranked from high to low on the basis of composite scores achieved on the Kuhlmann-Anderson Test (Form H). The subjects scoring above the median were designated as high ability students.

Low ability Student - A subject scoring below the median on the Kuhlmann-Anderson Test (Form H).

HH - a pair of high ability students.

LL - a pair of low ability students.

HL - a pair consisting of a high ability student and a low ability student.

Acquisition score - a score obtained on a test written immediately after a unit of material has been taken.

Retention score - a score obtained on a test written at the end of the experimental period, and sampling the entire content of the course covered during the period.

Application score - a score obtained on a test designed specifically to determine whether information gained can be used effectively in solving new problems.

Limitations of the Study

The results of this study are based only upon comparisons of pupils who were taking the Grade ten IPS course. Generalizations from this study are limited to students at the same level in similar situations.

Two teachers were involved in the experiment. However, it is assumed that since each teacher taught two classes, that the results, subject to other limitations, will not be affected seriously by the teacher variable.

The sample was drawn from a suburban community of middle and upper-middle class population. It seems reasonable to expect that this would affect the results.

The instruments used for evaluation, except the Kuhlmann-Anderson Test, were devised by the investigator. Apart from the attitude scale, no data concerning reliability or validity are available, imposing considerable restrictions on generalizations to be drawn from the findings.

Organization of the Thesis

The remainder of the thesis follows the format given below. Chapter II presents a review of literature related to the problem. Information about the sample, selection and description, evaluative instruments and experimental procedures is found in Chapter III. Chapter IV contains the presentation of data and statistical treatment of data. Chapter V presents the findings and conclusions.

CHAPTER II

REVIEW OF LITERATURE

The purpose of this chapter is to summarize available research related to team learning. Most of the literature, it is noted, has been written during the last ten years. The Education Index lists team learning for the first time in its 1964-65 edition. There is wide variance in studies regarding procedure, level of students, variables controlled, and specific criteria tested. There is also considerable variance in the amount of statistical evidence available to substantiate the many statements made with respect to team learning. But some of these innovations, and their by-products, have a bearing on this study in that they indicate interactions between various types of students. Further, learning improvement has been the objective of all investigators.

Articles of a descriptive nature have appeared in various educational publications describing pairing of students or team learning. A number of studies have been done comparing team learning with individual learning, but a scarcity of studies exists comparing homogeneous pairing with heterogeneous pairing.

Pertinent literature here will be reviewed in

in three areas, namely:

1. descriptive articles;
2. studies comparing team learning with individual learning;
3. studies comparing homogeneous pairing with heterogeneous pairing.

Descriptive Articles

These articles strongly suggest that pairing can be a valuable means of motivation within the classroom. They indicate that team learning can be implemented in various ways. Statistical evidence is not included to substantiate any of these statements, but some of the innovations described have a bearing on this study in that they indicate interactions between various student-types.

In her article "Pair the Bold with the Shy and Get Results", Witter (1967) utilized student pairing in music, oral English, science and crafts. Teaming the timid with the aggressive, according to the writer, led to an ideal blending of talents, capitalizing on the best in each partner, and stimulating new interests which might otherwise never have been developed.

In another study, Robbins and Hallock (1966)

teamed first-graders with sixth-graders in an effort to overcome language difficulties of the first-graders. The sixth-graders adopted the role of teacher. The results of this innovation included improvement in leadership skills, independence, and self-initiated learning.

Similar conclusions were drawn by Graffam (1964), who stated that the experiences and testimony of six hundred students, fifty elementary teachers and principals, and six consultants indicated that team learning could stimulate individual motivation and class morale for better and faster learning. The alphabetical method of team selection was used, but Graffam suggested that in other situations homogeneous grouping might be desirable. He stated, further, that with the increasing complexity and interdependence of our society and the rapid multiplication of knowledge, better techniques of learning and teaching are required to produce citizens capable of meeting the demands of present day living. Team learning, he said, "is designed to accomplish these ends, and consequently, it is appropriate for the needs and trends of our times."

Stoot's (1966) observations complement Graffam's

findings. According to Stoot, great strength of motivation is required for students to work alone at computers. Children paired learned equally well in appreciably shorter time than children working alone. Group learning, according to Stoot, frequently reinforces understanding since a clear understanding of a concept is needed before a student can explain it to the other member of a pair.

The objectives in the articles reviewed, in spite of variation in methods, reflect a common end--the improvement of learning. Further, all writers report some measure of success as a result of the team approach.

Team Learning Compared with Individual Learning

Available sources reveal that, although considerable investigation has been carried on, a variance of findings is evident with respect to the effectiveness of paired learning. The majority of studies have been aimed at determining the effectiveness of an individual working alone as compared to the effectiveness of an individual working as a member of a team. Most of the studies were conducted with either programmed learning or rote learning. The studies reviewed here present some evidence that paired learning may be at least as effective as individual learning.

Durrell (1959), the author of the team learning plan tested in the Dedham Project, has done a substantial amount of research comparing the effects of paired learning versus individual learning, generally using homogeneous pairing. He drew the following generalizations after observations of forty-seven fourth, fifth, and sixth grade pupils in mathematics and spelling programs:

1. Slow learners benefited more from pairing than from working individually.

2. Independent work of self-directing teams allowed the teacher more time with teams that needed help.

3. Pupils in pairs carried on a great deal of discussion, often making corrections on their own, thereby allowing the teacher additional time for rendering individual assistance.

4. Noise level in the classroom increased, but students were not bothered by it.

5. Pupil response and individual practice in oral activities increased.

6. Student attitudes toward school improved.
(This, however, was not substantiated by any statistical data.)

7. Students liked the idea of working together.

With reference to the Dedham Project, Durrell and Palos (1960) noted that even with uniform assignments required of entire classes, study teams permitted the use of different levels of study guides and offered richer opportunities for individual recall and reaction to material used. Further, it provided greater security in learning, especially when pupils checked their knowledge with each other. Team work, they said, "obviously provides experiences in social and group responsibility." Some disadvantages also became evident. Hard workers did most of the work and laggards did as little as possible. Certain children provided distractions which might lower working discipline. Differences of opinion could lead to quarrels, and finally, the burden on the teacher of keeping track of the class and in material preparation was much greater. They advised moderation in the use of paired learning, but added that pupil preference for team activities was great enough to warrant a wider use of study teams in classroom instruction.

Durrell and Scribner (1959), again assessing the Dedham Project, concluded that judging by teacher acceptance of the program and achievement results, the team learning program was definitely worthwhile. This

statement was unanimously endorsed by the school committee.

Experiments involving programmed learning were conducted by Dick (1963) and by Dick and Seguin (1963) to determine the effect of paired learning on individual students. Based on a second year contemporary algebra program, students were randomly paired. The performance of paired students was compared with that of students who worked alone. An attitude scale, constructed by Hartmann (1957) using Guttman scaling techniques, was administered at the conclusion of the program to determine any possible changes of attitude toward school or program.

Dick drew the following generalizations from his experiment:

1. Paired students retained a significantly greater amount of material studied than did individuals who worked alone.
2. Paired students took significantly longer to complete programmed learning units than the individual student working alone--an average of 3.7 minutes per unit longer. Dick concluded from these findings that the extra time was spent in discussions between members of pairs, and this resulted in superior retention.
3. Working in pairs provided relief from the boredom often associated with programmed learning.
4. No significant change in attitude was observed.

The evidence presented by Dick is not conclusive since he was prepared to accept a significance level of .07 when testing differences between retention scores of members of pairs and of individuals. In addition, he did not account for an attrition of twenty percent of his sample between test and retest. This may well have confounded the findings since he did not compare the lost cases with the remaining sample on any variable. However, his study strongly suggested that team learning had beneficial results on the students involved. It substantiated the findings of earlier studies.

The study by Dick and Seguin (1963) attempted to ascertain the effects of personality-pairing on the performance of freshman students in a programmed English grammar course. Fifty-six students were ranked and paired on the basis of Bernreuter's Personality Inventory. The results of this experiment indicated no significant differences on the criterion measures between similar and dissimilar groups.

Austwick (1965), in a trigonometry program with second year forms, used twenty subjects as a control, twenty-six subjects paired randomly, and twenty-four subjects paired homogeneously. He reported no significant differences in gain scores from a pretest to a

post-test. It was noted that girls took less time than boys in both treatments.

A study by Myers, Travers, and Sanford (1965) examined the effect of reinforcement of verbal learning by pupil pairs and by pupils working alone with a self-instructional task. They used 192 students at the fourth, fifth, and sixth grade levels. The task was the memorization of sixty German words and their English equivalents. Efficiency of learning, defined as the amount of learning per unit of time, was greater for students working alone. This conclusion was substantiated by another study (Myers and Travers, 1966).

Other studies have focussed attention on various phases of team learning as opposed to individual learning to determine the effect of pairing on the individual. McHugh (1959) used fifth and sixth grade students. He stated that:

1. Sixth grade students with an I.Q. of 120 or over improved significantly in science and literature.
2. Fifth grade students with I.Q.s from 95 to 119 gained in social studies, literature, and science.
3. Students with I.Q.s below 96 neither gained nor lost as a result of the paired learning program.

A study by Harms (1966) points toward more effect-

iveness and greater independence of the paired learners. He observed that students in English liked working together, and that nineteen out of twenty pairs finished the assigned task without teacher interference or assistance. No comparisons with a control group were reported.

Experimenting with a team learning approach in freshman English, Greenbaum and Schmerl (1967) were far from satisfied with the results of their experience. Lack of equipment and shortage of time produced frustrations. Evaluation of students was a problem. The experimenters were not able to ascertain whether the course would have any lasting value. In spite of these difficulties, Greenbaum and Schmerl stated that the method seemed, "a significant and useful departure from many of the present approaches to the course."

Maurer (1967, 1968), principal of a Junior-Senior high school, reported on the reactions of his teachers and their students to team learning. Generally homogeneous pairing was used. The following advantages of team learning were listed:

1. It helped to individualize instruction.
3. It encouraged student involvement and participation.

3. It increased student creativity.
4. It enabled teachers to get to know students better.
5. It provided relief from monotony.
6. Discipline problems were reduced to a minimum.
7. Teachers worked more creatively.
8. No extra demands were made upon the administrators.

The course was teacher-designed and pupil-centred.

Disadvantages of the method included:

1. Team learning classes were much noisier than conventional classes. (However, teachers insisted that the noise was easy to live with.)

2. Extra demands were made upon the teachers. They had to stay ahead of the top team.

3. Team learning in a school with a sizeable minority group might create a problem in terms of pairing. Maurer mentioned Negroes and Caucasians as a possibility, but this could apply to any other groups as well.

Maurer's teachers used team learning for mathematics, social studies, English, general science, biology, and some reading classes. Grades eight to twelve were included in the program. Of a total enrolment of 700, approximately 600 were involved in at least one team learning class per

day, and 350 students were involved in at least two team learning classes per day. The number of teachers involved in team learning increased from seven to nineteen after the first year.

Fry (1968), in spite of the advantages he acknowledged, held certain reservations regarding student pairs. He listed the chief advantages as heightened motivation, increased participation by the shy student, and decreased evaluation time. However, time was wasted adjusting pairs, and the possibility existed that a good student paired with a poor student might be penalized by this arrangement. Consequently, he advised restraint in the adoption of the paired structure.

It would appear, on the basis of these studies, that team learning has a number of advantages over individual learning. Student involvement seems to be increased, interest heightened, and results generally favor team learning. Evidence presented by investigators relating to team learning as opposed to individual learning tends to be positive.

Homogeneous Pairing Compared with Heterogeneous Pairing

Particularly applicable to this investigation are the studies on homogeneous versus heterogeneous pairing. Sawiris (1966) worked with twenty-eight individuals,

fourteen homogeneous pairs, and fourteen heterogeneous pairs, all thirteen year-olds, on a linear geometry program. He reported that homogeneous pairs took less time to finish a task than did heterogeneous pairs. There was insufficient data to generalize as to the effectiveness in terms of test results. Sawiris stated that tasks designed for individual use tended to hide the effectiveness of the group. The short duration of the experiment, terminated before boredom set in, obscured the motivational effect of group learning.

A finding of importance was that of Amaria, Biran, and Leith (1966). They experimented with primary children using a programmed course on levers. Their study indicated that the poorer members of heterogeneous pairs gained significantly more from their program than did similar students in homogeneous pairs.

An experiment in miniature was conducted by Hartley and Cook (1967). They attempted to determine the effect of pairing an individual of high ability with an individual of low ability, also a high ability student with another high ability student, and a low ability student with another low ability student. They stated that there was no reason to believe that a low ability student of a high-low pair benefitted particularly, or that a high ability

atudent of a high-low pair suffered as a result of the pairing. The subjects were twelve to fourteen years old. They used a machine-presented branching program in mathematics. The small sample size, however, (in some cases as low as four subjects) limits seriously any generalizations that can be drawn from this investigation.

Table 2:01 summarizes the results of the studies referred to earlier in this study.

Summary of the Review of Literature

A brief survey of literature pertinent to this study has been presented. Several points of particular interest emerge:

1. Findings indicate that individuals working in pairs, except where the task is rote learning, function at least as well as individuals working alone.

2. Pairing appears to offer advantages in terms of motivation, teacher time made available, learning efficiency.

3. Inconclusive findings are in evidence with respect to a comparison of the effectiveness of homogeneous pairing with heterogeneous pairing..

TABLE 2:01
Summary of Paired Learning Studies

Investigator	Student Level	Sample Size	Pairing Method	Comparison	Program	Advantage	Experiment Length
Durrell 1959	Grades 4 to 6	47 classes	homogeneous	pairs versus individuals	arithmetic spelling	pairs	school term
Dick 1962	College	36 exp. 34 con.	random	pairs versus individuals	maths. programmed learning	pairs	29 hours
Dick Seguin 1963	College	56	personality	homogeneous versus heterogeneous	English	neither	10 hours
Austwick 1965	2nd year forms	62	random	pairs versus individuals	trig. programmed learning	neither	not given
Travers Myers 1966	Grades 4 to 6	192	not given	pairs versus individuals	vocabulary rote learning	individuals	4 hours
Sawiris 1966	13	82	controlled	homogeneous versus heterogeneous	maths. programmed learning	homogeneous	not given
Maurer 1966- 1967	Grades 8 to 12	600 part time	homogeneous	homogeneous versus individuals	general	pairs	school term
Hartley Cook 1967	12 to 14 years max.	30 max.	controlled	homogeneous versus heterogeneous	maths. programmed learning	not conclusive	5 hours per experiment
Amaria Biran Leith(1968)	10 years	36	controlled	homogeneous versus heterogeneous	levers	heterogeneous	153 frames

CHAPTER III

DESIGN OF THE STUDY

The purpose of the present chapter is to outline the design of the study including a description of the sample, procedure of data collection, and proposed methods of data analysis.

The study was designed to determine the effect of differential pairing of students in Grade ten Introductory Physical Science.

Experimental Setting

The School

The subjects for the experimental treatment were Grade ten students in Vincent Massey Collegiate, one of two senior high schools in Fort Garry School Division Number 5. Fort Garry is a suburb of Winnipeg, Manitoba. The collegiate, offering courses in Grades ten, eleven, and twelve, has a total population of 918 students. Three hundred thirty-one students are enrolled in Grade ten, of whom 245 are in the University Entrance program.

No attempt was made to obtain objective data regarding socio-economic levels represented by the sample as this was not one of the dependent variables to be investigated. However, a subjective assessment shows

evidence of all levels of the socio-economic strata represented in the school system. There is further evidence that the community favours the middle and upper-middle strata. Student information forms indicated that parental occupations are predominantly professional and semi-professional. Attendance at parent-teachers meetings, home and school meetings, as well as school dramas, exhibits, and festivals, would indicate that school activities are well supported by the taxpayers.

Course Description

Reports from Physical Science Study Committee and Chemical Education Material Study teachers indicated that an understanding of basic scientific skills and the nature of experimental physical science should be acquired by students prior to enrolment in these courses. Based on these reports, the program, now called Introductory Physical Science, was developed and written by the IPS Group of Educational Services Incorporated. The first version of the program was used in 1963 and 1964. Feedback from teachers involved in teaching the course resulted in two major revisions. The present course is a product of the initial draft and ensuing revisions.

The program was piloted in Manitoba in 1966, conducted on a voluntary basis in 1967, and designated the official science course for all Grade ten students enrolled in the University Entrance program in 1968.

The course is designed to furnish students with a background for further study in other science courses, such as physics, chemistry, and biology. The theme of the course is the development of the atomic model of matter. Student experimentation and group discussions constitute the major portion of school work. Although a fully equipped laboratory is an asset, the course may be conducted in a classroom containing regular flat-topped desks and one sink. According to a survey conducted by the authors of the program, the course can and does serve needs of students with a wide range in background and ability.

Content of the first three units of the course was covered during the present investigation. The first unit serves as an introduction to the whole course. One experiment--the distillation of wood--provides the basis for discussion of experimental procedures, composition of matter, and course objectives. Here the student is introduced to the laboratory and the apparatus.

Measurement of matter is the main topic in the

second unit. Units of measurement, processes involved in measurement, advantages of mass over volume are some of the ideas discussed.

Unit three deals with characteristic properties. Density, thermal expansion, elasticity, freezing and boiling points are included in the section. Gases, liquids, and solids are examined.

Course Treatment

Class procedures for the experimental group did not vary from that accorded the regular classes. Broadly, the program could be divided into the following areas:

1. Discussion of concepts and principles from the text
2. Pre-laboratory discussions
3. Laboratory work
4. Post-laboratory discussions
5. Home, Desk, and Laboratory questions
6. Related activities

Each of these items will be dealt with briefly.

Discussion of concepts and principles from the text

Many portions of the text are of a descriptive or factual nature. Some sections were treated as reading assignments. Many concepts were discussed in class because of special significance with respect to related principles. Frequent

opportunity was given students to contribute information, ask questions, or share experiences. The lecture method was employed only rarely. Generally, the role of the teacher was that of discussion leader or consultant.

Pre-laboratory discussions. The main aims of the pre-laboratory discussions were to ensure that students were familiar with the procedures required to carry on the experiment, and that the objectives of the experiment were defined. If special techniques were required, these were noted. Safety precautions were emphasized, methods of recording data were discussed, and questions regarding any part of the experiment were answered.

Laboratory work. This phase included distribution of materials, setting up apparatus, and the experimental procedures. The students performed the experiment in pairs, and recorded the required data. The teacher engaged in assisting students by answering questions, asking questions, making suggestions, locating supplies, etc. After all pairs completed the experiment, the results were recorded on the blackboard. This provided the basis for the post-laboratory discussion.

Post-laboratory discussions. The procedures, results, and problems related to the experiment were discussed. Results were examined for trends and possible

generalizations to be drawn from the experiment. Sample data for an experiment involving elasticity of gases are given in Appendix A.

Home, Desk, and Laboratory problems. Each unit concluded with a series of problems. After each experiment a number of problems were assigned. These problems were designed to broaden the understanding and the scope of generalizations derived from the experiment, as well as to provide additional application of skills such as reading graphs, applying formulae, and calculating results. The problems might also suggest further activities which could be carried on, perhaps outside the classroom. The partners worked together at these problems preceding full-class discussions.

Related activities. These activities will be mentioned only since they are self-explanatory. The basic procedures have been outlined above, but many activities do not fall into specific categories. These include field trips, films, laboratory tests for fun, reports from students on experiments conducted at home, discussion of newspaper items, and experiments suggested by Home, Desk, and Laboratory problems. Review sheets, in preparation for written examinations, were handed out. (See Appendix B for sample review sheet.) On several

occasions time was allocated for students to perform experiments of their own choosing.

The Sample

The total Grade ten population consisted of 331 students. This population was divided into two groups on the basis of course selection. Eighty-six were enrolled in the General or Commercial course, and 245 were enrolled in a University Entrance program. The University Entrance group was sub-divided into classes on the basis of selection of options, such as French, American History, and Industrial Arts and Home Economics. These classes were randomly assigned to classrooms, and to teachers. Two teachers were involved in teaching the IPS course, one assigned to three classes, and the other to four classes. Each teacher selected two classes at random to constitute the experimental group.

The original sample consisted of 138 subjects. One student transferred to another classroom, two students were left without a partner due to an odd number of students in the classroom, leaving a total sample of 135 subjects. All had chosen French as an option, and 86 Industrial Arts and Home Economics. There were eighty-seven girls and forty-eight boys.

Method of Pairing

The method of pairing the students in the experimental group varied slightly in design from the one used by Hartley and Cook (1967). Initially, the students in each of the four classes were stratified on the basis of sex. Each group was ranked from high to low on the basis of scores achieved on the Kuhlmann-Anderson Test (Form H). The subjects scoring above the median (for each class and sex) were designated as high (H); those scoring below the median were designated as low (L). The highest ranking subject of the H group was paired with the highest ranking subject of the L group to form an HL pair. The second and third highest ranking students from the H group and the L group were paired to form HH and LL pairs respectively. This procedure was followed with the remaining subjects as shown schematically in Figure I.

The criterion test for ability was the Kuhlmann-Anderson Test (Form H). The pairing was on a permanent basis for the duration of the experiment unless critical problems arose which made it advisable to adjust the grouping. The students were encouraged to work together not only during the actual experiment, but also with all other IPS tasks.

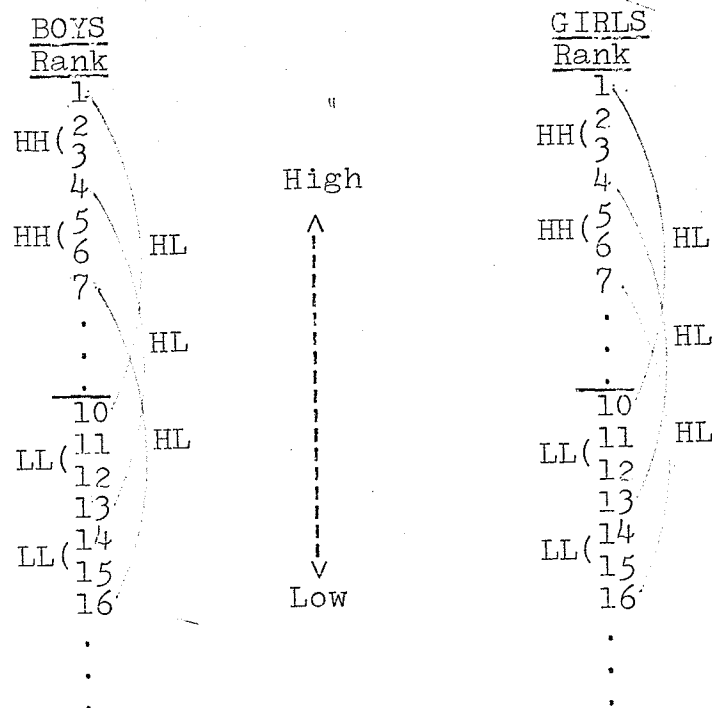


Figure 1
Schematic Representation of Pairing Method

Table 3:01 presents the range of I.Q. scores of both male and female subjects in the high and low group designations.

TABLE 3:01

RANGE OF KUHLMANN-ANDERSON I.Q. SCORES FOR SAMPLE
BY CLASS, SEX, AND GROUPING

SEX	GROUP	CLASS			
		I	II	III	IV
Boys	H	126 - 137	118 - 137	114 - 127	133 - 162
	L	104 - 128	107 - 112	99 - 113	117 - 136
Girls	H	124 - 134	109 - 138	117 - 150	133 - 150
	L	111 - 122	90 - 112	96 - 118	118 - 133

Hypotheses to be Tested.

The object of this investigation was to compare the differential effects of pairing on scientific and mathematical achievement and attitude changes.

The null hypotheses to be tested can be stated as follows:

Hypotheses Related to Acquisition Scores

1. There are no differences in mean scores between high ability subjects of the HH group and high ability subjects of the HL group.

2. There are no differences in mean scores between low ability subjects of the LL group and low ability subjects of the HL group.

Hypotheses Related to Retention Scores

1. There are no differences in mean scores between high ability subjects of the HH group and high ability subjects of the HL group.

2. There are no differences in mean scores between low ability subjects of the LL group and low ability subjects of the HL group.

Hypotheses Related to the Application of Scientific Concepts and Mathematical Skills

1. There are no differences in mean scores between high ability subjects of the HH group and high ability subjects of the HL group.

2. There are no differences in mean scores between low ability subjects of the LL group and low ability subjects of the HL group.

Hypotheses Related to Attitudes

1. There are no differences in changes of attitudes between high ability subjects of the HH group and high ability subjects of the HL group.

2. There are no differences in changes in attitudes between low ability subjects of the LL group and low ability subjects of the HL group.

Data Collection Procedures

Ability Testing. The Kuhlmann-Anderson Test, seventh edition, Form H, was selected as the criterion measure of learning ability in this study. The test consists of eighty-two verbal and eighty-four quantitative items. Administration requires approximately forty-five minutes (twenty-three minutes actual working time). Deviation I.Q.s are used for this form. The mean of these I.Q.s is 100 and the standard deviation is 16.

A number of comparisons have indicated validity coefficients ranging from +.59 to +.92. The total score of the Kuhlmann-Anderson Form H correlated with Sequential Tests for Educational Progress, Form 2A, and final academic grades at +.79 and +.59 respectively (Anderson, 1963).

Various reliability studies have shown the Kuhlmann-Anderson Test to be a highly reliable instrument. Successive administrations of the Kuhlmann-Anderson Test, Form H, to a group in Grade nine and in Grade eleven yielded a $+0.86$ correlation between the two sets of I.Q.s. The correlation between Grade ten and Grade eleven I.Q.s was $+0.92$ (Anderson, 1963).

Apart from the relatively high validity and reliability coefficients, the Kuhlmann-Anderson Test, Form H, was selected for this study because both verbal and quantitative items are used to measure academic potential. It was felt that an excessively verbal intelligence test would not be appropriate in a study dealing with scientific and mathematical concepts.

To determine the validity of the hypotheses, measuring instruments were designed by the investigator. The tests included instruments designed to measure acquisition, retention, and application, of knowledge and concepts, and an attitude evaluation scale.

Acquisition Testing. Tests of knowledge acquired were administered after the completion of each of the three units studied during the experimental period. These tests appear in Appendix C.

Retention Testing. One test, based on all material

covered, that is, the first three units, was administered at the end of the experiment (See Appendix D for the test). The purpose of the test was to determine how much of the material studied during the entire experimental period had been retained.

Application Testing. The degree to which subjects were able to apply information and concepts was assessed by administration of a laboratory test and a written report on an experiment conducted during a class period. The laboratory test consisted of finding the density of a liquid. This specific job was selected because (1) it involved mechanical skills, such as determining mass and measuring volume, (2) computational skills were required to determine density from the data collected, (3) the task was simple enough to allow every subject to enjoy some measure of success, yet challenging enough to sustain the interest of the more capable students, and (4) enough different samples could readily be prepared to ensure that no subject would be tempted to 'adopt' results from another person.

The student's work was scored on the basis of (1) organization, (2) techniques, (3) independence, (4) recording, (5) results, and (6) clean-up operations. The laboratory check form appears in Appendix E.

The written report was based on an experiment conducted by the whole class and included data from each station, comments suggested by leading questions in the text, a tabulation of class results, and generalizations or conclusions based on a full-class discussion of the experiment. The laboratory check form appearing in Appendix E was used to score the written report.

Attitude Evaluation. The attitude scale used was designed to measure the subjects' attitudes toward (1) science, (2) laboratory, (3) mathematics, (4) teacher, (5) classroom, and (6) partner. The investigator was interested in determining whether differential pairing affected the subject's attitude toward any or all of the items mentioned above.

Using Osgood's Semantic Differential Scale as a model, eleven bi-polar items were written for each of the six areas under consideration. A seven-point Guttman-type scale for each item enabled the subject to indicate the degree of feeling toward each item. Positive and negative choice positions were varied to avoid a subject's checking all items on either the positive or the negative side in order to express general approval or disapproval. Item seven was included as a distractor. A sample of the attitude scale appears in Appendix F. Scoring of the

attitude scale was done as follows: scores ranged from one to seven--completely negative was assigned a score of one, completely positive a score of seven. A mark halfway between the two extremes was given a score of four.

The attitude scale was administered to the sample and to a grade twelve class on September 10, 1968, at the beginning of the experiment. The scale was administered to a random sub-sample and to the grade twelve class a week later in order to determine the reliability of the scale.

The experimental period was concluded with a second administration of the scale to the whole sample in order to measure any changes in attitude in the five areas. Since the subjects did not know their partners at the beginning of the experiment, the scale on 'Partners' was not included in the first administration of the scale, but was included in the second administration to measure the attitude of each subject toward his partner. Change of attitude, of course, could not be measured in this area.

Method of Analysis

To test the first six hypotheses related to acquisition, retention, and application, a 2 X 2 analysis of variance design was used. The independent variables

employed in the design were sex and ability levels. The .05 level of significance was set as the level for rejection or acceptance of hypotheses.

To test the last two hypotheses related to attitude change, the t-test for correlated measures was used to examine the means of the difference-scores between the two administrations of the attitude scale. The .05 level of significance was set as the level for rejection or acceptance of the hypotheses.

Summary

A random sample of 140 students was drawn from the Vincent Massey Collegiate grade ten population. Each class was stratified on the basis of sex and total scores achieved on the Kuhlmann-Anderson Test, Form H. A description of the instrument, as well as reasons for its selection, was given.

The subjects were designated as either high ability or low ability students. They were paired to form homogeneous (HH and LL) and heterogeneous (HL) pairs.

Three units of Introductory Physical Science were studied during the experimental period. The course and course treatment were described. The topics under consideration were (1) matter, (2) measures of matter, and (3) characteristic properties.

Tests to determine acquisition, retention, and application were administered. An attitude scale was administered at commencement and at the conclusion of the experimental period in order to measure subjects' attitude change toward (1) science, (2) mathematics, (3) classroom, (4) teacher, (5) laboratory, and attitudes toward partners. These instruments were described.

The statistical treatments in the study were outlined and hypotheses to be tested listed.

CHAPTER IV

ANALYSIS OF THE DATA

Before presenting the analysis, a review of the procedures is outlined below.

Specific procedures were:

1. Administration of the Kuhlmann-Anderson Test, Form H, to Grade ten sample, stratification by sex, and pairing on the basis of this stratification. The following treatment groups were designated:

- a) High ability student of a pair of high ability students (H of HH)
 - b) High ability student of a pair consisting of a high ability student and a low ability student (H of HL)
 - c) Low ability student of a pair consisting of a high ability student and a low ability student (L of HL)
 - d) Low ability student of a pair of low ability students (L of LL).
2. Administration of Attitude scale
 3. Acquisition testing
 4. Application testing
 5. Retention testing

6. Second administration of Attitude scale to measure attitude change.
7. Examination of means in acquisition, retention, and application scores of treatment groups to determine trends in direction of differences.
8. Examination of means of difference scores to determine trends in attitude changes.
9. Tests for differences between scores of H of HH and H of HL in acquisition, retention, application, and attitude changes.
10. Tests for differences between scores of L of HL and L of LL in acquisition, retention, application, and attitude changes.
11. Tests for differences between scores of H of HH and H of HL in partner scores.
12. Tests for differences between scores of L of HL and L of LL in partner scores.

The purpose of the present chapter is to present the analysis of the data.

Examination of Treatment Means

Tables 4:01 to 4:03 summarize comparative means and standard deviations of the treatment groups using acquisition, retention, and application scores respectively.

Table 4:01

SUMMARY OF ACQUISITION SCORES FOR EACH TREATMENT GROUP AND FOR TOTAL SAMPLE

	Total Sample	H of HH	H of HL	L of HL	L of LL
\bar{x}	44.3	45.3	47.4	42.5	42.0
s.d.	11.9	12.9	11.0	9.85	12.5
N	135	38	28	28	41

Heterogeneous pairs are favored, although differences appear to be minimal. The low variability in the L of HL treatment group is worthy of note.

TABLE 4:02

SUMMARY OF RETENTION SCORES FOR EACH TREATMENT GROUP AND FOR TOTAL SAMPLE

	Total Sample	H of HH	H of HL	L of HL	L of LL
\bar{x}	15.8	15.8	17.6	15.3	15.0
s.d.	2.73	4.42	5.14	2.68	4.03
N	135	38	28	28	41

The means for heterogeneous groups, again, are slightly higher than the means for homogeneous groups. Again, the variability of the L of HL groups is considerably more limited than the variability of other treatment groups.

TABLE 4:03

SUMMARY OF APPLICATION SCORES FOR EACH
TREATMENT GROUP AND FOR TOTAL SAMPLE

	Total Sample	H of HH	H of HL	L of HL	L of LL
\bar{x}	8.05	8.35	8.04	7.71	8.00
s.d.	1.73	1.22	1.49	1.78	2.20
N	135	38	28	28	41

The differences in the means are slight, but tend to favor homogeneous groups. The L of HL and the L of LL tend to exhibit considerably more variability than do the treatment groups involving high ability subjects.

Table 4:04 presents means and standard deviations for attitude difference scores on the total attitude scale for all treatment groups. To eliminate negative values, 100 was added to each score. Thus a score of 100 would indicate no difference in attitude. A score in excess of 100 would indicate "positive change", and a score below 100 would denote "negative change".

TABLE 4:04

SUMMARY OF ATTITUDE DIFFERENCE SCORES FOR EACH
TREATMENT GROUP AND FOR TOTAL SAMPLE

	Total Sample	H of HH	H of HL	L of HL	L of LL
\bar{x}	98.4	95.8	98.7	96.4	101.2
s.d.	28.5	28.5	30.7	25.3	31.6
N	135	38	28	28	41

Table 4:04 indicates that all treatment groups cluster around a mean of 100 indicating little difference in attitude differential for total groups. It is noteworthy that the L of LL and H of HH show the least difference as well as the widest variability.

Table 4:05 indicates descriptive statistics for scores related to attitude toward partners for each treatment group and the total sample. A score of 40 denotes "indifference"; over 40, "positive feeling"; and under 40, "negative feeling".

TABLE 4:05

SUMMARY OF PARTNER ATTITUDE SCORES FOR EACH
TREATMENT GROUP AND FOR TOTAL SAMPLE

	Total Sample	H of HH	H of HL	L of HL	L of LL
\bar{x}	52.2	53.5	49.9	54.7	51.0
s.d.	11.9	8.68	13.2	10.5	11.1
N	135	38	28	28	41

The means are slightly in favor of the H of HH and the L of HL groups. The H of HL subjects show the lowest scores with the greatest degree of variability. The variability of the H of HH subjects is considerably lower than that of other groups.

Tables 4:06 to 4:20 summarize the means and standard deviations of the treatment groups and the

total sample using individual items of the attitude scale--science, laboratory, mathematics, teacher, and classroom scores for both administrations of the scale.

TABLE 4:06

SUMMARY OF INITIAL AND FINAL SCIENCE ATTITUDE SCORES FOR TOTAL SAMPLE

	\bar{x}	s.d.	N
Initial	54.9	8.12	135
Final	52.3	9.39	135

The means indicate no appreciable change in attitude toward science for the total sample.

TABLE 4:07

SUMMARY OF INITIAL AND FINAL SCIENCE ATTITUDE SCORES FOR HIGH ABILITY SUBJECTS

	H of HH			H of HL		
	\bar{x}	s.d.	N	\bar{x}	s.d.	N
Initial	52.3	8.96	38	53.0	7.27	28
Final	52.6	8.94	38	50.6	11.2	28

The direction of difference favors homogeneous grouping, since the mean for the heterogeneous groups decreased slightly, while the mean for homogeneous pairs remained stationary. Further it appears noteworthy that the variability in response for the H of HL increases substantially while the mean score decreased.

TABLE 4:08

SUMMARY OF INITIAL AND FINAL SCIENCE ATTITUDE
SCORES FOR LOW ABILITY SUBJECTS

	L of HL			L of LL		
	\bar{x}	s.d.	N	\bar{x}	s.d.	N
Initial	52.8	8.1	28	53.5	8.2	41
Final	51.3	9.9	28	53.8	8.2	41

The data favors homogeneous grouping where the mean remained unchanged, while a slight decrease is indicated for homogeneous grouping. There is little shift in variability for either of the groups.

TABLE 4:09

SUMMARY OF INITIAL AND FINAL LABORATORY ATTITUDE
SCORES FOR TOTAL SAMPLE

	\bar{x}	s.d.	N
Initial	55.1	8.85	135
Final	52.3	9.39	135

Table 4:09 indicates considerable decrease in mean scores from initial to final testing. The variability from one testing to the next shows little change.

TABLE 4:10

SUMMARY OF INITIAL AND FINAL LABORATORY ATTITUDE
SCORES FOR HIGH ABILITY SUBJECTS

	H of HH			H of HL		
	\bar{x}	s.d.	N	\bar{x}	s.d.	N
Initial	56.1	7.6	38	54.0	12.9	28
Final	55.6	7.2	38	53.1	8.1	28

The mean scores in Table 4:10 show little difference for either homogeneous or heterogeneous pairs. The marked decrease in variability for the H of HL on the final administration stands out.

TABLE 4:11

SUMMARY OF INITIAL AND FINAL LABORATORY ATTITUDE
SCORES FOR LOW ABILITY SUBJECTS

	L of HL			L of LL		
	\bar{x}	s.d.	N	\bar{x}	s.d.	N
Initial	54.8	8.62	28	55.2	6.82	41
Final	52.4	8.57	28	54.8	8.28	41

No substantial change in scores is evident from Table 4:11. The marked increase in variability for the L of LL group is interesting when no change whatsoever in variability was noted in Table 4:08 regarding attitude toward science.

TABLE 4:12

SUMMARY OF INITIAL AND FINAL MATHEMATICS ATTITUDE
SCORES FOR TOTAL SAMPLE

	\bar{x}	s.d.	N
Initial	48.9	13.0	135
Final	51.5	11.4	135

Table 4:12 indicates an increase in scores from the initial to the final administration of the scale with lowered range of variability on the final test session.

TABLE 4:13

SUMMARY OF INITIAL AND FINAL MATHEMATICS ATTITUDE
SCORES FOR HIGH ABILITY SUBJECTS

	H of HH			H of HL		
	\bar{x}	s.d.	N	\bar{x}	s.d.	N
Initial	49.7	13.3	38	51.0	13.4	28
Final	50.9	13.9	38	55.2	10.1	28

Considerable increase in scores in favor of the heterogeneous pairs is reflected in Table 4:13. The sharp drop in variability is reminiscent of the decrease in spread shown in Table 4:10. The H of HH indicate little change in range of variation, a pattern consistent with trends observed in Tables 4:07 and 4:10.

TABLE 4:14

SUMMARY OF INITIAL AND FINAL MATHEMATICS ATTITUDE
SCORES FOR LOW ABILITY SUBJECTS

	L of HL			L of LL		
	\bar{x}	s.d.	N	\bar{x}	s.d.	N
Initial	49.1	14.3	28	46.5	11.7	41
Final	51.6	10.9	28	49.3	9.63	41

Table 4:14 indicates an increase in scores for both 'low' treatment groups and considerable decrease in variability.

TABLE 4:15

SUMMARY OF INITIAL AND FINAL TEACHER ATTITUDE
SCORES FOR TOTAL SAMPLE

	\bar{x}	s.d.	N
Initial	50.8	7.7	135
Final	50.4	9.9	135

Mean scores on the two administrations of the teacher attitude section of the scale are essentially the same. An increase in spread of scores, however, is indicated.

TABLE 4:16

SUMMARY OF INITIAL AND FINAL TEACHER ATTITUDE
SCORES FOR HIGH ABILITY SUBJECTS

	H of HH			H of HL		
	\bar{x}	s.d.	N	\bar{x}	s.d.	N
Initial	51.8	8.0	38	49.1	3.6	28
Final	50.0	9.2	38	49.7	10.2	28

Table 4:16 indicates that the high ability students of both homogeneous and heterogeneous pairs are fairly consistent in mean score and variability with the performance of the total sample.

TABLE 4:17

SUMMARY OF INITIAL AND FINAL TEACHER ATTITUDE
SCORES FOR LOW ABILITY SUBJECTS

	L of HL			L of LL		
	\bar{x}	s.d.	N	\bar{x}	s.d.	N
Initial	49.7	4.88	28	51.6	8.0	41
Final	50.0	11.9	28	51.6	9.2	41

Again, no marked deviations in mean scores are noted for L of HL and L of LL treatment groups. However, a striking increase in range of scores is reflected in the changes in standard deviations of L of HL group.

TABLE 4:18

SUMMARY OF INITIAL AND FINAL CLASSROOM ATTITUDE
SCORES FOR TOTAL SAMPLE

	\bar{x}	s.d.	N
Initial	49.5	9.3	135
Final	47.3	11.6	135

Table 4:18 reflects a slight drop in mean scores between the initial and final administrations of the attitude scale. The increase in over-all variability is consistent with the trends indicated in Tables 4:06, 4:09, and 4:15.

TABLE 4:19

SUMMARY OF INITIAL AND FINAL CLASSROOM ATTITUDE
SCORES FOR HIGH ABILITY SUBJECTS

	H of HH			H of HL		
	\bar{x}	s.d.	N	\bar{x}	s.d.	N
Initial	49.6	9.25	38	48.1	9.78	28
Final	46.6	6.92	33	47.4	7.93	28

Both homogeneous and heterogeneous pairs reflect a slight decrease in scores consistent with the trend indicated in Table 4:18. The decrease in range of variability for the H of HH is unique to this particular item.

TABLE 4:20

SUMMARY OF INITIAL AND FINAL CLASSROOM ATTITUDE
SCORES FOR LOW ABILITY SUBJECTS

	L of HL			L of LL		
	\bar{x}	s.d.	N	\bar{x}	s.d.	N
Initial	49.2	9.35	28	50.4	4.65	41
Final	45.8	10.4	28	43.9	11.1	41

The greatest decrease in scores for all groups on classroom attitude is seen for the L of HL group. A substantial increase in variability is noted for the L of LL treatment group.

Analysis of Treatment Means

The statistical design of this investigation is described in Chapter III, where the specific hypotheses to be tested are listed. Following the order outlined in Chapter III, each of the hypotheses is stated and tested.

The hypotheses were tested by means of the t-test for significance of differences in acquisition, retention, application, attitude changes, and partner attitude.

Hypotheses Related to Acquisition MeasuresHypothesis 1.

There are no differences in mean scores between high ability subjects of the HH group and high ability subjects of the HL group.

Table 4:21 presents the analysis of the means attained by high ability subjects on the acquisition measures.

TABLE 4:21

ANALYSIS OF ACQUISITION MEASURES OF
HIGH ABILITY SUBJECTS

	Mean	Mean Square	D.F.	t-value
H of HH	45.3	2052	} 64	.695 N.S.
H of HL	47.4	2252		

Although a difference in means favors the H of HL group, the difference is non-significant.

The hypothesis is accepted.

Hypothesis 2.

There are no differences in mean scores between low ability subjects of the LL group and low ability subjects of the HL group.

Table 4:22 indicates the analysis of data relevant to acquisition scores of low ability subjects.

Table 4:22

ANALYSIS OF ACQUISITION SCORES
OF LOW ABILITY SUBJECTS

	Mean	Mean Square	D.F.	t-value
L of HL	42.5	1805	} 67	.175 N.S.
L of LL	42.0	1764		

The table shows the results for low ability subjects

to be congruent with those for high ability subjects.

The t-value is non-significant.

The hypothesis is accepted.

Hypotheses Related to Retention Measures

Hypothesis 1.

There are no differences in mean scores between high ability subjects of the HH group and high ability subjects of the HL group.

Table 4:23 summarizes the analysis relevant to the retention measures for high ability subjects.

TABLE 4:23

ANALYSIS OF RETENTION MEASURES OF HIGH ABILITY SUBJECTS

	Mean	Mean Square	D.F.	t-value
H of HH	15.8	250	64	3.273*
H of HL	17.6	309		

* significant at .01 level

The table indicates the difference in means to be significant at the .01 level, approaching significance at the .001 level. The difference favors the H of HL treatment group.

The hypothesis is rejected.

Hypothesis 2.

There are no differences in mean scores between low ability subjects of the LL group and low ability subjects of the HL group.

Table 4:24 outlines the analysis for retention mean scores of low ability subjects.

TABLE 4:24

ANALYSIS OF RETENTION MEASURES
OF LOW ABILITY SUBJECTS

	Mean	Mean Square	D.F.	t-value
L of HL	15.3	234	67	.346 N.S.
L of LL	15.0	225		

The low t-value is consistent with the low value for low ability subjects on acquisition measures (Table 4:22).

The hypothesis is accepted.

Hypotheses Related to Application Measures

Hypothesis 1.

There are no differences in mean scores between high ability subjects of the HH group and high ability subjects of the HL group.

Table 4:25 gives inferential statistics relevant to mean application scores for high ability subjects.

TABLE 4:25

ANALYSIS OF APPLICATION MEASURES
OF HIGH ABILITY SUBJECTS

	Mean	Mean Square	D.F.	t-value
H of HH	8.35	70.0	64	.934 N.S.
H of HL	8.04	64.2		

Non-significant differences between means is noted, a finding consistent with results on acquisition measure (Table 4:21), but in sharp contrast to the highly significant t-value for retention (Table 4:23).

The hypothesis is accepted.

Hypothesis 2.

There are no differences in mean scores between low ability subjects of the LL group and low ability subjects of the HL group.

Analysis of mean scores on application measures for low ability subjects is presented in Table 4:26.

TABLE 4:26

ANALYSIS OF APPLICATION MEASURES OF LOW ABILITY SUBJECTS

	Mean	Mean Square	D.F.	t-value
L of HL	7.71	59.5	67	.569 N.S.
L of LL	8.00	64.0		

The low t-value compares with the findings on both acquisition (Table 4:22) and retention (Table 4:24).

The value is non-significant.

The hypothesis is accepted.

Hypotheses Related to Attitude Change

Hypothesis 1.

There are no differences in mean scores between high ability subjects of the HH group and high ability subjects of the HL group.

Table 4:27 summarizes the analysis of means of difference scores on attitude change for high ability subjects.

TABLE 4:27

ANALYSIS OF ATTITUDE DIFFERENCE SCORES
OF HIGH ABILITY SUBJECTS

	Mean	Mean Square	D.F.	t-value
H of HH	95.8	9150	} 64	.411 N.S.
H of HL	98.8	9710		

The difference between the means is non-significant.

The hypothesis is accepted.

Hypothesis 2.

There are no differences in mean scores between low ability subjects of the LL group and low ability subjects of the HL group.

Table 4:28 indicates the test for significance between means for low ability subjects on attitude difference means.

TABLE 4:28

ANALYSIS OF ATTITUDE DIFFERENCE SCORES
OF LOW ABILITY SUBJECTS

	Mean	Mean Square	D.F.	t-value
L of HL	96.4	9300	} 67	.653 N.S.
L of LL	101.2	10210		

Non-significance of the t-value is consistent with results on the same dependent variable for high ability subjects (Table 4:27).

The hypothesis is accepted

Hypotheses Related to Attitudes Toward Partners

Hypothesis 1.

There are no differences in mean scores between high ability subjects of the HH group and high ability subjects of the HL group.

Table 3:29 presents the analysis relevant to means on "attitude toward partner" scores for high ability subjects.

TABLE 4:29

ANALYSIS OF PARTNER MEASURES OF
HIGH ABILITY SUBJECTS

	Mean	Mean Square	D.F.	t-value
H of HH	53.5	2860	} 64	1.34 N.S.
H of HL	49.9	2490		

Although the hypothesis is accepted, the t-value approaches significance at the .05 level favoring the homogeneous pairs of subjects.

Hypothesis 2.

There are no differences in mean scores between low ability subjects of the LL group and low ability subjects of the HL group.

The test for "attitude toward partner" mean

scores is summarized in Table 4:30.

TABLE 4:30

ANALYSIS OF PARTNER MEASURES OF
LOW ABILITY SUBJECTS

	Mean	Mean Square	D.F.	t-value
L of HL	54.7	2990	} 67	1.37 N.S.
L of LL	51.0	2600		

The table indicates results closely comparable with those of the high ability subjects on the same variable. The difference in this case, however, favors the heterogeneous pairs. Again, the difference approaches the .05 level.

The hypothesis is accepted.

Summary of Findings of the Study

This study was designed to investigate the effect of differential pairing--HH, HL, LL,--in grade ten Introductory Physical Science. Tentative answers to questions raised are presented here.

Findings on Acquisition Measures

Non-significant t-values were found for both high and low ability subjects. Differences, although small, favored heterogeneous pairs at both ability levels.

Findings on Retention Measures

A significant t-value for H of HL was found for the retention measure. The very slight difference in means for the low ability subjects also favored the heterogeneous pairs.

Findings on Application Measures

Non-significant t-values were found for both high and low ability subjects. Differences for both groups favored homogeneous pairs. The differences, however, did not approach significance.

Findings of Attitude Change

Non-significant t-values were found for both ability groups. The slight differences favored the H of HL and L of LL treatment groups.

Findings on the "Attitude Toward Partner" Measure

Differences in means approached significance for both high and low ability groups. The difference favored homogeneous pairs for high ability subjects and heterogeneous pairs for low ability subjects.

CHAPTER V

SUMMARY AND CONCLUSIONS

Summary of Design and Procedures

The main purpose of this study was to determine the effect, if any, of differential pairing of Grade ten students on their achievement in Introductory Physical Science. The questions raised in this regard were:

1. Does homogeneous pairing in a grade ten Introductory Physical Science (IPS) program enhance
 - a) acquisition of factual information
 - b) retention of factual information
 - c) application of informationas opposed to heterogeneous pairing?

2. Do students in a grade ten Introductory Physical Science program exhibit significant differences in attitude as a result of method of pairing?

A random sample of 135 Fort Garry grade ten pupils, stratified on the basis of sex and scores on the Kuhlmann-Anderson Test, Form H, was selected for the study. These students were paired in a manner similar to that followed by Hartley and Cook (1967) to form the four treatment groups --H of HH, H of HL, L of HL, L of LL. The

acquisition criterion consisted of three tests, one administered at the conclusion of each unit of work. A retention test was given at the conclusion of the experimental period. The application criterion consisted of daily laboratory work which included practical laboratory tests. An attitude scale was administered at the commencement and the conclusion of the experimental period to determine possible attitude changes regarding selected aspects of the program.

Pearson-Product-Moment Correlation coefficients were employed to test the reliability of the attitude scale. The t-test was used to test for significance between mean differences of attitude scores on initial and final administrations of the attitude scale. Further, the t-test was used to test for significance of mean differences between treatment groups on each of the dependent variables--acquisition, retention, application, total attitude change, and 'attitude toward partner'.

Summary of Findings

1. Acquisition scores did not differ appreciably between treatment groups.
2. Retention scores favored heterogeneous pairs of the high and low ability subjects. Differences were

significant at the .01 level for the high ability group.

3. Mean score differences of application measures favored the high ability subjects of homogeneous pairs but by little more than a chance level of significance.

4. Method of pairing was found to have no significant effect on attitude of students toward any variables tested.

Limitations of Findings

As mentioned in the discussion in Chapter I, generalizations from the findings of this study are limited by the sample, the population from which the sample was drawn, and the reliability and validity of the measuring instruments employed. These limitations must be considered with respect to any conclusions based on the findings.

Conclusions

Several conclusions appear warranted on the basis of the findings of this study:

1. The results of this investigation indicate that retention of acquired information is affected by method of pairing in at least one instance. High ability subjects who were paired with low ability subjects retained significantly more information than did high ability subjects of homogeneous pairs. A possible

explanation for this greater retention might be that the high ability students were required to adopt the teacher-role. They were called upon to give explanations by their partners. Student comments lend weight to this argument, e.g., "I like my partner because she knows more than me, and therefore I can always ask her if I'm in trouble". It is noteworthy that Dick (1963) reported greater retention by paired students than by individuals. His study, however, was not designed to study effects of types of pairing.

2. There is no reason to believe that the L of HL hindered the H of HL with whom they were paired. There is also no evidence from this study to indicate that the L of HL performed significantly worse than the L of LL. This is contrary to some of the earlier findings. Generally, except for the retention of acquired information, the data from this study support the statement made by Dick and Seguin (1963) that method of pairing does not appreciably affect the student's work. It would appear that heterogeneous pairs do at least as well as homogeneous pairs.

3. On the basis of classroom and laboratory observation, heterogeneous pairing appears to have some advantages. Homogeneous pairs of low ability

subjects take up much more teacher-time, while homogeneous pairs of high ability students and heterogeneous pairs function quite well with considerably less teacher direction. Heterogeneous pairing could be advantageous to the teacher and to some of the students--to the teacher in terms of time available for individual help, to the high ability students in terms of greater retention.

4. The scores of the attitude scale tend to indicate that any differences in attitude arising as a result of the pairing are not significant. However, there is some reason to believe that students themselves, in spite of scores on attitude scales, would prefer homogeneous pairs. Students were asked to comment on the pairing system. Several examples of statements made follow: 'She's smart; I'm dumb, so I just do the writing', 'My partner's stupid; he messes things up', 'It appears if there is one smart one only, the other person will usually copy off him or her to save work', 'You may not learn anything if your partner does all the work'.

5. Data from the initial and final administrations of the attitude scale indicate a decrease in mean scores for all treatment groups except L of LL. Possibly, the general decrease could be attributed to the timing of the scale administrations. Typical high enthusiasm at the

beginning of a school year may have created a basal on the test that was unrealistic for the purpose.

Recommendations for Further Study

The subjects in this study were not informed about the method of pairing. Judging by comments, some students were aware that pairs based on varying criteria existed. It seems reasonable that research could be done devising measures by which subjects could indicate which type of pairing they would prefer, and why.

The present study could be replicated in another area, such as mathematics.

The possibility of employing team learning in the contract system or in continuous progress programs suggest interesting possibilities for further experimentation. It is quite possible that any differences which exist, or differences suggested by the results of this study, might be accentuated under the suggested conditions.

It is interesting to note that the H of HL had higher means in acquisition, retention, and total attitude scale scores than H of HH. Further, H of HL exhibited greater variability in all areas except acquisition. A study designed to investigate, more intensively, the dynamics operative in HL pairs should prove both

interesting and valuable.

The data on attitude change indicate a higher mean and greater variability for heterogeneous pairs than for homogeneous pairs among high ability subjects, but a higher mean and greater variability for homogeneous pairs than for heterogeneous pairs among low ability subjects. Were some of the high ability subjects frustrated by having to help the low ability subjects? Were some of the high ability subjects happier in a situation where they were able to take the initiative and assume a responsible role? These are questions to be answered only by carefully designed research.

Replication of the present study extending the time to a full school term should be of value. Perhaps some of the trends suggested by this study would be substantiated or clearly negated by a study investigating long-range effects.

Replication of this study with a different method of pairing should prove of value. A comparison of the four treatment groups where students choose their own partners should prove efficacious. This would allow for investigation of specific criteria which students perceive to be relevant in an ideal learning partner.

There was considerable overlap in ability between

high and low ability subjects, introducing a rather crucial confounding element. Stratification of the complete sample according to high and low ability, prior to class assignment would eliminate this rather serious limitation.

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APPENDIX A

Sample Data For Experiment Involving
Elasticity of Gases

SAMPLE DATA

Elasticity of Gases

Mass (bricks)	Volume (cm ³)	Change (cm ³)	Volume (cm ³)	Change (cm ³)
0	34.0	0.0	35.0	0.0
1	22.0	12.0	23.0	12.0
2	16.5	17.5	17.0	18.0
3	13.0	21.0	13.5	21.5
4	11.0	23.0	11.0	24.0
5	9.8	24.2	10.0	25.0

APPENDIX B

Sample Review Sheet

REVIEW SHEET CHAPTER 2
GRADE X IPS

1. What unit of measurement could you use to measure the following:

- (a) length _____
- (b) weight _____
- (c) mass _____
- (d) height _____

2. What experiments have you performed to determine whether mass is conserved when the form of a substance is changed?

Is mass conserved when the form of a substance is changed?

3. What is meant by 'precision of a balance'?

4. How precise are the balances?

5. Give an example to show that you understand the term 'percentage of error'.

6. How do you determine the mass of
(a) an object that has an irregular shape?

(b) an object that has a regular shape?

7. How do you determine the volume of
(a) an object that has an irregular shape?

7. (b) an object that has a regular shape?
8. Define the term 'density'.

What is the formula for determining the density of an object?

Give an example to show that you understand this concept.

What is the density of water?

Which of these has the greatest density: aluminum, wood, steel?

An object measures 2in. by 4cm. by 16mm. It has a mass of 72 beads. What is its density?

9. Write the following in scientific notation:
- (a) 835,000 _____
- (b) .00000000726 _____
10. Give an example of a number that contains:
- (a) three significant digits. _____
- (b) Three significant and three non-significant digits. _____
11. List the possible sources of error with regards to the results of experiment 3:2.
12. What is meant by the term 'characteristic property'?
13. Why is mass often better for measuring matter than volume?

APPENDIX C

Tests of Knowledge Acquired

1. Test - Unit I
2. Test - Unit II
3. Test - Unit III

IPS TEST UNIT I

1. The most suitable way of taking wood apart to see what it is made of is to:
 - a. dissolve it in acid
 - b. burn it and collect all the products
 - c. break it up into small pieces
 - d. heat it and collect all the products
 - e. dissolve it in water

2. By examining the wood splints in the test tube, before anything is done to them, it was evident that the wood was made up of:
 - a. carbon and hydrogen
 - b. charcoal and water
 - c. only wood
 - d. atoms and molecules
 - e. solids, liquids, and gases

3. In order to increase the precision of an equal-arm balance, the rider scale was divided into 100 equal units. The precision of the balance will be about:
 - a. 1 bead
 - b. .001 bead
 - c. .1 bead
 - d. .01 bead
 - e. 100 beads

4. What units (two for each item) could you use to measure each of the following:
 - a. length _____
 - b. volume _____
 - c. weight _____
 - d. mass _____
 - e. height _____

5. What is meant by the term 'precision of a balance'?

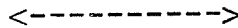
.....
.....
.....

6. How precise are the balances?

.....
.....

7. A student weighs an object on the bead balance. By mistake he places the object on the same side as the rider. He balances the object by means of 52 beads in the opposite pan and by setting the rider to .8 beads. What is the mass of the object?

.....
.....
.....



IPS TEST UNIT II

1. A block of iron is 4.2 cm by 3.0 cm by 5.0 cm. It has a mass of 75.0 beads. Its volume is nearest to
 - a. 63 beads
 - b. 63 cm³
 - c. 63 cm³
 - d. 63 cm²
 - e. 6.3 cm³

2. If one gram equals 5 beads, the mass in grams of the block of iron in Question 1 is nearest to
 - a. 255
 - b. 15
 - c. 33
 - d. 3.3
 - e. 330

3. The mass of a beaker of water and some dry powder is measured as 124.6 beads. The powder is dropped into the water and fizzing occurs. After the fizzing stops, the mass of the beaker and its contents is measured as 120.2 beads. From the experiment alone you could conclude that
 - a. the mass of the beaker or its contents decreased
 - b. the law of conservation of mass does not hold
 - c. the balance does not give any information about the masses of the items used
 - d. mass is conserved when the water dissolves the powder
 - e. the mass of the powder remains the same

4. 36 beads of sugar were dissolved in 200 grams of water.
 - a. the mass of the sugar decreased
 - b. the combined volume of sugar and water increased
 - c. the combined volume of sugar and water decreased
 - d. the combined mass of sugar and water increased
 - e. the mass of sugar increased

5. If the needle swings too far to the left when you weigh an object in the left pan of your balance,
- more beads will be required to balance the object
 - the object is too heavy to be weighed accurately
 - the rider should be moved to the right
 - the clip opposite the rider arm should be adjusted
 - none of the above are correct

6. Why are volumes measured in terms of unit cubes rather than in unit spheres?

.....

7. Under what circumstances is volume not a good measure for comparing the quantity of matter of different samples?

.....

For questions 8 and 9

Some dry sand is poured into a graduate cylinder and its volume is read as 18 cm^3 . Water is poured into a second cylinder and its volume is 16 cm^3 . The sand is then poured into the cylinder containing the water, and the water level rises to 28 cm^3 .

8. What is the total volume of the sand particles?

.....

9. Why is the answer to question 8 different from the volume measured by pouring dry sand into the cylinder?

.....

For questions 10 - 12.

A student used paper fasteners as his unit of mass. To compare his data with that of his classmates, he borrowed beads, weighed his fasteners, and tabulated the results as follows:

<u>Clips</u>	<u>Beads</u>
2	5.2
4	10.3
6	15.5
8	20.8
10	25.9

10. Graph the data

11. According to the graph, how many beads are equal to 7 fasteners?

.....

12. How many fasteners equal 3 grams, if 1 gram is equal to 5 beads?

.....

For questions 13 and 14.

Suppose you weighed a nickel on the bead balance a number of times, removing the nickel and the beads from the balance each time, i.e. after each weighing.

13. By how much would the weighings probably differ?

.....

14. Why would the weighings differ?

.....

.....

.....

<----->

Choose the best answer in questions 1 - 11.

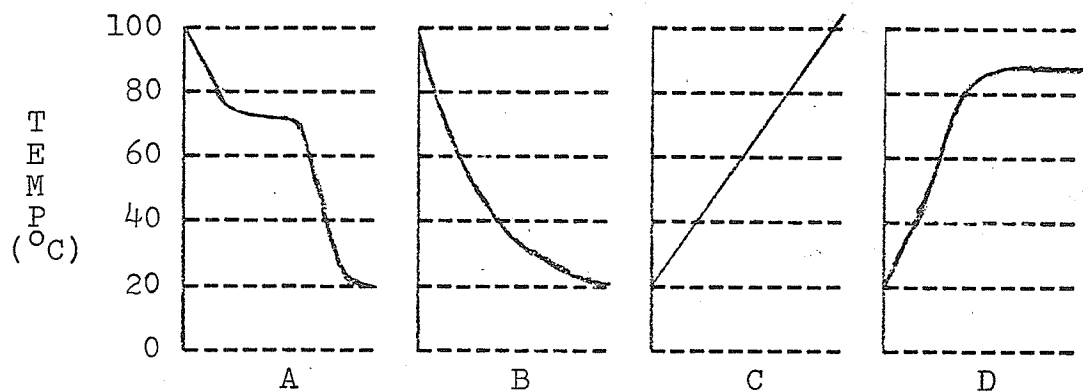
1. Density can be measured in
 - a. cm/g
 - b. cm³/g
 - c. beads/cm
 - d. g/cm³
 - e. ml/cm³

2. In order to use the Elasticity of Solids apparatus to directly compare the elasticity of two wires, the two wires must have the same
 - a. length only
 - b. diameter only
 - c. change of load only
 - d. length, diameter, and change of load
 - e. length and change of load only

3. All of the following are characteristic properties EXCEPT
 - a. density
 - b. mass
 - c. melting point
 - d. boiling point
 - e. freezing point

For questions 4 - 6.

Temperature changes in a variety of substances were studied in a room whose temperature was 20°C. Several of the graphs representing the data are shown below.



4. Which graph represents the temperature of a substance cooling in the room as a function of time, if it does not freeze?
- | | |
|---------|------|
| a. A | b. B |
| c. C | d. D |
| e. None | |
5. Which graph represents the temperature of a gas being heated at constant pressure as a function of its change in volume?
- | | |
|---------|------|
| a. A | b. B |
| c. C | d. D |
| e. None | |
6. Which graph represents the temperature of a solution of table salt in water as a function of time, if it is continuously being heated?
- | | |
|---------|------|
| a. A | b. B |
| c. C | d. D |
| e. None | |
7. Two different gases are placed in identical flasks at the same temperature and pressure. Which of the following properties would best distinguish the gases?
- | |
|-----------------------------------|
| a. Density |
| b. Volume |
| c. Thermal expansion |
| d. Elasticity |
| e. All of the above could be used |

8. Which of the following expressions of these numbers in powers-of-ten notation is INCORRECT?

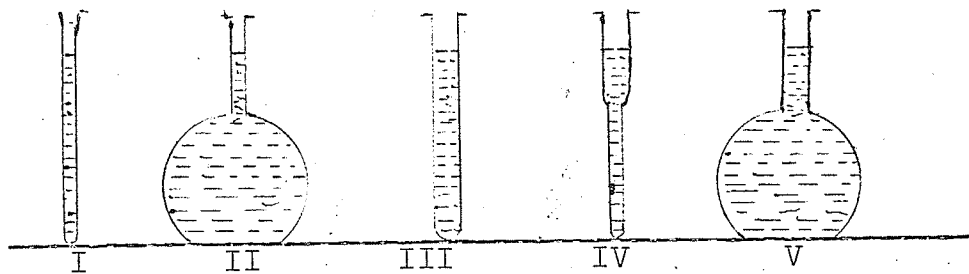
- a. $0.032 = 3.2 \times 10^{-2}$
- b. $0.0631 = 6.31 \times 10^{-2}$
- c. $1.030 = 1.03 \times 10^{-3}$
- d. $0.000435 = 4.35 \times 10^{-4}$
- e. $10,007 = 1.7 \times 10^3$

9. Three blocks of different substances I, II, and III, each having a volume of 10 cm^3 , are placed in various combinations on an equal arm balance. Block I just balances blocks II and III together, and block II is not heavy enough to balance block III. The substances, in order of increasing density, are

- a. I, II, III
- b. II, III, I
- c. III, II, I
- d. I, III, II
- e. III, I, II

For questions 10 and 11.

The containers shown all contain the same liquid, and the initial levels are all the same.



10. If the temperatures of the liquids in all five containers are raised by the same amount, in which container will the level be the highest?

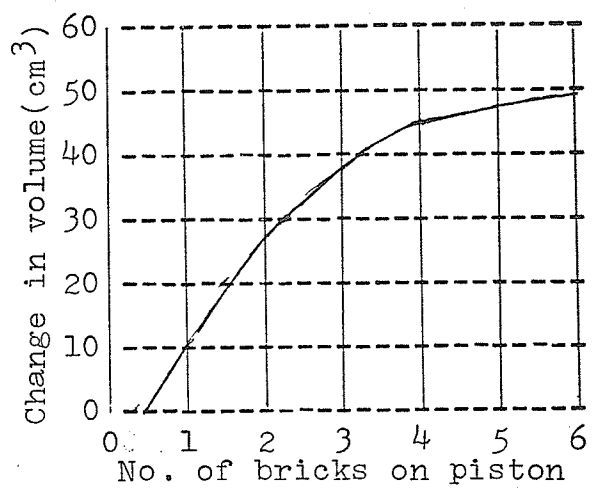
- a. I
- b. II
- c. III
- d. IV
- e. V

11. Which two containers will have equal levels for all temperatures?
- I, II
 - III, IV
 - I, III
 - III, V
 - I, IV
12. A rectangular box 20 cm long, 10 cm wide, and 5 cm deep, is filled with mercury, which has a density of 13.6 g/cm^3 .
- What is the volume of the mercury in the box?
.....
 - What is the mass of the mercury in the box?
.....
13. Some small cubes are found to have a density of 3.0 g/cm^3 , and each has a volume of 2.0 cm^3 . How many of these cubes are needed to balance a mass of 90 g?
.....
.....

For questions 14 and 15.

The graph below shows the change in volume of a gas in a cylinder closed by a piston as a function of the number of bricks on the piston. (next page)

14. What is the change in volume when the number of bricks is increased from 1 to 2?
.....
15. When there are 2 bricks on the piston, how many bricks must be added to give the same change in volume as when the load changed from 1 to 2 bricks?
.....



APPENDIX D

Retention Test

Test on Units I - III

IPS TEST UNITS I - III

1. In looking at the wood before heating, we could see that it was made of
 - a. charcoal and water
 - b. gases, liquids, and solids
 - c. atoms and molecules
 - d. wood
 - e. carbon and oxygen

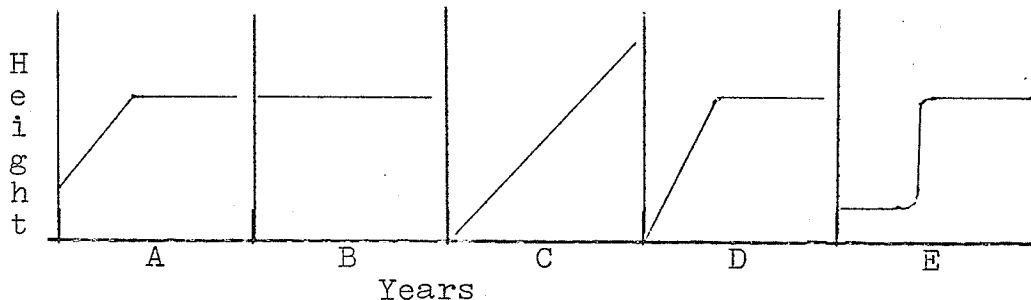
2. From the experiment 'Distillation of Wood' alone, you could tell that
 - a. the volume of solids, liquids, and gases produced equalled the volume of wood.
 - b. the mass of solids, liquids, and gases produced equalled the mass of wood
 - c. the mass of liquid obtained was greater than the mass of gas
 - d. wood consists of atoms and molecules
 - e. wood can be broken down into solids, liquids, and gases

3. When 25.0 cm^3 of dry sand was added to a beaker containing water, the water level rose 12.5 cm^3 on the scale. The volume of air in the sand was
 - a. 12.5 cm^3
 - b. 17.5 cm^3
 - c. 25.0 cm^3
 - d. 32.5 cm^3
 - e. 37.5 cm^3

4. When water is heated, which of the following is always true?
 - a. the density increases, but the volume remains the same
 - b. the density decreases, and so does the volume
 - c. the density increases, and so does the volume
 - d. the density remains the same, but the volume of the water increases
 - e. the density decreases, but the volume increases

5. 140 beads of salt were dissolved in 100 cm^3 of water at 0°C .
- The mass of the salt decreased
 - The combined mass of the salt and water increased
 - The combined volume of salt and water increased
 - the combined volume of salt and water decreased
 - the mass of the salt increased

6. Which graph shows best the relationship between the height of people and their ages?

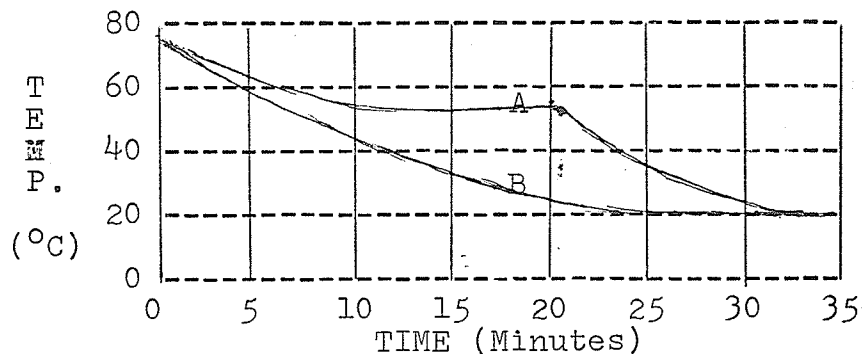


7. A student wishes to make two pieces of plasticine have equal masses. He puts them on the pans of the balance, and finds they don't balance. He takes little pieces off one of the plasticine pieces until they just balance. Then he switches the pieces to opposite pans, but they don't balance. He correctly concludes that
- the arms of the balance are equal in length, but the masses are not equal
 - the arms of the balance are not equal in length, the masses are not the same
 - the arms of the balance are equal, and the masses are the same
 - the arms of the balance are not equal, but the masses are the same
 - none of the above conclusions are correct

8. Which of the following is not a characteristic property of a solid?
- elasticity
 - mass of a unit volume
 - thermal expansion of a unit length
 - mass
 - freezing point
9. Which of the following is a law of nature?
- The density of a substance is its mass per unit volume
 - The freezing point of water is 0°C .
 - One metre equals 39.37 inches
 - The change in length of a glass rod 100 cm long is .0075 cm when the temperature is changed from 25°C to 90°C .
 - All gases expand when heated at a constant pressure
10. If you weighed an object at 100°C and again at 0°C , at least five times, and found no change in mass, you could conclude that, within the accuracy of the balances
- for this substance, there is no change in mass, even if the temperature changes by 500°C
 - the mass of this object is the same at 100°C as it is at 0°C
 - a better balance would indicate a change in mass
 - nothing significant is shown
 - for all substances, there is no change in mass when the temperature changes
11. The freezing point of a substance
- has no relation to its melting point
 - is always lower than its melting point
 - is always equal to its melting point
 - is always higher than its melting point
 - depends on the mass of the sample

For questions 12 - 14.

Two test tubes, A and B, each containing a clear liquid and a thermometer, were left out in the air in a room whose temperature was 23°C . The graph below shows the results.

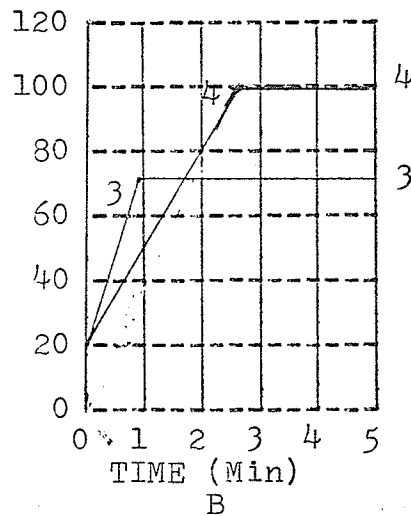
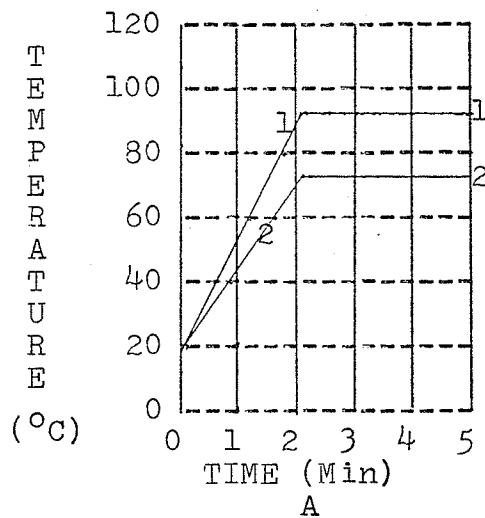


12. What can you conclude about the liquids?
- Only the liquid in A could be water
 - Only the liquid in B could be water
 - Both liquids could be water
 - Neither of the liquids could be water
 - The liquid in B is water.
13. When is the substance A entirely solid?
- all the time
 - 0 to 20 minutes
 - 10 to 20 minutes
 - 20 to 30 minutes
 - at no time
14. The freezing point of the substance in A is
- 0°C
 - 55°C
 - 25°C
 - 100°C
 - can't tell from the graph

15. The density of steel is 8.1 g/cm^3 . If you have a piece of steel with a mass of 81 grams, its volume is
- 0.1 cm^3
 - 10 cm^3
 - 100 cm^3
 - 60.8 cm^3
 - 608 cm^3

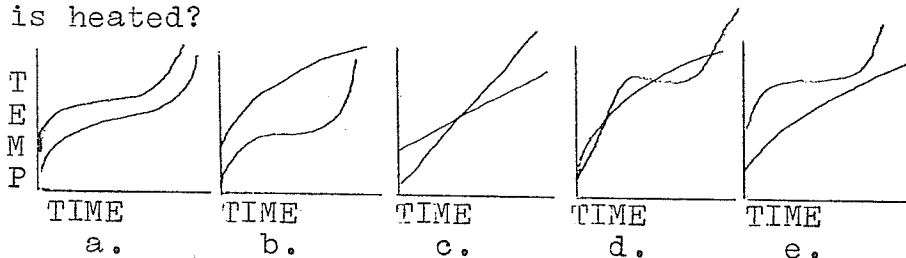
For questions 16 - 18.

Two students, A and B, each got two test tubes with different amounts of clear liquids. They heated the liquids, and the results are shown in the graphs below.



16. Who could have only water in one of the test tubes?
- only A
 - only B
 - both A and B
 - neither A nor B
 - the graphs don't show which

17. Which liquids might be the same?
- 1 and 4
 - 3 and 4
 - 2 and 3
 - 1 and 2
 - none of them
18. Which of the following is correct (most likely)?
- there is more of 2 than of 3
 - there is less of 2 than of 1
 - there is less of 4 than of 3
 - there is less of 4 than of 1
 - there is less of 2 than of 4
19. A test tube containing moth flakes is placed in a beaker of water at room temperature. Which graph best represents the temperatures of the water bath and the moth flakes as the water bath is heated?

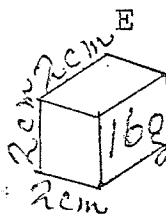
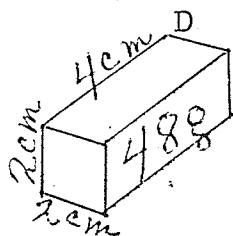
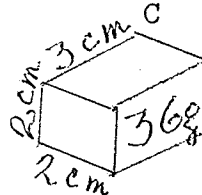
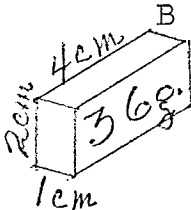
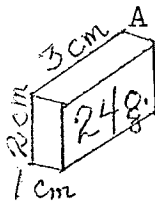


20. The density of methane is about 8 times that of hydrogen. From your experience with other gases, you would expect the expansion of methane compared with hydrogen, given the same temperature change, to be
- 8 times as great
 - 4 times as great
 - the same
 - $1/3$ as great
 - $1/8$ as great

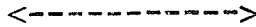
21. When a solid and a liquid react together in a closed container to produce a gas, the mass will
- increase
 - remain the same
 - decrease
 - increase if the container is opened
 - none of the above
22. Which object would most nearly have a mass of 55 beads?
- a paper clip
 - a 50-cent piece
 - a penny
 - a pint of cream
 - the air in an empty milk bottle
23. All of the following statements are correct EXCEPT
- The volume of an object is the amount of space it takes up.
 - The volume of a solid is measured in terms of unit cubes.
 - Whenever substances are changed, their total volume remains the same.
 - The volume of a solid that does not dissolve in water can be found by displacement of water.
 - The volume of a ball is measured in unit cubes.

For questions 24 - 26.

Five solid metal blocks are cut as shown below. The mass of each is also given.



24. One of the blocks is dropped into a graduate cylinder containing water. The level of the water changes from 20 cm^3 to 26 cm^3 . This must be
- a. A
 - b. B
 - c. C
 - d. D
 - e. E
25. If a 1 cm^3 piece is cut from each block and the pieces weighed, the piece with the greatest mass would come from block
- a. A
 - b. B
 - c. C
 - d. D
 - e. E
26. Which of the blocks might be of the same material?
- a. A and B
 - b. B and C
 - c. A and D
 - d. C and D
 - e. B and D



APPENDIX E

Laboratory Check Form

APPENDIX F

Attitude Scale

Name _____ Room _____ Date _____ 102

DIRECTIONS: This sheet is given to find out how certain words make you feel. When you fill out the sheet, decide how the word at the top of the page makes you feel, and then mark the scales below the word. If the word at either end of the scale very strongly describes your feeling about the word at the top of the page, place your check-mark as shown below:

GOOD X | ___ | ___ < ___ > ___ | ___ | ___ BAD
OR

GOOD ___ | ___ | ___ < ___ > ___ | ___ | X BAD

If the word at either end of the scale gives a fairly good description of the way you feel about the word at the top of the page (but you don't feel quite as strongly about the word) mark the scale as follows:

EASY ___ | X | ___ < ___ > ___ | ___ | ___ DIFFICULT
OR

EASY ___ | ___ | ___ < ___ > ___ | X | ___ DIFFICULT

If the word at either end of the scale only slightly describes your feeling about the word, mark the scale as follows:

TERRIFIC ___ | ___ | X < ___ > ___ | ___ | ___ TERRIBLE
OR

TERRIFIC ___ | ___ | ___ < ___ > X | ___ | ___ TERRIBLE

If neither word seems to describe your feelings about the word at the top of the page, you should mark the scale as shown below:

SILLY ___ | ___ | ___ < X > ___ | ___ | ___ WISE

Try this sample:

FISHING

GOOD ___ | ___ | ___ < ___ > ___ | ___ | ___ BAD

INTERESTING ___ | ___ | ___ < ___ > ___ | ___ | ___ BORING

STUPID ___ | ___ | ___ < ___ > ___ | ___ | ___ SMART

DISLIKE ___ | ___ | ___ < ___ > ___ | ___ | ___ LIKE

IMPORTANT:

1. Be sure to check every scale.
2. Don't take too much time for any one item. We are interested in how you feel when you first look at the words.
3. Wait for further instructions.

Note to teacher- Answer any questions. Then start the test by saying, "Ready-Begin".

SCIENCE

103

GOOD ___|___|___<___>___|___|___ BAD

INTERESTING ___|___|___<___>___|___|___ BORING

SILLY ___|___|___<___>___|___|___ SENSIBLE

USEFUL ___|___|___<___>___|___|___ USELESS

SMART ___|___|___<___>___|___|___ STUPID

FAIR ___|___|___<___>___|___|___ UNFAIR

NOISY ___|___|___<___>___|___|___ QUIET

EASY ___|___|___<___>___|___|___ DIFFICULT

SATISFACTORY ___|___|___<___>___|___|___ UNSATISFACTORY

DISLIKE ___|___|___<___>___|___|___ LIKE

TERRIFIC ___|___|___<___>___|___|___ TERRIBLE

Go on to the next page.

LABORATORY

GOOD ___|___|___<___>___|___|___ BAD

INTERESTING ___|___|___<___>___|___|___ BORING

SILLY ___|___|___<___>___|___|___ SENSIBLE

USEFUL ___|___|___<___>___|___|___ USELESS

SMART ___|___|___<___>___|___|___ STUPID

FAIR ___|___|___<___>___|___|___ UNFAIR

NOISY ___|___|___<___>___|___|___ QUIET

EASY ___|___|___<___>___|___|___ DIFFICULT

SATISFACTORY ___|___|___<___>___|___|___ UNSATISFACTORY

DISLIKE ___|___|___<___>___|___|___ LIKE

TERRIFIC ___|___|___<___>___|___|___ TERRIBLE

Go on to the next page.

MATHEMATICS

GOOD ___|___|___<___>___|___|___ BAD

INTERESTING ___|___|___<___>___|___|___ BORING

SILLY ___|___|___<___>___|___|___ SENSIBLE

USEFUL ___|___|___<___>___|___|___ USELESS

SMART ___|___|___<___>___|___|___ STUPID

FAIR ___|___|___<___>___|___|___ UNFAIR

NOISY ___|___|___<___>___|___|___ QUIET

EASY ___|___|___<___>___|___|___ DIFFICULT

SATISFACTORY ___|___|___<___>___|___|___ UNSATISFACTORY

DISLIKE ___|___|___<___>___|___|___ LIKE

TERRIFIC ___|___|___<___>___|___|___ TERRIBLE

Go on to the next page.

TEACHER

106

GOOD ___|___|___<___>___|___|___ BAD

INTERESTING ___|___|___<___>___|___|___ BORING

SILLY ___|___|___<___>___|___|___ SENSIBLE

USEFUL ___|___|___<___>___|___|___ USELESS

SMART ___|___|___<___>___|___|___ STUPID

FAIR ___|___|___<___>___|___|___ UNFAIR

NOISY ___|___|___<___>___|___|___ QUIET

EASY ___|___|___<___>___|___|___ DIFFICULT

SATISFACTORY ___|___|___<___>___|___|___ UNSATISFACTORY

DISLIKE ___|___|___<___>___|___|___ LIKE

TERRIFIC ___|___|___<___>___|___|___ TERRIBLE

Go on to the next page.

CLASSROOM

107

GOOD ___|___|___<___>___|___|___ BAD
INTERESTING ___|___|___<___>___|___|___ BORING
SILLY ___|___|___<___>___|___|___ SENSIBLE
USEFUL ___|___|___<___>___|___|___ USELESS
SMART ___|___|___<___>___|___|___ STUPID
FAIR ___|___|___<___>___|___|___ UNFAIR
NOISY ___|___|___<___>___|___|___ QUIET
EASY ___|___|___<___>___|___|___ DIFFICULT
SATISFACTORY ___|___|___<___>___|___|___ UNSATISFACTORY
DISLIKE ___|___|___<___>___|___|___ LIKE
TERRIFIC ___|___|___<___>___|___|___ TERRIBLE

Go on to the next page.

PARTNER

- GOOD ___|___|___<___>___|___|___ BAD
- INTERESTING ___|___|___<___>___|___|___ BORING
- SILLY ___|___|___<___>___|___|___ SENSIBLE
- USEFUL ___|___|___<___>___|___|___ USELESS
- SMART ___|___|___<___>___|___|___ STUPID
- FAIR ___|___|___<___>___|___|___ UNFAIR
- NOISY ___|___|___<___>___|___|___ QUIET
- EASY ___|___|___<___>___|___|___ DIFFICULT
- SATISFACTORY ___|___|___<___>___|___|___ UNSATISFACTORY
- DISLIKE ___|___|___<___>___|___|___ LIKE
- TERRIFIC ___|___|___<___>___|___|___ TERRIBLE

+++++

APPENDIX G

Raw Data Tables

RAW DATA TABLES

Explanation of Columnar Headings

1. Subject Number
2. Classroom Number
3. Sex
4. Classification
5. Pairing
6. Verbal Score
7. Quantative Score
8. Total Score
9. Intelligence Quotient
10. Acquisition Score
11. Retention Score
12. Application Score
13. Attitude Scale Difference Score
14. Partner Score

RAW CLASS DATA

1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	4	B	H	HH	50	71	121	140	51	20	8	-59	65
2	4	B	H	HH	61	75	136	153	60	24	9	+32	46
3	4	G	H	HH	56	75	131	148	65	19	7	-3	54
4	4	B	H	HH	65	67	132	148	66	24	10	-14	36
5	4	G	H	HH	56	74	130	146	60	17	7	-8	55
6	4	B	H	HH	57	62	119	138	54	21	8	+26	55
7	4	G	H	HH	63	54	117	137	61	17	7	-35	64
8	4	G	H	HH	58	59	117	136	63	21	8	+30	60
9	4	G	H	HH	62	52	114	135	52	13	8	-29	52
10	3	G	H	HH	55	62	117	135	39	16	6	-55	43
11	1	B	H	HH	48	70	118	135	60	22	9	+3	49
12	1	G	H	HH	43	72	115	134	51	11	9	-4	51
13	1	G	H	HH	42	71	113	134	46	15	9	+13	52
14	4	G	H	HH	43	71	114	133	58	19	9	+71	42
15	3	G	H	HH	51	58	109	133	35	16	6	+3	50

RAW CLASS DATA

1	2	3	4	5	6	7	8	9	10	11	12	13	14
16	1	G	H	HH	60	51	111	133	44	16	10	+17	36
17	2	B	H	HH	52	62	114	130	53	18	9	-22	36
18	2	G	H	HH	48	57	105	129	46	17	9	+23	52
19	1	B	H	HH	52	55	107	129	48	19	5	+14	64
20	1	B	H	HH	48	60	108	128	53	22	9	-10	53
21	1	G	H	HH	53	49	102	127	53	20	9	+22	66
22	3	G	H	HH	52	60	112	126	59	19	10	+14	51
23	3	G	H	HH	36	61	97	125	40	16	9	-28	57
24	2	B	H	HH	47	55	102	125	42	14	9	+1	59
25	1	G	H	HH	44	56	100	124	54	14	9	-31	48
26	3	B	H	HH	48	45	93	120	32	10	6	-15	68
27	2	G	H	HH	42	53	95	120	44	12	8	-17	53
28	2	G	H	HH	45	45	90	120	39	15	8	+9	62
29	3	G	H	HH	37	52	89	119	36	10	8	-2	45
30	2	G	H	HH	41	48	89	119	45	8	8	+32	62

RAW CLASS DATA

1	2	3	4	5	6	7	8	9	10	11	12	13	14
31	3	G	H	HH	40	47	87	118	28	13	10	-32	63
32	2	B	H	HH	43	51	94	118	38	19	9	-35	39
33	3	G	H	HH	47	43	90	118	31	13	8	-27	52
34	2	G	H	HH	40	46	86	117	32	10	9	-49	55
35	3	G	H	HH	37	51	88	117	31	13	10	+2	63
36	3	B	H	HH	48	39	87	116	27	11	8	0	61
37	2	G	H	HH	37	48	81	115	33	10	9	-23	57
38	2	G	H	HH	39	48	87	114	25	8	8	+43	54
39	4	B	H	HL	58	89	147	162	64	21	8	-17	69
40	3	G	H	HL	67	72	134	150	45	18	9	-2	58
41	4	G	H	HL	65	69	134	150	63	23	9	+15	52
42	4	B	H	HL	52	69	121	141	54	21	7	-54	49
43	4	G	H	HL	57	62	119	140	61	19	7	+22	40
44	2	G	H	HL	54	63	117	138	58	16	10	-35	51
45	1	B	H	HL	50	69	119	137	55	14	9	-45	47

RAW CLASS DATA

1	2	3	4	5	6	7	8	9	10	11	12	13	14
46	2	B	H	HL	62	62	124	137	61	22	10	+35	51
47	4	G	H	HL	46	68	114	135	49	19	6	-23	35
48	1	G	H	HL	65	52	117	134	40	12	7	-5	65
49	4	G	H	HL	47	68	115	134	45	18	5	+8	54
50	1	B	H	HL	44	70	114	133	58	18	4	-19	36
51	1	B	H	HL	47	59	106	129	54	21	7	+7	45
52	3	G	H	HL	42	61	103	128	33	10	7	-20	43
53	1	G	H	HL	48	54	102	127	48	13	9	-13	50
54	3	B	H	HL	46	60	106	127	47	15	10	+16	37
55	1	B	H	HL	48	52	100	126	53	21	8	-18	40
56	1	G	H	HL	48	49	97	124	61	13	9	0	52
57	3	G	H	HL	41	50	91	121	38	21	9	+51	56
58	2	G	H	HL	44	49	93	120	38	14	9	+38	39
59	2	B	H	HL	39	51	90	120	36	10	8	+42	51
60	3	B	H	HL	45	42	87	118	31	12	7	-74	40

RAW CLASS DATA

1	2	3	4	5	6	7	8	9	10	11	12	13	14
61	3	G	H	HL	46	42	88	117	27	15	9	-20	60
62	2	G	H	HL	40	49	89	117	32	11	9	+20	58
63	2	G	H	HL	38	47	85	114	41	16	7	-22	55
64	3	B	H	HL	27	53	80	114	54	22	9	+36	53
65	2	G	H	HL	31	47	78	110	35	12	9	+12	58
66	2	G	H	HL	37	40	77	109	45	13	8	+28	54
67	4	B	L	HL	58	57	115	134	56	20	8	-31	70
68	4	G	L	HL	51	61	112	133	58	19	9	-24	60
69	4	G	L	HL	51	56	107	130	55	19	8	+30	57
70	4	G	L	HL	50	52	102	127	53	19	5	-1	64
71	1	B	L	HL	50	50	100	126	38	17	8	+18	42
72	4	B	L	HL	33	69	102	125	57	22	5	+36	54
73	1	G	L	HL	53	44	97	122	39	12	7	-21	58
74	1	B	L	HL	40	52	92	120	43	10	3	+30	60
75	1	G	L	HL	49	43	92	120	52	14	9	-25	54

RAW CLASS DATA

1	2	3	4	5	6	7	8	9	10	11	12	13	14
76	4	G	L	HL	36	55	91	119	57	16	6	-21	52
77	3	G	L	HL	37	40	87	118	35	10	9	-15	65
78	1	B	L	HL	46	40	86	117	36	15	7	+24	58
79	3	G	L	HL	45	42	87	115	41	14	9	-3	62
80	3	G	L	HL	36	45	81	115	30	6	7	+23	52
81	3	B	L	HL	39	40	79	113	47	18	7	+4	46
82	2	G	L	HL	26	51	77	112	35	14	9	-63	65
83	3	G	L	HL	31	46	77	112	34	10	9	-7	48
84	2	B	L	HL	34	46	80	112	58	20	10	-47	56
85	1	G	L	HL	40	39	79	111	35	10	5	+5	69
86	3	B	L	HL	38	41	79	111	51	23	10	-6	65
87	2	G	L	HL	40	31	71	109	37	11	9	-41	21
88	2	B	L	HL	26	44	70	107	34	10	8	+4	46
89	3	B	L	HL	29	42	71	107	29	16	7	+26	53
90	2	G	L	HL	28	37	65	105	35	15	9	-8	53

RAW CLASS DATA

1	2	3	4	5	6	7	8	9	10	11	12	13	14
91	1	B	L	HL	28	35	63	104	44	18	9	+6	60
92	2	G	L	HL	31	29	60	101	36	16	7	-27	13
93	3	B	L	HL	25	30	55	99	32	14	9	+8	60
94	2	G	L	HL	26	14	40	90	32	11	8	+26	52
95	4	B	L	LL	49	65	114	136	59	19	8	+8	49
96	4	G	L	LL	57	53	110	132	52	12	7	-54	58
97	4	G	L	LL	63	42	105	130	42	15	7	+36	31
98	1	B	L	LL	50	48	98	128	42	13	9	+25	45
99	4	G	L	LL	52	53	105	128	54	17	8	+54	38
100	4	G	L	LL	50	58	108	123	62	20	7	-30	51
101	4	B	L	LL	60	46	106	128	60	23	8	+23	28
102	4	B	L	LL	43	59	102	126	55	18	8	-33	59
103	1	B	L	LL	46	52	98	125	65	23	9	+3	37
104	4	G	L	LL	48	46	94	123	50	19	5	+40	62
105	4	G	L	LL	56	43	99	123	50	21	5	-3	53

RAW CLASS DATA

1	2	3	4	5	6	7	8	9	10	11	12	13	14
106	1	G	L	LL	37	56	93	122	54	16	10	+18	58
107	4	B	L	LL	47	49	96	121	64	19	8	-42	63
108	1	G	L	LL	49	42	91	121	43	14	8	-21	57
109	1	G	L	LL	50	44	94	121	49	14	10	+43	58
110	4	G	L	LL	47	40	87	119	49	18	7	-15	59
111	1	B	L	LL	46	43	89	118	37	18	7	+70	43
112	1	G	L	LL	42	46	88	118	39	15	7	+13	47
113	4	G	L	LL	54	37	91	118	59	17	7	-38	49
114	4	B	L	LL	41	48	89	117	45	22	5	+47	47
115	3	G	L	LL	38	47	85	116	38	17	10	-45	63
116	3	G	L	LL	37	44	81	115	33	12	7	-40	45
117	1	B	L	LL	42	44	86	115	36	18	8	-11	45
118	3	G	L	LL	37	46	83	113	31	15	10	-40	60
119	1	B	L	LL	44	33	77	112	45	14	10	+3	50
120	3	B	L	LL	32	45	77	110	34	12	8	+16	54

RAW CLASS DATA

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
121	3	3	G	L	LL	25	48	73	108	25	11	10	+24	68
122	2	2	G	L	LL	36	40	76	110	28	12	7	-12	42
123	3	3	G	L	LL	32	47	79	109	34	6	7	-10	23
124	2	2	B	L	LL	29	45	74	108	53	18	7	-14	64
125	2	2	G	L	LL	36	34	70	107	35	14	6	+8	55
126	3	3	B	L	LL	40	37	77	107	25	13	8	+6	60
127	3	3	G	L	LL	34	35	69	106	31	10	10	+24	48
128	2	2	G	L	LL	36	34	70	106	44	12	6	-12	67
129	2	2	G	L	LL	38	33	71	105	43	10	7	-35	33
130	2	2	G	L	LL	36	27	63	104	26	14	9	+2	38
131	2	2	G	L	LL	28	35	63	102	34	11	10	+50	46
132	2	2	G	L	LL	25	35	60	101	34	12	9	+23	54
133	3	3	G	L	LL	33	25	58	97	25	13	7	-34	54
134	3	3	G	L	LL	16	35	51	96	22	9	7	-4	58
135	2	2	G	L	LL	23	22	45	90	17	10	9	+5	70

APPENDIX H

Attitude Scale Scores

ATTITUDE SCORES FOR ALL
TREATMENT GROUPS

Explanation of Columnar Headings

1. Subject Number
2. Initial Score - Science
3. Initial Score - Laboratory
4. Initial Score - Mathematics
5. Initial Score - Teacher
6. Initial Score - Classroom
7. Final Score - Science
8. Final Score - Laboratory
9. Final Score - Mathematics
10. Final Score - Teacher
11. Final Score - Classroom
12. Difference Between Total Initial and Total Final Scores
13. Partner Score

ATTITUDE SCORES

	1	2	3	4	5	6	7	8	9	10	11	12	13
1	57	58	55	48	46	48	55	47	47	35	22	-59	65
2	55	55	49	39	37	61	54	59	44	44	37	+32	46
3	47	50	51	38	50	40	52	47	47	47	47	-3	54
4	65	61	64	65	45	63	58	64	64	64	37	-14	36
5	52	51	47	44	50	50	53	41	41	50	42	-8	55
6	59	65	66	52	53	64	67	64	64	67	55	+26	55
7	51	65	44	60	58	55	55	32	32	53	48	-35	64
8	46	53	44	50	46	58	56	44	44	60	51	+30	60
9	43	50	57	62	53	28	55	61	61	43	49	-29	52
10	54	67	56	51	57	43	58	44	44	38	45	-55	43
11	61	58	64	49	51	66	59	67	67	51	42	+3	49
12	63	61	42	57	55	62	60	53	53	48	53	-4	51
13	54	58	47	38	24	56	61	48	48	42	27	+13	50
14	38	40	25	42	51	55	56	50	50	55	54	+71	42
15	41	59	53	44	45	48	57	54	54	44	42	+3	50

ATTITUDE SCORES

	1	2	3	4	5	6	7	8	9	10	11	12	13
16	43	18	32	51	21	57	31	49	24	22	+17	36	
17	61	60	64	50	61	58	56	58	52	50	-22	45	
18	68	57	58	53	44	68	60	64	57	54	+23	51	
19	58	62	67	62	46	60	63	66	63	57	+14	64	
20	54	51	53	44	42	56	46	49	42	41	-10	53	
21	62	68	65	54	57	65	65	65	67	66	+22	66	
22	54	46	46	54	45	55	57	58	53	46	+14	51	
23	54	61	60	60	51	51	47	58	51	51	-28	57	
24	56	55	55	54	66	55	54	58	54	51	+1	59	
25	60	62	62	53	57	55	56	49	59	48	-31	48	
26	36	51	24	57	66	36	65	10	48	60	-15	68	
27	54	62	39	47	42	50	55	33	47	42	-17	53	
28	52	55	52	55	50	54	60	55	53	51	+9	62	
29	52	47	20	54	52	51	53	23	53	41	-2	45	
30	34	65	59	61	51	56	65	57	55	59	+32	62	

ATTITUDE SCORES

	1	2	3	4	5	6	7	8	9	10	11	12	13
31	47	54	46	48	47	37	50	58	44	45	45	-32	63
32	60	63	56	62	63	57	61	63	34	53	53	-35	39
33	48	50	20	51	49	38	36	12	53	52	52	-27	52
34	62	59	70	45	44	47	47	50	45	43	43	-49	55
35	58	60	49	56	53	47	57	69	53	52	52	+2	63
36	48	53	47	58	51	50	51	55	59	42	42	0	61
37	52	57	52	59	58	50	52	47	56	50	50	-23	57
38	28	48	48	33	46	50	57	53	39	44	44	+40	54
39	57	61	70	39	61	54	47	64	40	66	66	-17	69
40	46	54	41	54	41	34	53	57	44	52	52	-2	48
41	44	53	46	39	31	48	58	48	36	38	38	+15	40
42	64	69	68	54	70	66	59	67	42	37	37	-54	49
43	52	54	41	48	45	54	53	43	58	54	54	+22	40
44	59	65	65	59	55	55	50	60	50	43	43	-35	51
45	63	65	66	66	62	53	52	61	59	52	52	-45	47

ATTITUDE SCORES

	1	2	3	4	5	6	7	8	9	10	11	12	13
46	58	64	67	51	46	66	64	70	66	55	+35	51	
47	50	49	47	49	46	51	48	44	40	35	-23	35	
48	54	50	65	51	47	48	53	48	70	43	-5	65	
49	47	47	30	37	62	46	46	37	48	54	-17	54	
50	61	64	47	58	35	52	48	53	55	41	-19	36	
51	59	59	65	59	51	60	60	67	58	55	+7	52	
52	49	52	42	43	52	29	48	52	44	45	-20	43	
53	60	66	67	56	47	58	62	64	54	45	-13	60	
54	57	64	61	46	46	52	62	66	55	53	+16	37	
55	54	61	37	50	47	58	67	57	49	61	-18	40	
56	63	58	62	61	38	63	51	63	63	42	0	52	
57	54	40	39	41	45	54	57	62	46	51	+51	56	
58	47	54	47	63	33	66	62	51	67	46	+38	39	
59	54	61	37	50	47	58	67	57	49	61	+42	51	
60	59	55	43	42	54	31	34	34	40	40	-74	40	

ATTITUDE SCORES

	1	2	3	4	5	6	7	8	9	10	11	12	13
61	35	46	54	35	32	23	41	60	26	32	-20	60	
62	43	49	34	37	40	45	36	55	41	46	+20	58	
63	46	56	37	57	53	42	51	38	51	45	-22	38	
64	50	49	50	44	45	62	62	55	54	45	+36	53	
65	47	46	44	45	47	53	55	49	39	45	+12	58	
66	46	49	26	43	59	41	52	51	50	57	+28	54	
67	65	66	69	66	69	66	66	67	55	40	-31	70	
68	46	58	61	46	55	50	59	56	61	16	-24	60	
69	59	59	57	57	50	65	66	62	60	58	+30	55	
70	59	61	50	43	57	53	58	46	61	51	-1	64	
71	40	51	53	36	34	47	45	54	45	41	+18	42	
72	53	64	65	57	52	51	54	63	55	47	-21	58	
73	44	43	26	40	31	44	48	40	42	40	+30	41	
74	52	52	51	44	50	61	58	57	60	49	+36	54	
75	54	58	58	49	57	50	52	54	43	52	-25	55	

ATTITUDE SCORES

1	2	3	4	5	6	7	8	9	10	11	12	13
76	47	46	38	52	48	51	51	34	40	30	-21	52
77	55	63	54	56	41	49	57	44	53	51	-15	65
78	61	64	50	42	51	63	64	56	54	55	+24	58
79	52	43	38	42	53	49	50	36	42	48	-3	62
80	51	52	62	47	48	50	55	62	59	58	+23	52
81	56	50	47	60	53	55	50	53	59	53	+4	46
82	47	68	34	51	63	43	42	30	40	45	-63	65
83	40	47	47	49	42	44	46	47	43	38	-7	48
84	64	69	64	61	59	58	49	57	52	54	-47	56
85	63	53	54	61	54	59	45	61	67	60	+5	69
86	61	63	68	62	44	63	63	69	55	42	-6	65
87	42	45	42	42	48	32	38	53	29	28	-41	21
88	52	48	48	53	42	54	50	49	53	41	+4	46
89	41	51	42	48	51	51	55	49	50	54	+26	57
90	47	50	44	32	43	42	46	51	27	42	-8	53

ATTITUDE SCORES

1	2	3	4	5	6	7	8	9	10	11	12	13
91	64	64	64	63	65	60	61	68	64	57	-4	60
92	43	35	15	30	34	20	29	31	18	32	-27	13
93	59	56	58	56	49	54	59	57	62	54	+8	60
94	62	55	15	50	36	54	52	40	52	46	+26	52
95	54	55	47	45	57	55	58	49	47	57	+8	49
96	48	61	55	51	30	55	28	49	28	31	-54	58
97	43	49	34	45	51	57	54	39	58	50	+36	31
98	49	48	46	50	61	58	53	51	58	70	+38	59
99	34	39	52	36	48	55	58	41	59	52	-54	38
100	62	63	58	62	53	59	60	58	50	37	-30	51
101	52	62	37	50	30	62	60	39	57	36	+23	28
102	59	64	62	61	68	58	67	51	50	55	-33	59
103	67	67	54	55	42	64	60	49	59	56	+3	37
104	56	54	44	36	54	57	54	50	63	60	+40	62
105	59	52	44	41	49	57	54	44	39	48	-3	53

ATTITUDE SCORES

	1	2	3	4	5	6	7	8	9	10	11	12	13
106	44	47	60	47	52	64	53	58	45	48	+18	58	
107	61	60	61	56	59	61	55	48	50	41	-42	63	
108	57	58	53	57	53	50	53	50	54	50	021	57	
109	42	49	21	42	41	53	52	34	52	48	+43	58	
110	53	56	46	50	54	50	55	39	52	48	-15	59	
111	51	55	50	41	32	62	64	57	49	59	+70	43	
112	50	55	43	49	41	53	54	52	60	34	+13	47	
113	54	63	49	49	57	59	53	38	46	36	-38	49	
114	51	51	47	44	40	56	56	55	62	51	+47	47	
115	49	55	43	43	49	43	48	56	41	16	-45	63	
116	56	59	37	56	60	48	57	39	41	43	-40	45	
117	53	53	69	48	48	50	55	58	49	46	-11	45	
118	64	56	48	48	53	45	49	47	47	48	-40	60	
119	56	64	49	49	53	57	64	54	61	42	+3	50	
120	53	48	38	43	47	55	51	49	46	44	+16	54	

ATTITUDE SCORES

1	2	3	4	5	6	7	8	9	10	11	12	13
121	61	62	57	58	58	66	64	62	64	64	+24	68
122	56	42	25	54	47	43	45	37	41	46	-12	42
123	26	42	22	37	36	26	33	17	36	43	-10	23
124	62	59	44	50	48	50	48	57	49	45	-14	67
125	45	63	55	49	34	51	62	60	45	34	+8	55
126	62	56	60	57	56	63	63	54	56	61	+6	60
127	46	53	27	57	53	42	52	47	60	59	+24	48
128	56	51	44	66	64	54	53	45	61	56	-12	67
129	59	50	35	63	51	44	40	49	44	46	-35	33
130	43	58	42	58	54	44	60	51	46	56	+2	38
131	52	54	66	49	49	65	64	67	64	63	+50	65
132	65	57	35	66	65	49	66	67	67	62	+23	54
133	59	54	35	57	59	44	53	53	45	35	-34	54
134	53	48	47	48	51	56	48	40	43	56	-4	58
135	63	69	65	67	61	65	67	61	70	67	+5	70