A MODEL OF CLASSROOM LEARNING FOR EIGHTH GRADE AND HIGH SCHOOL STUDENTS BASED ON THE RELATIONSHIP BETWEEN STUDENT ABILITY, PERCEIVED CLASSROOM CLIMATE AND THEIR INTERACTION

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Scope and Method of Study: The study was to determine relationships between general ability (A), classroom averages of classroom environment (CE), and classroom learning (CL) and retention (Rtn) of eighth grade and high school students (S). A model of CL was proposed to investigate this problem. CL = f(A) + f(CE) + f(A X CE). This model was tested for two groups using analysis of partial variance (APV): an experimental group (E), and a control group (R). Both groups were taught the same unit of instruction (T).

Focus was on representativeness of instructional treatment (T) - external validity, while maintaining internal validity. The T that S received was an average of 11.0 days of instruction on acid-base theory. Teachers (Trs) were instructed to teach using normal methods and materials. S taught by different Trs received different amounts and types of instruction. These differences were controlled by APV.

Nine Trs volunteered. Trs were assigned to E and R. Trs taught 27 classes containing 541 S (375 high school and 166 eighth grade). Trs selected a unit on acid-base theory as the T. Sixteen independent variables (IV) were collected three weeks before T began. Trs administered three A tests (Cattell's Culture Fair Test: 4 scales), and a vocabulary (2 scales) and an induction test (I-1) (from Kit of Factor References Tests). Next, Trs administered the Classroom Environment Scale (CES: 9 scales).

Two unit tests (UT) were designed by the author measuring CL and Rtn. A UT was administered to R as a pretest on the first day of T. A UT was administered to both the E and the R on the last day of the T. The T took 11.0 class periods to complete. After 15.3 days of the posttest, a UT was given to the E to measure Rtn.

Findings and Conclusions: The 15 IV were reduced to 5 factors (F) by a likelihood factor analysis and varimax rotation. Two A Fs were named verbal and nonverbal ability; three CE Fs were named: student centered environments (Env), high structure Env, and high discipline Env. The A set accounted for 13.8% (E) and 17.6% (R) of the covariate (COV) adjusted (Ad) CL variance (V). The CE set

accounted for 8.5% (E) and 5.3% (R) of the Cov Ad Cl V. The (Grade level X CE) set accounted for 0.0% (E) and 4.5% (R) of the Cov Ad Cl V. The A set accounted for 11.8% (E) of the Cov Ad retention V. The CE set accounted for 13.6% of the Cov Ad Rtn V. The (A X CE) set accounted for 8.3% (E) of the Cov Ad Rtn V, and the (Grade level X CE) set accounted for 0.1% (E) of the Cov Ad Rtn V.

The best model of Cl and Rtn only contained an A and a CE set. This model accounted for 23.6% (E), and 22.2% (R) of the Cov Ad Cl V, and 23.7% (E) of the Cov Ad Rtn V. There is a great deal of room for improvement. This model accounted for 45.8% (E) and 60.0% (R) of the total CL V, and 36.2% of the total Rtn V.

ADVISER'S APPROVAL John D. Hampton

ACKNOWLEDGMENTS

One of the things that impressed me the most in the course of this study was the number of people who were willing to volunteer their time, effort and emotional support. Essentially, they gave me a piece of their life; thank you seems trivial when you consider how limited ones time and emotional energy are.

In considering who to acknowledge first, it occurred to me that this study would have been impossible without the efforts of all of the individuals noted below. However, it was clear to me that two people were more essential to this effort, and gave more of themselves than any others: my wife, Betty, and my chairman, Dr. John Hampton.

Betty spent hundreds of hours scoring tests, doing my household chores so I could work on this study, and constantly giving me the emotional support I needed to persevere. Dr. Hampton guided me through the mazes of academia, shaped me into an educational researcher, and stood by my side when I needed intellectual or emotional support. Dr. Hampton likes to think that he just provides the foundation for his students to stand on. But the reality is that he provides an intellectual model which has few rivals.

I would also like to acknowledge the valuable help Dr. Kay Bull provided with the rough drafts of my dissertation. His attention to details and insightful comments at this stage made the orals and final draft much easier than would have otherwise been possible. The other

members of my committee, Dr. Frazier, and Dr. Grissom, invaluable during the final stages; they teamed up to perfect the statistical logic, and generally to polish the final draft.

Finally, I would like to thank the teachers and school administrators who volunteered for this study. Without their help this study literally would not have been possible. Two other people should be mentioned: Shirley Slatter, my typist, devoted countless hours of her free time to this project; she never let me down when I needed her help. Pat Goff, in the Graduate College, also provided valuable help in the editing of this study.

A final observation: All of the above mentioned people took their part in this endeavor for granted. They invariably felt that " they were just doing their job." I think the world would be a much more productive and joyful place if more people took this much pride in their work. Thank you for a job well done.

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LIST OF SYMBOLS

A	-Aptitude or ability
AOV	-Analysis of variance
APV	-Analysis of Partial Variance
ATI	-Aptitude Treatment interaction
CE	-Classroom environment
CES	-Classroom environment scale
(CE X A)	-Classroom environment by ability interaction
COV	-Covariate
G_c	-Crystalized intelligence
G_f	-Fluid intelligence
GPA	-Grade point average
(Grade X CE)	-Grade by classroom environment interaction
I-1	-Induction test
R^2	-Squared multiple correlation
sR^2	-Squared semi-partial correlation
V-1 or V-2	-Vocabulary tests
Y	-Observed value of the dependent variable
$\hat{Y}$	-Predicted value of the dependent variable
Y'	-Covariate-adjusted dependent variable
X_i	-Independent variable

CHAPTER I

INTRODUCTION

Introduction to the Study

One of the most common questions asked by the beginning teacher or novice educational psychologist is "What is the best or most effective method of teaching?" In fact, this question has dominated research on teaching. Gage (1963) refers to this type of research "as the criterion of effectiveness paradigm" (p. 114).

Gage (1963) suggests that "Research by this paradigm has been abundant; hundreds of studies, yielding thousands of correlation coeficients, have been made. In the large, these studies have yielded disappointing results" (p. 118). Mitzel (1957) rejects the criterion of effectiveness paradigm and suggests that "the complex of pupil-teacher interaction in the classroom is the primary source to which one must look to account for pupil growth" (p. 1).

Wallen and Travers (1963)

> found that most of the teaching research which they reviewed consisted of comparisons of two contrasting methods...they concluded optimistically that the era of research comparing one teaching method with another seems to be coming to a close. (Cited in Nuthall and Snook, 1973, p. 71)

However, ten years later when the second handbook of research on teaching was published, Nuthall and Snook (1973) found that models of teaching were more psychologically sophisticated but they still were essentially comparisons of the effectiveness of two methods of teaching. They suggest that "the deficiencies of model-dominated research are the result not of models per se, but of inadequate models" (p. 72).

The sequel will pursue the idea that progress toward a theory of teaching/instruction/classroom learning has been impeded because educational researchers have been asking the wrong questions or using the wrong model. Cronbach (1957), Snow (1974), Hunt (1974), and Tobias (1976) suggest that a more fruitful question is: "which teaching method is better for a particular type of student, working on a particular task." The model they suggest has been called Aptitude Treatment Interaction (Cronbach, 1957), Trait Treatment Interaction (Berliner and Cahen, 1973), Attribute Treatment Interaction (Rhett, 1972), and Person Environment Interaction (Hunt, 1974).

Aptitude Treatment Interaction (ATI) is the most common name for the above model. Despite the fact that there are subtle differences betweeen each of the above models, the present author will adopt the practice of lumping all the models together under the label of ATI. "The label is not important as long as the concept conveys the idea that individual difference variables may interact with educational treatments" (Berliner and Cahen, 1973, p. 59).

The basic idea of an ATI is an old one in psychology. Lewin (1935) proposed that behavior is a function of the person and the environment. Murray (1938) suggested that a person's needs interact with environmental presses to produce behavior.

More recently, Cronbach (1957) suggested that correlational and experimental psychologists should alter their favored paradigms to include ATI's. This paper, though quoted often, has had a limited impact in altering the traditional way psychologists do research.

Twenty years later, most psychologists are still unaware of the ATI paradigm. However, a growing number of people are beginning to write, use and argue about this paradigm for doing research.

Variables Considered for the Study

The present author believes that understanding in the field of classroom learning/instruction will increase faster by using the ATI research paradigm, than by any other research paradigm currently available. Support for this view can be found in Chapter II. So, the present study will adopt the ATI paradigm.

The ATI paradigm requires that characteristics or aptitudes of the learner, and characterisitcs of the instructional treatment are both related to classroom learning. That is, aptitudes and treatments interact to produce classroom learning. Thus, the present study needs to consider three types of variables: (a) aptitude variables, (b) instructional treatment variables, and (c) classroom learning variables.

Aptitude Variables

The major aptitude variables which could be considered in a study of classroom learning are general ability, specific ability, personality, interest, cognitive style, motivation, attitude, sex, race, age (developmental level), and socio-economic status (SES). Most readers will be familiar with these variables, so they will not be discussed in detail. Cronbach and Snow (1969, 1977) did extensive reviews of likely aptitude variables for ATI research. Their first and second choices for relevant aptitude variables are: (a) general ability, and (b) fluid and crystalized intelligence. Both of these variables will be used in the present study as aptitude variables.

Instructional Environment/Treatment Variables

The present author used the term "instructional environment variables" rather than the term "treatment variables" to emphasize the belief that the instructional environment is a more inclusive term than treatment. Instructional environment also carries the implication that these variables are interdependent parts of a system. The present author believes that this is a valuable addition to the ATI paradigm.

A major premise of the present study was that

> teaching should be conceived as the creation of an environment composed of interdependent parts. Content, skills, instructional roles, social relationships, types of activities, physical facilities, and their use all add up to an environmental system whose parts interact with each other to constrain the behavior of all participants, teachers as well as students. Different combinations of these elements create different environments eliciting different educational outcomes. (Joyce and Weil, 1972, p. 25)

If teaching is the creation of an environment, then it seems reasonable to ask what the basic dimensions of the teaching/learning environment are. Many studies have looked at the variables of the teaching learning environment, e.g. instructional style, class size, school and community norms; in spite of these efforts, the basic dimensions of the teaching/learning environment remain unknown. That is, the set of clearly defined, non-overlapping variables which completely describes the teaching/learning environment are presently unknown. The present author suggests that this state of affairs is due to the complexity of the problem, not lack of effort on the part of educational researchers.

The range of instructional environment variables to be considered in a study of classroom learning is much broader and less well understood than the range of aptitude variables. In surveying the literature of instructional environments one is immediately overwhelmed with a sense of disorganization, overlapping concepts, and a general ignorance of the basic dimensions of instructional environments.

The major instructional environment factors which have been shown by previous research to effect classroom learning are listed in Table I. For the purpose of the present study a factor is a general determinant of classroom learning. Each factor can be described by a number of different aspects or variables. Only the most commonly studied variables are listed in Table I. These factors define the classroom learning system.

The list in Table I was compiled from a review of the literature. It is not intended to be exhaustive, but rather is representative of the complexity involved in studying learning environments.

The factors in Table I are listed in terms of the level for observing the instructional enviornment (Walberg, 1977). The broadest level of observation is the National and State level; it influences classroom learning primarily by educational policies, e.g. curriculum, busing.

The next level of observation is the community level; this level was not looked at often, it includes variables like community norms, values, and socio-economic level.

The next lower level of observation is the school level. Two types of variables are looked at in this level: school organizational variables and school environmental variables. Organizational variables

TABLE I

CAUSAL FACTORS FOR CLASSROOM LEARNING AND RETENTION

NATIONAL AND STATE FACTOR
1. policy decisions

COMMUNITY FACTOR
2. community norms
3. socio-economic level

SCHOOL FACTOR
4. organizational variables, e.g. ability grouping, tracking
5. physical setting
6. school norms

TEACHER FACTOR
7. teacher demographics, e.g. sex, experience, race, age, degree level
8. instructional style
9. teacher's personality
10. philosophy/model of teaching

CLASS FACTOR
11. physical properties of the classroom environment, e.g. lighting, spatial arrangement, size of room
12. equipment available
13. method of instruction
14. subject matter
15. media of instruction
16. male/female ratio
17. class size
18. instructional time
19. class norms
20. group perception of psycho-social environment
21. grade level

STUDENT FACTOR
22. ability (general)
23. motivation
24. interest
25. personality
26. cognitive style
27. specialized ability
28. demographic characteristics, e.g. age, sex, race, SES

include homogenous ability groups, tracking, special schools, e.g. vocational, art, science, gifted, retarded, and remedial instructional programs. Environmental variables include: teacher-pupil ratio, cost per student, books in library, school setting, facilities available.

The teacher level is the next level of observation. The effect of the teacher is usually completely confounded with the effect of the classroom environment; so these variables are usually considered together as one level of observation. However, when several different teachers are observed teaching several different classes, it is possible to separate the effects of teacher from the effects of the classroom.

Teacher variables include:

1. Instructional Style--the ways in which the instructor controls the external learning situation. (Gagne, 1967) or, the different ways of handling information and applying sanctions in the classroom (Flanders, 1965) or "the choice of curriculum, its content, level, sequence, pace and style of presentation" (Sperry, 1972, p. 186).

2. Teacher's role--e.g. authoritarian, democratic, permissive.

3. Teaching methods--are "recurrent instructional processes, applicable to various subject matters, and usuable by more than one teacher" (Berliner and Gage, 1976, p.4), e.g. lecture, discussion group, tutor.

4. Teacher characteristics--e.g. personality, experience, training.

5. Models of teaching--"are models for creating environments- they provide rough specifications which can be used to design and actualize learning environments" (Joyce and Weil, 1972, p. 25).

Classroom environment variables include properties of the physical environment or the classroom, psycho-social characteristics of the group of students created by forming the students into a group, and the methods and materials of instruction. This factor includes:

1. Physical properties of the classroom environment--e.g. size of class, physical setting, ratio of females to males.

2. Media of instruction--e.g. textbook, film slides.

3. Subject matter content.

4. Classroom average of psycho-social characteristics of classroom climate--measures what the students perceived the teacher did, and how the students perceive the psycho-social characteristics of the class, e.g. perceived control and orderliness of the teacher, perceived classroom norms and values.

The lowest level of observation is the observation of student behavior. All of the variables of differential psychology fall into this level of observation.

The present discussion of instructional environment variables focused attention on the teacher and classroom levels of observation in the belief that these levels of observation were the most productive for developing prescriptions for teaching. Within these levels the reader should note the large number of interrelated variables. This suggests that these variables could be better represented by a smaller number of non-overlapping dimensions; the nature of these basic dimensions is unknown.

Within the teacher factor instructional style was ruled out as an instructional environment variable becasue it could not be used with the present emphasis upon ecological representativeness (see Chapter II). This is unfortunate since instructional style has shown great promise as a treatment variable. The most common technique for measuring instructional style is systematic observation of the classroom, e.g. Flander's interaction analysis. All of the systematic observation techniques have the potential for being highly reactive, and thus inappropriate for the present study (Sperry, 1972).

The teacher's personality is a promising potential candidate for an independent variable. Several authors (Rhett, 1972, Cronbach and Snow, 1977) have suggested that "the teacher" may be one of the most important influences on classroom learning, and that variance due to teachers should be studied, not discarded as error variance and randomized away. Measuring the teacher's personality, and other demographic aspects of the teacher are readily accomplished with existing instruments.

Model of teaching is the complement of psycho-social characteristics of classroom climate. Model of teaching measures what the teacher intended to do in class and what he actually did. Whereas, psycho-social characteristics measures the student's perceptions of what the teacher did. In Murray's (1938) terms, this is the distinction between alpha and beta press. The major problem with including model of teaching as an instructional environment variable is that the present author can find no instrument for measuring it; constructing such an instrument is beyond the scope of the present study.

In summary, of all the variables listed under the teacher factor in Table I, only teacher personality and teacher demographics are potentially useful as independent variables for the present study.

Of the variables listed under the class factor in Table I, there is no evidence that the physical properties of the classroom environment, and the equipment available influence classroom learning.

Teaching methods was not considered as an instructional environment variable for three reasons: (a) all teaching methods have been found to be equally effective in producing learning when class averages are used as the measure of learning (Flanders, 1969). (b) Comparing teaching methods for differential effectiveness raises the problem of operational definition of the teaching methods used, and (c) forcing teachers to use methods of instruction which are incompatible with their personality, training, or philosophy does not give the experimental treatments a very good chance to show their effectiveness (Cronbach and Snow 1977).

Subject matter content and media of insruction are important treatment variables which should be considered in ATI studies, but unfortunately, they are simply beyond the scope of the present study. However, descriptive data on these variables were collected.

Male/female ratio, class size, instructional time, class norms, group perception of the psycho-social environment, and grade level have all been shown to influence classroom learning. Data were collected on all of the above variables except class norms. Data on the psycho-social environment contain information on some class norms, e.g. competition, affiliation, student involvement. It was beyond the scope of the present study to collect more direct observations of student's norms.

Unfortunately, all of the variables listed above could not be used as independent variables. Most of these variables were used as covariates to control for the present author's inability to randomly assign students to classes. Grade level, Instructional time, and class size were used as covariates (see Chapter III).

In summary, only group perception of the classroom environment and male/female ratio are available as potential instructional environment variables at the class level. Evidence indicates that the perception for the classroom psycho-social environment is the better predictor of classroom learning (Cronbach and Snow, 1977).

A preliminary analysis of the potential instructional environment variables has narrowed the range of variables to three candidates: teacher personality and demographics, perceived classroom social climate, and male/female ratio. Male/female ratio seems to be the weaker of the three candidates for predicting classroom learning. The resources of the study do not permit analysis of both the teacher's personality and the classroom psycho-social climate. The present author chose to study the psycho-social environment of the classroom because it is more in line with his interests, and because there was no evidence to suggest that the teacher's personality would be a more powerful predictor of classroom learning.

Classroom Learning Variables

Gagne (1974) suggests that there are five major categories of learned human capabilities: verbal information, intellectual skills, cognitive strategies, attitudes and motor skills. All five of these capabilities were considered as dependent variables for the present study of classroom learning. However, due to the limitations listed below the present study examined only two of these capabilities: verbal information, and intellectual skills. The students probably learned attitudes during the instructional treatment but it was impossible under the present design to separate their attitudes to the instructional treatment from their attitudes toward all the instruction they received prior to the treatment.

The above rationale also applies to cognitive strategies; however, the present author does not believe that a great deal of class time is actually devoted to the learning of cognitive strategies (Ausubel, 1968). This situation is in sharp contrast to the amount of rhetoric which extolls that learning to think is a major goal of education. Cognitive strategies were not included in the present study because a significant proportion of instructional time was not devoted to this learning outcome.

Motor skills were not included in the present study because they were not a significant part of the unit of instruction. If a different unit of instruction had been chosen, motor skills would have played a more significant role in the unit of instruction.

In summary, two types of learned human capabilities were selected to measure classroom learning: verbal information and intellectual skills. These capabilities were used to develop an operational definition of classroom learning (see Chapter II).

Statement of the Problem

After 100 years of research on school learning and effective teaching, the educational psychologist cannot prescribe with much certainty what the determinants of school learning are, or what the teacher should do to be effective, i.e., promote achievement (Gage, 1963; Stephens, 1967; Nuthall and Snook, 1973). Some psychologists ask for more time (Glasser, 1972).

This pessimistic note should not imply that nothing has been learned about school learning in the last 100 years of research. Indeed, mountains of facts have been accumulated. The educational psychologist of today would do a better job of designing instruction, describing conditions that promote school learning or developing prescriptions for effective teaching than his collegue fifty years ago. The paradox is that despite a much better understanding of many learning phenomenon, the phenomenon of school learning remains largely unexplained.

The problem for the present study is to determine the relationship between characteristics of the student, characteristics of the learning environment, and classroom learning. These relationships have been studied before; several comprehensive reviews of the subject have suggested that progress in solving this problem has been slow because the wrong models of teaching/classroom learning were used (Gage, 1963; Nuthall and Snook, 1973; Cronbach and Snow, 1977). The task of the present study is to select the best educational research methods (see Chapter II), and the most appropriate model of classroom learning, and apply them to the problem stated above.

The emphasis of the present study is upon classroom learning. Since it is a later stage in the learning process, classroom retention is also of interest. Together, both variables produce a more accurate picture of the classroom learning phenomenon, than either variable would separately.

A Model of Classroom Learning

When learning occurs in the average classroom, it is impossible to say what it is the teacher did to produce learning, i.e. did changes in the learning environment produce the learning or are other factors responsible for the learning? A multitude of hypotheses can be suggested to explain classroom learning; several of these hypotheses are:

1. The teacher's instructional style.

2. The textbook used by the teacher.

3. The supplementary materials used by the teacher.

4. All of the things the teacher did in class, e.g. method of instruction.

5. None of the things the teacher did, e.g. student aptitudes alone are responsible for the learning.

6. Interactions of any or all of the above.

Clearly, a model of classroom learning would be of great benefit to education by showing which factors are responsible for classroom learning.

The purpose of the present study was to account for the variance of classroom learning and retention, not to predict classroom learning and retention. That is, the present study sought to understand the causes of classroom learning by proposing a model of classroom learning. Since the present experiment did not manipulate any independent variables, it was impossible to make definitive statements about the causes of classroom learning. The data from the present study were too weak to prove causation; conclusions from the present study <u>must</u> be limited to either lending support for the proposed model of classroom learning, or failing to support the proposed model of classroom learning.

The present study was an exploration. If the proposed model of classroom learning was supported, then it would point the way for future controlled experiments in the schools. If the model was not supported, then valuable resources would not be wasted on a controlled experiment. Given the enormous difficulty of controlled experiments in actual classrooms, this seems to be a parsimonious way of screening out unfruitful hypotheses.

<u>The major assumption</u> of the present study was that the classroom room learning of any individual student is the result of characteristics of the student interacting with characteristics of the perceived learning environment (Lewin, 1935). This implied that the student is part of a system; the present study assumed that, in order to understand a student's learning in the classroom, it is necessary to understand how this classroom system operates. The present author suggests that past attempts to explain student learning have failed, because the full complexity of the learning environment was not dealt with.

Figure 1 is a graphic illustration of the classroom learning environment; it is called a path diagram. This diagram presents all of the causal factors of learning listed in Table I. It shows how each factor influences classroom learning, and how each factor relates to the other factors in the system. An arrow indicates that one factor has a causal influence on another factor. A two headed arrow indicates a feedback loop. That is, both factors influence each other.

For example, the diagram illustrates that the teacher factor is one cause of classroom learning. This means that at least one of the variables listed under the teacher factor causes classroom learning. It does not tell you which variable is responsible, or how strong a relationship exists between the teacher factor and classroom learning.

The diagram also illustrates that classroom learning has a causal influence on the teacher factor. This is an example of a feedback loop. The teacher tries to cause classroom learning. The degree of learning that results will have an influence on the teacher, e.g. poor learning might cause the teacher to change her/his model of teaching, instructional style, anxiety level or career. Feedback loops, like

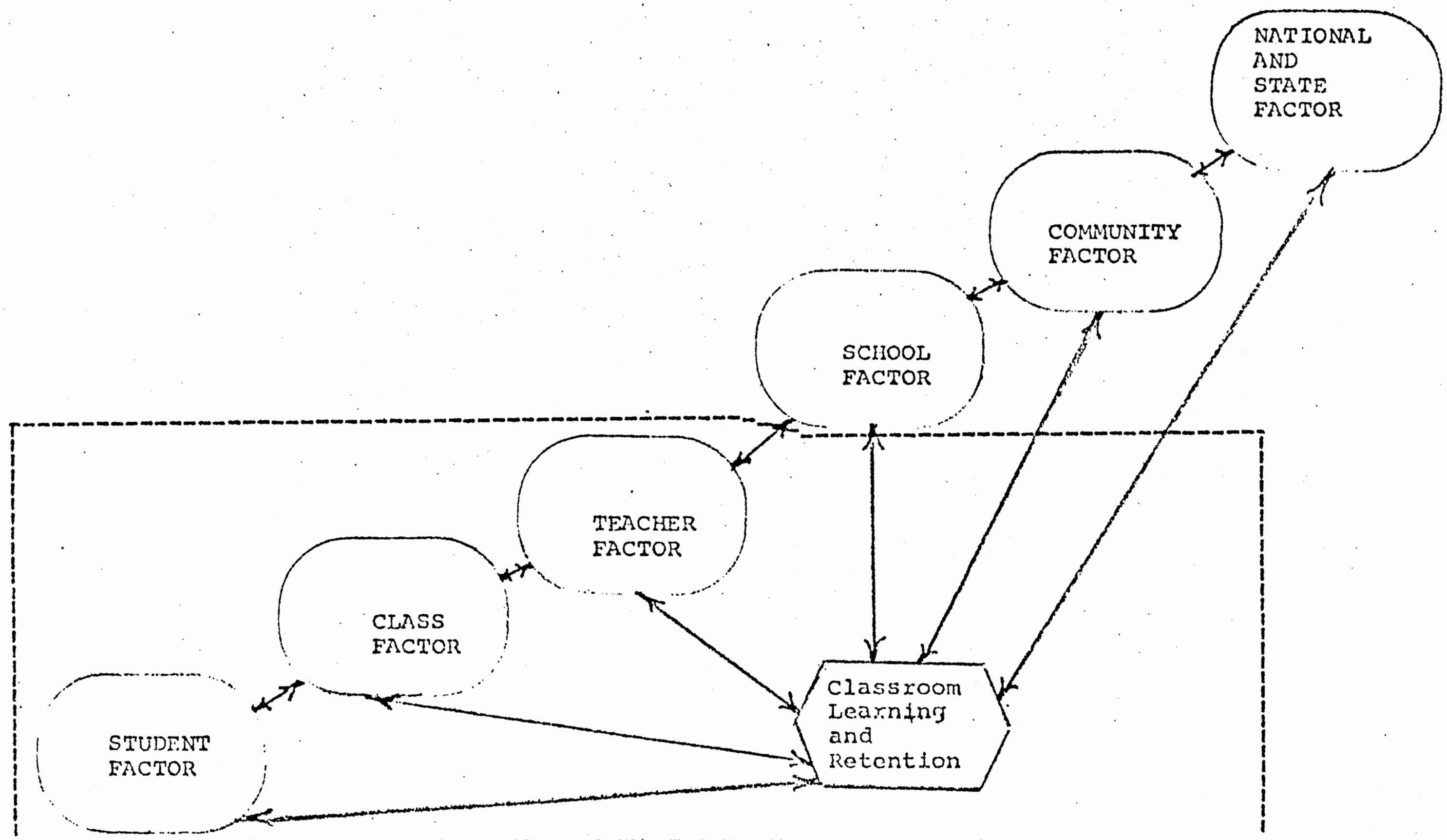


Figure 1. A Path Diagram of the Causal Factors of Classroom Learning and Retention. (For illustrative purposes this figure assumes that learning and retention are the same process, and that causal factors only relate to the next lower factor in the hierarchy.)

the one described above, greatly complicate the task of understanding the system, but also make the system much more flexible and responsive.

The last feature of the path diagram to be discussed is the large dotted line rectangle. This rectangle shows the boundary of the system which was examined in the present study. Due to limitations of resources and methodology, it was not possible to study the entire classroom learning system as described in Figure 1.

The reader should note that the path diagram assumes that there is no interaction between factors. If factors do interact in the real system, then the classroom learning system is even more complex than the diagram illustrates.

The large number of feedback loops indicates that the causal factors illustrated, and probably their component variables, are highly interrelated. This suggests that it will be difficult to isolate the factors which are having the greatest causal effect on classroom learning.

There are three reasons for using a path diagram to illustrate the classroom learning system:

1. It is an heuristic device which helps improve your understanding of the classroom learning system.

2. It graphically illustrates to the reader the complexity of the classroom learning system.

2. It illustrates the flow of causality, i.e. how one factor will be the cause of another factor. It is necessary to understand the flow of causality in order to construct the regression models which will be discussed in the sequel.

The review of the literature, and the causal analysis presented above suggested the following model of classroom learning: classroom learning (CL) is a function of the student's general ability (A), plus classroom average of the psycho-social environment as perceived by the student (CE), plus the interaction of perceived environment and ability (A x CE). This model can be written symbolically as:

$$CL = f\ (A) + f\ (CE) + f\ (A \times CE)$$

Many psychologists (Hunt and Sullivan, 1974; Piaget, 1971) would argue that a person's cognitive stage influences the way they perceive and learn. This suggests that any model of classroom learning should also consider the developmental level of the students being taught. Hypotheses four and eight expand the general model stated above by testing developmental interactions; the resources were not available to explore these hypotheses in great detail.

Hypotheses

The general model of classroom learning stated above cannot be tested by a single hypothesis. Under the present design six hypotheses need to be tested to confirm the general model. Two hypotheses need to be tested to confirm the developmental hypothesis, and one hypothesis needs to be tested to confirm the internal validity of the present study. Thus, the present study tested a total of nine hypotheses. (Each independent variable in the model needs to be tested for significance; this procedure insures that each independent variable is making a unique contribution to the model of classroom learning.)

The present study examined two aspects of classroom learning: initial learning (L) and retention (R). In order to confirm the general model of classroom learning stated above both dependent variables need to be tested.

Each hypothesis tested by the present study examined a different aspect of the proposed general model of classroom learning. Each hypothesis corresponds to a different model of classroom learning. The hypotheses and their corresponding models are listed below:

H_1: General ability is not a significant predictor of initial classroom learning when differences in initial classroom learning have been adjusted by a set of covariates (COV).

Model 1: L = COV + A

H_1: $I_A = 0$ (This method of significance testing is explained in detail in Chapter III.)

H_2: The classroom average of the perceived psycho-social classroom environment is not a significant predictor of initial classroom learning when initial classroom learning has been adjusted for general ability and a set of covariates.

Model 2: L = COV + A + CE

H_2: $I_{CE} = 0$

H_3: The interaction of general ability and perceived classroom environment is not a significant predictor of initial classroom learning when initial classroom learning has been adjusted for the classroom average of the perceived psycho-social classroom environment, general ability and a set of covariates.

Model 3: L = COV + A + CE + (A X CE)

H_3: $I_{(A \times CE)} = 0$

H_4: The interaction of grade level and the classroom average of the perceived psycho-social classroom environment is not a significant predictor of initial classroom learning when initial classroom learning has been adjusted for the interaction of general ability and the classroom average of the perceived psycho-social classroom environment, the classroom average of the perceived psycho-social classroom environment, general ability, and a set of covariates. This hypothesis is a refinement of the proposed general model of classroom; it tests the idea that high school students learn more in perceived classroom environments which are different from those perceived environments which are most beneficial for the classroom learning of eigth grade students. Thus, this is a developmental hypothesis; it suggests that as a person ages, the type of perceived environment which is most beneficial to learning changes.

Model 4: L = COV + A + CE + (A X CE) + (G X CE)

H_4: $I_{(G \times CE)} = 0$

H_5: General ability is not a significant predictor of classroom retention when retention has been adjusted for a set of covariates.

Model 5: R = COV + A

H_5: $I_A = 0$

H_6: The classroom average of the perceived psycho-social classroom environment is not a significant predictor of classroom retention, when retention has been adjusted for general ability and a set of covariates.

Model 6: R = COV + A + CE

H_6: $I_{CE} = 0$

H_7: The interaction of general ability and the classroom average of the perceived classroom environment is not a significant predictor of classroom retention, when retention has been adjusted for the classroom average of the perceived psycho-social environment, general ability and a set of covariates.

Model 7: R = COV + A + CE + (A X CE)

H_7: $I_{(A \times CE)} = 0$

H_8: The interaction of grade level and the classroom average of the perceived psycho-social classroom environment is not a significant predictor of classroom retention, when retention has been adjusted for the interaction of general ability and the classroom average of the perceived psycho-social classroom environment, the classroom average of the perceived psycho-social classroom environment, general ability, and a set of covariates.

Model 8: R = COV + A + CE + (A X CE) + (G X CE)

H_8: $I_{(G \times CE)} = 0$

Hypotheses 1-3 and 5-7 all need to be rejected in order to confirm the proposed general model of classroom learning. Hypotheses 4 and 8 need to be rejected in order to confirm the proposed developmental hypotheses. Failure to reject of any of the above hypotheses places limitations on the proposed general model of classroom learning.

Before the above hypotheses can be tested, the internal validity of the experiment needs to be verified. The internal validity check insures that learning occurred during the instructional treatment, and that this learning could only be caused by some aspect of the instructional treatment. Formally this internal validity check can be stated as:

H_{IV}: The experimental group which received three weeks of instruction on a chemistry unit, performed no better on a test of initial learning than the control group which received no instruction on the experimental unit.

The internal validity hypothesis H_{IV} is testing the obvious proposition that students who are exposed to a unit of instruction learn more than students who are not exposed to the unit. This hypothesis was tested using a t test for independent groups; the unit of analysis was the teacher. The initial learning test scores were averaged over all the students taught by each teacher. The teacher was used as the unit of analysis because teachers were assigned at random to the experimental replication groups.

The Instructional Treatment

The instructional treatment proposed for the present study is referred to as "general classroom instruction." It is defined as anything that occurs inside the classroom which reliably produces student learning. This includes teacher's efforts, the instructional media available to the student, and the classroom social, psychological, and physical environment. This treatment may seem foreign to the reader with a strong experimental background; an explanation may make the treatment seem more plausable (see Chapter III).

Summary of Chapter I

The present study selected one aptitude of the student, i.e. general ability, and one aspect of the learning environment, i.e. classroom average of the perceived psycho-social classroom environment. The ATI research paradigm was selected as the most promising approach to the research problem. The research problem for the present study was to determine the relationship between general ability, the classroom average of the perceived psycho-social classroom environment, and the classroom learning of eighth grade and high school science students. A general model of classroom learning was proposed to investigate the research problem stated above. The proposed model of classroom learning was analyzed using regression analysis. The present study was designed to answer the following questions:

1. What proportion of classroom learning is uniquely accounted for by general ability?

2. What proportion of classroom learning is uniquely accounted for by the classroom average of the perceived psycho-social classroom environment?

3. What proportion of classroom learning is uniquely accounted for by the interaction of general ability and the classroom average of the perceived psycho-social classroom environment?

4. Do high school students learn best from the same perceived classroom environments that are most beneficial for the classroom learning of eighth grade students?

Methodological Note

The present study developed and tested an explanatory model of classroom learning. The basic emphasis was upon using information from the independent variables to explain variability in classroom learning. The results of the present study do not demonstrate causation. Kerlinger and Pedhauzer (1973) suggest that,

> When an analysis is complete the researcher should determine if the data are consistent with his explanatory model. If the data are inconsistent with the model, doubt is cast on the theory that generated it. Consistency of the data with an explanatory model, however, is not <u>proof</u> of a theory; it only lends support to it. (p. 307)

Significance of the Problem

The present study is significant for five reasons:

1. The most significant result of the present study will probably

be the refinement it makes of the ATI research paradigm, i.e. the present study will consolidate the current, ATI methodological advances into one model with many of the present day methodological flaws removed. This should provide much clearer data from which to evaluate the effectiveness of the ATI paradigm.

2. The present study will refine the definition of a major environmental dimension: the psycho-social dimension, and relate this dimension to classroom learning. Educational psychology desperately needs a clearer understanding of the major dimensions of classroom behavior, and the relation these dimensions have to classroom learning.

Just as physique can be described by combinations of three basic somatotypes, it seems reasonable to hope that learning environments could be described by a limited number of basic dimensions. If these basic dimensions are identified, it would be possible to describe instructional treatments in quantitative terms (e.g. scores of 5, 2, 7 on the basic dimensions) rather than in qualitative terms (e.g. didactic method, discovery method). This would eliminate a major problem with the qualitative descriptions of instructional treatments, i.e. instructional treatments are grouped together on the basis of one dimension of the treatment situation, e.g. teacher's role, while other treatment dimensions are free to fluctuate.

3. Cronbach and Snow (1969, 1977) put great faith in the possibility of general ability as a primary candidate for an aptitude variable in ATI research. A significant finding from the present study would provide an empirical foundation to base this faith upon.

4. The results of the present study were based on a target population of high school science students in the metropolitan Boston

area. Science students are a slightly more select group of students than the average high school student, e.g. a student in freshman English. That is, Chemistry is an elective course for all high school students, however, many students take chemistry to meet their science requirement; they perceive it as the lesser of two evils. Physics is the course commonly selected as an alternative for meeting the science requirement. Science is a required course for eighth grade students.

The relatively normal population from which the study sample was drawn, provides a strong base for generalizations. The representativeness of the instructional treatment and the target population used in the present study is one of the strong points of the present study. If the present study finds educationally significant ATI's, then researchers would have ample justification to look for similar ATI's in other metropolitan areas.

5. One of the major goals of instructional psychology is the development of a body of educational prescriptions to guide teacher behavior. These prescriptions will probably be based on differential effects resulting from Aptitude Treatment Interactions. If the present study finds an "educationally significant" ATI, i.e. an ability by psychosocial climate interaction, this finding could significantly advance the theory of instructional psychology. Provided it is validated by future research.

"Educational significance" needs to be defined and differentiated from statistical significance. Very often statistical significance is the only criterion for successful educational research; this is not enough. For results to have educational significance they should meet at least two additional criteria:

1. Differences between instructional treatments must have practical significance. That is, the psychological meaning of treatment differences, the cost of producing treatment differences should all be considered in determining the practical significance of a result.

2. Treatment variables should account for a substantial proportion of the variance of the dependent variable. Substantial is a relative term. It can be defined in terms of what is known; for poorly understood phenomenon, almost any increase in the variance accounted for should be considered a substantial amount.

Limitations

The limitations of the present study fall into three different categories: (a) Sampling problems, (b) Treatment problems, and (c) Analysis problems.

Sampling Problems

Rather than randomly assigning students to treatments or to classes the present study used intact classes for the instructional treatment. Students were assigned to classes at the beginning of the school year. It seems probable that students were assigned to classes on the basis of ability (see Chapter III).

Cronbach and Snow (1977) suggest that

> when students are not randomly assigned to classes that this confounds person characteristics with class characteristics. The reliability of different measures may differ from class to class or school to school. This difference in stated reliability will exist to the extent that the measures were normed on groups different from those used in the experiment. Any interpretation of the data must carry a warning about the above confounding. (p. 49)

Any generalizations about the findings of the present study should be limited only to classes which were formed on the basis of the same policies. For the present study there is evidence that the high school classes were formed on the basis of ability.

Since classes did not have pre-experimental sampling equivalence, the analysis of covariance was used to reduce this problem by equating classes on the covariates. The reader should note that the analysis of covariance does not equate classes on any unmeasured variables. The reader should also note that since teachers were randomly assigned to treatments, a pretest was not used to establish the equivalence of the experimental classes and the control classes.

The next sampling problem to be discussed is that all teachers in the present study were volunteers. Thus, any generalizations from the present study should be limited to teachers who would volunteer for a similar study.

The present author believes that the high school teachers in the present study were fairly representative of the general population of high school teachers. All of the high school teachers, who were contacted by their department heads, volunteered for the present study. There was no coercion on the part of department heads, but the department head in several cases seemed to select his better teachers (see Chapter III).

Teachers at the grammar school level are not necessarily representative of all grammar school teachers. Only six out of approximately 15 teachers contacted by department heads volunteered for the present study. Four of these six teachers did not participate in the present study because they were not planning to teach a unit on acid-base theory, the experimental unit of instruction (see Chapter III).

The largest sampling problem concerns experimental mortality rates. Two types of experimental mortality rates raise questions about the representativeness of the sample of classes and the sample of students used in the analysis.

Six classes were dropped from the analysis because they never received the unit of instruction; these classes ran out of time at the end of the school year. Five of these classes were categorized as "Academic Chemistry;" these classes usually contain less able or less motivated students (see Chapter III).

Twenty five percent of the students who received the unit of instruction were missing one or more independent variables, and were dropped from the analysis. This appears to be a high degree of mortality, but is a common problem with school research. In general data were missing due to student absenteeism.

Treatment Problems

The major treatment problem was that it was impossible to keep the amount of instructional time available to all classes constant. So instructional time was used as a covariate to statistically equate the amount of instructional time received by each class.

A related treatment problem was that the informational content of the experimental unit of instruction was not identical for each class. Teachers added material or deleted material to meet their own instructional goals. This problem is not as serious as it may seem. All but two of the high school classes used the same textbook. However, the two eighth grade teachers used different instructional material (see Chapter III).

The next treatment problem concerns the reactivity of the experimental treatment. Despite the fact that teachers were instructed to keep the experiment secret from the students, some teachers did tell their classes an experiment was in progress. This creates a threat to internal and external validity.

However, of all the classes which knew an experiment was being conducted, only one class behaved differently because of the experiment. So, because knowledge of the experiment did not have a large influence on student behavior, the present author concludes that internal and external validity are not seriously threatened (see Chapter III).

The next treatment problem to be discussed is that the retention interval for the present experiment was only two weeks long. Originally, a six week retention interval was intended. The present author does not believe that this creates a problem. It is probably an adequate demonstration of retention since, forgetting increases rapidly after learning.

Finally, the reader should be cautious in his interpretation of the classroom average of the perceived psycho-social classroom environment. Cronbach and Snow (1977) suggest that

> the person investigating classroom climate or teacher style ordinarily looks upon that variable as an objective property of the instructional situation, even when he uses student reports as his source of evidence. Such information, aggregated at the group level, may be as much of an indicator of group moral as it is a veridical report on what the instructor did....<u>One can also consider the report of the student individually, as a phenomenal description of the treatment as he experienced</u> it. His perceptions may directly reflect his personality or may themselves be products of a Personality X Treatment Interaction. (p. 455)

<u>Analysis Problems</u>

All of the regression models tested in the present study used the individual student as the unit of analysis. Since students were members of existing classes, these observations were probably not independent. Cronbach and Snow (1977) suggest that

> analysis at the individual level is not a legitimate basis for statistical inference as it greatly underestimates the alpha risk.
>
> In inferences from classes pooled, the number of degrees of freedom is derived from the number of persons. This appears to be unjustified when the effect tested is a mixture of group and individual effects. It is legitimate only if one is prepared to assert that: the experience a Person P had in Class C does not differ from the experience he would have had in Class X.
>
> The following effects all prevent students in Class A from being independent of each other.
>
> 1. teacher effects
> 2. rivalry
> 3. contagion effects
> 4. chance effects due to class A (p. 103)

The data from the present study do not support the assertion of independence of student observations mentioned above. So, the reader should be cautious in his interpretation of the stated significance levels. It would be more appropriate to treat the data as descriptive rather than inferential.

The next analysis problem deals with analytical problems created by the use of multivariate methods. In any multivariate study the reader should be cautious in his interpretation of the results because these methods capitalize to a large degree on chance fluctuations in the data. In order to minimize these chance effects many authors recommend a large ratio of cases to variables. Cattel (1952) argues that a ratio of 4 to 1 is adequate. Rummel (1970) suggests that for factor analysis it is still a matter of taste.

The present study performed two types of multivariate analyses:

a factor analysis and several regression analyses. The factor analysis had 375 cases and 15 variables, i.e. a 25 to 1 ratio. The full regression model contained 17 variables.

Three different regression analyses were performed. The initial learning model was tested on two different samples: the experimental group and the replication group. The experimental group contained 137 cases and 17 variables; this is a ratio of 8 to 1. The replication group contained 149 cases and 17 variables; this is a ratio of 8.8 to 1. The retention model was tested on one sample which was drawn from the experimental group. This group contained 90 cases and 17 variables; this is a ratio of 5.3 to 1. The present author believes that these case to variable ratios are adequate, because the regression models tested were based on theory, rather than stepwise regression analysis. Stepwise regression capitalizes on chance fluctuations in the data, and thus needs a much higher case to variable ratio to produce stable results (see Chapter III).

The reader should note that it is possible that too many variables were included in the regression models. The addition of these variables reduced the power of the tests for interactions. This situation could be improved by adding the two ability measures together. This would result in three interaction terms as opposed to six, and would increase the size of the average interaction effect so that it was significant.

The reader should also note that the present study was based on observed scores as opposed to true scores. This policy was adopted because Nunnally (1978) suggested that with few exceptions there is a perfect correlation between observed scores and true scores, and the correction for the unreliability of the observed scores is unnecessary. However, Cronbach and Snow (1977, p.35) present a strong argument in favor of the use of true scores in ATI research. The lack of significant interactions could be attributed to the use of observed scores.

Finally, a limitation of the analysis of covariance needs to be discussed. This technique assumes that the covariates are causally prior to the research factors. If the research factors are causally prior to the covariates, then the covariate set will steal variance that rightfully belongs to the research factor. The choice of covariates is a critical issue; the possible relationship between Ability, Classroom-Environment and the covariate set is discussed in Chapter III.

Assumptions of the Present Study

The major assumption of the present study was that the classroom learning of any individual student is the result of characteristics of the student interacting with characteristics of the learning environment. That is, behavior is a function of the person and his environment.

The present study assumes that the student is part of a system, e.g. a classroom or a school, and that it is necessary to understand how this system operates before an explanation of classroom learning will be complete.

The present study assumes that there are a universe of learning environments available to be tested. The classes in the present study were only a sample of the learning environments available. If classes had been sampled at random the environments in the present study would constitute a random sample of environments. However, teachers were selected as the unit of analysis for the present study, not classes. So that, the classes used in the present experiment do not constitute a random sample of learning environments.

The present study assumes that effective teaching/instruction involves the manipulation of the learning environment. That is, teaching is the creation of an environment. Student learning in the classroom is assumed to have multiple causes, i.e. student learning is a non-random phenomenon which can be modeled.

The present study assumes that classroom learning is predominantly a meaningful learning task, and that rote learning tasks are uncommon in junior and senior high school. It is also assumed that meaningful learning is the dominant form of classroom learning. This implies that the learner must be active in the learning process and that he must organize the information to be learned and relate it to his cognitive structure in a nonarbitrary fashion.

Since meaningful learning is assumed to be the dominant form of learning in the classroom, meaningful retention is assumed to be the dominant form of retention. This implies that interference will not play a large role in the retention process.

The two basic assumptions of the analysis of partial variance are:

1. There is no interaction between the covariate set and the research factors. Thus, it is reasonable to make the same covariate adjustments to all subjects.

2. If the covariate set and the research factor set are related,

then the covariate set must be causally prior to both the dependent variable and the research factor set.

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

This review will discuss the four areas of research which were needed to solve the problem discussed in Chapter I.

1. The first section of this review will discuss the conceptualization of an instructional Environment/Treatment dimension. A better understanding of this dimension is necessary before much progress can be made with the ATI research paradigm.

2. The second section of this review will discuss the conceptualization of the Aptitude dimension of ATI research, and the most promising candidates for Aptitude variables in ATI research.

3. The third section of this review will discuss the dependent variables, i.e. classroom learning and retention, and develop an operational definition of classroom learning.

4. The ATI model of research shows great promise as a methodological tool; however, researchers, using the ATI paradigm, have been slow to produce substantive results. The last section will discuss four reasons why the ATI paradigm has been unsuccessful in the past. This review will establish the foundation for the design section (see Chapter III).

Review of the Instructional Environment/ Treatment Dimension

Most readers are unfamiliar with the conception of an instructional treatment as an environment. The purpose of this review is to (a) acquaint the reader with the literature on environments, (b) describe the basic dimensions of the Instructional Environment, (c) Review the psycho-social dimension of Instructional Environments.

Conceptualizations of Treatment and Environment

There are a number of definitions of treatment and environment for the reader to choose from; several of these definitions will be discussed. Cronbach and Snow (1969) define treatment as "variations in the pace or style of instruction" (p. 7). Rhett (1972) suggests that "the term treatment is the analogue to instruction in individualized instruction, and refers to the various organizations of material or procedures which the subject is asked to cope with or respond to" (p. 270).

Hunt (1975) prefers the term environment to the term treatment; he does not restrict himself to one definition of environment, but prefers to let researchers use their own conception of environment.

In psychology the term environment originated with Lewin's field theory. In this theory

> the environment under consideration is the psychological environment....It differs in many respects from the physical world. For example, wishes exist in the psychological world. In addition there may be many psychological worlds, but there is only one physical world. (Weiner, 1972, p. 112)

Murray also included an environmental variable in his personality theory; he called it "press".

> Just as the concept of need represents the significant determinants of behavior with the person, so the concept of "press" represents the effective or significant determinants of behavior in the environment. In simplest terms a "press" is a property or attribute of an environmental object or person which facilitates or impedes the efforts of the individual to reach a given goal. Press are linked to persons or objects that have direct implications for the efforts of the individual to satisfy his need striving. The press of an object is what it can do to the subject or for the subject--the power it has to affect the well being of the subject in one way or another. By representing the environment in terms of press the investigator hopes to extract and classify the significant portions of the world in which the individual lives. (Cited in Hall and Lindzey, 1970, p. 180)

Murray distinguishes between alpha press and beta press. An alpha press reflects the properties of environmental objects as they exist in reality or as objective inquiry discloses them. Beta press reflects the property of an environmental object as it is perceived or interpreted by the individual. The individual's behavior is most closely correlated with the beta press. However, it is also important to discover situations in which there is a wide discrepancy between the beta press to which the individual is reacting and the alpha press which actually exists.

Since teaching is viewed as the creation of an environment, it is useful to review non-psychological conceptions of the treatment-environment dimension. Environment is defined as "the aggregate of all the external conditions and influences affecting the life and development of the organism." (Stein, 1971, p. 203) However, the environment that is studied depends upon the level of the environment you are interested in. In this sense there are many environments all nested within each other.

For example, if you are interested in the effect of climate on an organism, you can look at the climate from at least three different environmental levels. The broadest level of climate is measured by the geographical climate, e.g. the climate of New England; a narrower concept of climate is the ecological climate, e.g. the climate of an ecosystem such as a forest or a pond. The narrowest view of climate is the microclimate, i.e. the climate of the habitat in which the individual lives (Bates, 1968).

Several scientific disciplines have been developed to study the environment; some of these disciplines will be discussed.

> A major concern of the biological and social sciences has long been the nature of the interaction of organisms with the embedding environment. The generic term representing the scientific study of organism-environment interaction is ecology. (Sells, 1966, p. 131)

Two branches of ecology are of interest to the present study: social ecology and human ecology.

> Social ecology has evolved mainly from the effort of psychologists and behavioral scientists to direct their inquiries toward a more complete view of man interacting with his physical and social environment...Social ecology reflects the traditional concerns of ecology both in its emphasis on the measurement of objective physical characteristics of environment [e.g. temperature, rainfall, air pollution, noise levels and the shapes, sizes and physical arrangements of buildings] and in its inquiry into the the short-term evolutionary and adaptive consequences of these environments. Social ecology, however, expands these concerns by systematically dealing with the social environment and its interaction with the physical mileu...it has been concerned with promoting maximally effective human functioning. Finally, social ecology [places] special emphasis on the identification of maladaptive responses and their relationship to environmental variables...[Social ecology is concerned with understanding] the regulatory mechanisms which keep human societies in balance with the resources of their mileu. (Insel and Moos, 1974, p. 180)

Human ecology is of more recent origin; it extends the domain of the geographer and the sociologist who is interested in the distribution of human populations. Human ecology has been used to investigate the distribution of material resources, health, social, economic and cultural problems.

Another discipline which studies environmental variables is ecological psychology. Ecological psychology was proposed by Lewin and is the study of all non-psychological factors that can influence the life space. "The psychologist studies non-psychological data to find out what these data mean for determining the boundary conditions of the life of the individual or group" (Weiner, 1972, p. 153).

A discipline which lacks a name but which has been clearly asked for might be called "situational psychology". Frederickson (1972) suggests that one of the methodological difficulties of doing ATI research is

> that we lack a satisfactory classification of situations. We need a systematic way of conceptualizing the domain of situations and situational variables before we can make rapid progress in studying the role of situations in determining behavior. (p. 115)

Sells (1963) argues that "a taxonomic, dimensional analysis of stimulus variables comparable to the trait systems that have been developed for individual difference variables" (p. 700) is obviously needed.

Kraus (1970) suggests that

> Most research on psychological attributes, on the dispositions to behavior of persons, must be done in social situations. These situations are the analogue of psychological research to the mechanical and electrical apparatus in, for example, neuropsychological research. They are the basis for all experimental control and all dependent variable assessment in psychological research. Therefore, their preparation is, properly, as important a methodological topic for psychology as is instrumentation for neuropsychology. (p. 748)

One of the major problems of educational research is that it is difficult to compare treatment A with treatment B, or even to be sure that two classes which are receiving treatment A, are indeed, receiving the same treatment. A remedy for this problem would be to develop a subdiscipline of situational psychology. This subdiscipline would try to determine the major dimensions or attributes of an educational treatment. This knowledge would make it possible to compare the attributes of different educational treatments.

Basic Dimensions of the Environment Domain

At present psychologists are ignorant of the basic dimensions i.e. in a factor analytic sense, of the treatment/environment domain. However, several authors have developed useful conceptual models of this domain, e.g. Kraus, 1970. Moos (1973) has suggested that human environments fall into six dimensions or categories; these dimensions are overlapping and mutually interrelated. They are heuristic rather than theoretical or factor analytical models. They summarize the work that has been done, and point the way for future research. The reader should be reminded that all environmental dimensions can be described in terms of their press: alpha press, i.e. the environment as it exists in reality or as objectively measured, and beta press, i.e. the environment as it is perceived by the inhabitant.

The six environmental dimensions suggested by Moos (1973) are:

1. ecological dimensions
2. behavior settings
3. organizational structure dimensions
4. inhabitant attribute dimensions
5. psychosocial characteristics dimensions
6. reinforcement dimensions

The ecological dimension includes geographical, meterological, architectural, and physical design variables. Ecological variables fall primarily into the alpha press domain.

> The weight of evidence suggests that geographical and meterological variables may be more important in the determination of group and individual behavior than has been thought to be the case...Some of the variables implicated in the determination of behavior include extreme cold, barometric pressure, cyclonic and anti-cyclonic storm patterns, and oxygen, nitrogen, carbon dioxide, and ozone concentrations in the atmosphere. (Moos, 1973, p. 653)

Architectural and physical design variables are significant ecological variables because all behavior must take place in a physical setting, and this setting can impose major constraints on the range of possible behaviors.

> Research in ergonomics, human engineering, and human factors has been concerned with the relation of selected environmental variables such as heating, lighting, noise level, ventilation and the layout and design of machines to behavioral measures of work efficiency, comfort, social interaction, interpersonal perception, and exploratory behavior. (Moos, 1973, p. 653) (See Craik, 1970; Kates and Wohlwill, 1966; Proshansky, Itleson, and Rivlin, 1970; and Sommer, 1969)

At the present time, the author has found no evidence to suggest that ecological variables play a significant role in classroom learning, or produce differential effects for classroom learning or academic achievement.

The behavior setting dimension was first proposed and studied intensively by Barker (1968). He conceptualized a behavior setting as an ecological unit which has both a behavioral and environmental component. Any behavior is acceptable as the behavioral component, e.g. sitting in class, writing at the blackboard, group discussion. The environmental component includes the non-psychological objects with which the behavior is transacted, e.g. blackboard, desks, textbooks.

> The important characteristic of behavior settings is that they are stable, extra-individual units which have great coercive power over the behavior that occurs within them... behavior settings can be shown to have pervasive effects on individuals not only in terms of the specific behavior which is demanded by the setting, e.g. reading and writing in a classroom, but also on both other behaviors and affects experienced by individuals. (Moos, 1973, p. 654)

Organizational structural dimensions focus on the structural dimensions of organizations, and the relationship of these structural dimensions to the behavior and attitudes of the members of the organization. Porter and Lawler (1965) identify the following dimensions of organizational structure:

1. Centralized or decentralized shape
2. Number of organizational levels
3. Span of control
4. Size of the overall organization
5. Size of organizational subunits

Porter and Lawler (1965) concluded that structural variables had more impact on members attitudes than on their behavior. The research on classroom size and school size falls under the organizational structural dimension.

For example, Astin (1968) investigated the relationship of academic achievement to the structural characteristics of colleges. Some of the structural characteristics he used were: faculty-student ratio, number of books in the library per student, size of enrollment, per student expenditures. Astin (1968) found little relationship between these variables and student achievement; however others disagree with his findings (Moos, 1973).

The inhabitant characteristics dimension is based on the work of Linton (1945); the general idea is "that most of the social and cultural environment is transmitted through other people. It implies that the character of an environment is dependent in part on the typical characteristics of its members" (Moos, 1973, p. 655).

Astin developed the Inventory of College Activities to investigate this idea. He administered the inventory at 246 colleges and universities and found considerable diversity among the college environments. He suggested that this diversity indicates that colleges have "great potential for differentially influencing the experience and behavior of the individual student" (Moos, 1973, p. 656). For example, norms of learning, not learning or competition among the student population can have a tremendous effect on the amount and quality of learning that takes place in the classroom.

Holland (1966) suggested that vocational satisfaction and achievement depend on the congruence between the environment in which the person works, and his personality. Holland develped six environmental terms to describe the common physical and social environments in our culture: realistic, intellectual, social, conventional, enterprising, and artistic. He used these same terms to describe the person's orientation toward vocations. Since personal orientation and environment are described in the same terms, it is possible to measure the degree of congruence between the person's vocational orientation and his environment. Since some of these environmental orientations are characteristic of different subject matter in school; it might be possible to use these terms to measure the match between a student and his classroom environment.

The psychosocial characteristics dimension is the most throughly investigated of all the six dimensions suggested by Moos (1973);

The psychosocial characteristics dimension is the most throughly investigated of all the six dimensions suggested by Moos (1973); it measures the perceived climate of organizations in terms of general norms, value orientations, and other psychosocial characteristics of the environment.

Insel and Moos (1974) have developed nine different scales to measure the perceived climate in nine different organizations, e.g. classroom, mental health ward, industry. At least eight other organizational climate scales have been developed. These include:

1. Organizational Climate Index (Stern, 1970)
2. College and University Environment Scale (Pace, 1970)
3. Learning Environment Inventory (Walberg, 1969)
4. Organizational Climate Description Questionnaire (Halpin and Croft, 1963)
5. Agency Climate Questionnaire (Schneider and Bartlett, 1970)
6. Climate Questionnaire (Litwin and Stringer, 1968)
7. Institutional Functioning Inventory (Peterson, 1970)
8. Dimensions of Group Processes (Fairweather, 1969)

A good way to describe the psychosocial characteristics dimension is in terms of the patterns underlying this dimension. Insel and Moos (1974), after studying nine different environments, concluded that three patterns underly all of these different psychosocial environments: (a) a relationship dimension, (b), a personal development or goal orientation dimension, and (c) a system maintenance or change dimension. Insel and Moos (1974) concluded that each of these patterns "must be accounted for in order for an adequate and reasonably complete picture of the environment to emerge" (p. 186).

> Relationship dimensions identify the nature and intensity of personal relationships with the environment. They assess the extent to which individuals are involved in the environment and the extent to which they support and help each other....Personal development dimensions consider the potential or opportunity in the environment for personal growth and the development of self esteem....System maintenance and system change dimensions assess the extent to which the environment is orderly and clear in its expectations, maintains control and is responsive to change. (Insel and Moos, 1974, p. 181)

The last dimension of the environment to be discused is the reinforcement dimension; this dimension is an outgrowth of social learning theory.

> The social learning theorist takes as a given that people vary their behavior extensively in different social and physical environments, mainly because the reinforcement consequences for particular behaviors vary extensively.... Social learning theorists attempt to identify the exact controlling stimulus conditions for particular behaviors, for example, the specific models involved, the substantive reinforcers, and the precise discriminative stimuli. (Moos, 1973, p. 658)

The reinforcement dimension of the environment is highly idiographic and assessment procedures are complex. Therefore, the present author suggests that this dimension be ignored in the search for differential learning effects.

This review has attempted to demonstrate the nature of the treatment/environment domain, and that methods have been developed for measuring this domain. The purpose of this demonstration is to show that the treatment/environment domain, in one form or another, is a significant determinant of human behavior, in general, and classroom learning in particular.

Insel and Moos (1974) suggest that attributes of the environment have accounted for more of the variance in behavior than biographic, demographic or trait variables (Douglas, 1964; Mischel 1969; Wolf, 1966).

> Psychology has shown increased interest in the environment. This interest has arisen in part because of dissatisfaction with trait conceptulaizations of personality, in part because of low correlations obtained between measures of personality traits and various validity criteria, and in part because of growing evidence that substantial proportions of variance in behavior are accounted for by situational and environmental variables. (Moos, 1973, p. 652)

Psycho-Social Characteristics of Instructional Environments

Several studies have shown that the psycho-social characteristics of the instructional environment accounted for a significant proportion of the variance in measures of school learning. For example, Walberg (1969) showed that student perceptions of high school physics class environments predict cognitive and non-cognitive measures of learning after IQ, initial achievement, and interest in the subject matter, were statistically removed from the analysis.

Walberg (1969) used the scales from the Learning Environment Inventory to predict learning on three different measures of high school physics achievement. R^2 from this analysis ranged from .18 to .30, i.e. the psycho-social environment of the classroom accounted for approximately twenty-five percent of the variation in physics achievement! This analysis was based on classroom averages, rather than on individual scores.

Review of the Aptitude Dimension

Introduction

Experts are in general agreement that individual differences in the subject or student should be considered in ATI research. However, there is general disagreement on the name for these characteristics of the individual and the nature of the individual difference variables which will be most profitable for the study of ATI's.

Three names have been suggested to describe characteristics of the individual: aptitude, trait, and attribute. Cronbach and Snow (1969) define aptitude as "any characteristic of the individual that increases (or impairs) his probablity of success in a given treatment" (p. 7). However, Berliner and Cahen (1973)

> believe that 'trait' is a less restrictive term than others. Under it we have included personality, status, attitude and interest variables, but other researchers might not include these characteristics in their definition of trait or aptitude. The label is not important as long as the concept conveys the idea that individual differences variables interact with educational treatments. (p. 59)

Tobias (1976) prefers the term attribute, because aptitude has been traditionally associated with the cognitive domain. This association has the subtle bias of causing investigators to look to the cognitive domain for their inidividual difference variables. Tobias (1976) also rejects the term trait noting that it

> usually suggests a stable predisposition, and not infrequently in the personality domain, is unchanging over short periods of time....The term attribute in ATI research appears most attractive since it both retains the most widely used abbreviation for this body of work, and does not limit, intentionally or unintentionally, the range of variables studied. (p. 62)

Rhett (1972) agrees with Tobias. Rhett prefers the term attribute, because it implies that any individual difference variables is fair game.

> not just those constructs measured by conventional aptitude tests....Thus the term attribute is broad enough to include any individual difference or learner characteristic variable which proves to be empirically useful. (p. 270)

The distinction between aptitude, trait and attribute may seem like quibling to the reader, but there is an important issue here: Should the researcher restrict in any way the characteristics of the individual difference variables used in ATI research? Despite their different viewpoints all of the above authors agree that no restriction should be placed on the individual difference variables. To avoid confusion the present author will refer to all individual difference variables as aptitudes.

If the researcher wants to avoid restricting the aptitude variables, then he should look closely at the history of the variables he is interested in. It should be remembered, that

> the differential psychologist looks for person characteristics whose validity is not threatened by variation across situations or over time. A major criterion for an acceptable characteristic is consistency and stability [i.e. the variable should be insusceptable to environmental variation]. (Hunt, 1975, p. 212)

Given this design history, i.e. most aptitude variables used in ATI research were developed to be consistent and stable, and not for their ability to predict differential effects, it is not surprising that few ATI's have been found.

Because most measures of individual difference were not designed to predict interactions, Glaser (1972) and Hunt (1971) suggest that we search for "new aptitudes" or "accessibility characteristics" of persons which will predict which type of person to assign to which educational environment.

Glasser (1972) notes that aptitude tests were developed to predict the outcome of instruction, and that there is no logical reason why the same tests should predict which instructional strategy will be best for each student.

Now that the different definitions of aptitude have been discussed, it is time to select aptitude variables which are likely to interact with treatment variables. For an aptitude variable to be successful in an ATI, the regression slope of outcome onto aptitude must differ from treatment to treatment.

The first aptitude variable Cronbach and Glasser (1957) ruled out as an ATI variable was traditional scholastic aptitude. Because it was such a general measure of school success, they expected scholastic aptitude to have the same predictive validity for almost any kind of instruction. They believed that "only specialized aptitude measures could be expected to forecast differential success" (Cronbach and Snow, 1975, p. 119).

> The special ability hypothesis got off on the wrong foot. Between 1960 and 1970, many of us searched fruitlessly for interactions of abilities in the Thurstone or Guilford systems...No interactions of this sort were found...Contrary to our original view, conventional tests of mental ability or level of educational development do interact. They predict how much is learned from most instruction of fixed duration. (Cronbach and Snow, 1975, p. 119)

So Cronbach and Snow's (1969, 1975) first choice for an ability variable to use in ATI research is "general ability". They suggest that

> The term is used in our summary to capture in one verbal net: IQ, non-verbal IQ or more specialized tests of fluid ability, such as hidden figures, composites of crystalized ability acquired in school and collections of cognitive tests in the French and Guilford series. The reason for application of a broad, loose construct is that at present there is no evidence to support a more refined conclusion. (Cronbach and Snow, p. 185)

Cronbach and Snow's (1969) second choice for an aptitude variable in ATI research "is to pit the fluid and crystalized segments of general ability against each other" (p. 190).

Theories of Intelligence

Since the present study used general ability as an aptitude variable, the major theories of intelligence were reviewed to determine the best way to measure general ability. These theories include: Binet's, Spearman's, Thurstone's, Vernon's, Guilford's, and Cattell's.

Binet and Terman proposed a single factor theory of intelligence. For example, Terman defined intelligence as the ability to think in abstract terms, i.e. in terms of a single factor. Thus their intelligence tests were heavily loaded on verbal ability, and predict achievement on verbal tasks well. However, these theories do not predict achievement on non-verbal tasks very well, and thus are only of historical importance.

Spearman's two factor theory of intelligence has had considerably more impact on the theory of human abilities.

The thesis of Spearman's theory is that "any cognitive performance is a function of two factors--the general ability common to most cognitive performances and an ability specific to a given test" (Cattell, 1968). Thornburg (1973) provides a more detailed explanation.

> Spearman proposed that there is a controlling capability (g factor) in all intellectual functioning and that this is the predominant factor called upon and measured in most intelligence tests....He also suggested that there are specific abilities (s factors) which are fairly insignificant in terms of the total functioning of the individual but which overlap and form certain group factors--verbal ability, numerical ability, mechanical ability, attention and imagination or creative ability--that are not always highly correlated with the individuals general capability or g factor. (p. 218)

The g factor shows its greatest influence on the verbal-abstract content so common in educational settings, e.g. reasoning tests where the individual is asked to discover a relationship. Thus, Spearman's g seems closely allied with the general intelligence concept used by Terman.

However, some test batteries contained tests which could not be accounted for by g alone. These test batteries usually contained two tests with very similar content, e.g. two vocabulary tests. Factor analysis produced factors which were broader than the s factors but narrower than g. Spearman finally modified his theory to include these broad ability factors which he called group factors.

> In retrospect, 'The general factor which Spearman sought is now regarded as being a second order factor rather than a primary factor, and it is thought to consist perhaps of two factors--fluid and crystalized genral intelligence.' (Catell, 1968, p. 110)

It is important to note that Spearman's theory was based on one particular type of factor analysis, which produced one general factor and several specific, bipolar factors. Originally, this method was based on a tetrad-difference criterion; later the centroid method was used. Mathematically, the centroid method must produce a general factor and bipolar specific factors. Other methods of factor analysis will produce a different pattern of factors. Traditionally, the centroid method and Spearman's theory of g has been preferred by British psychologists.

In America, Thurstone took another approach to the problem

> Instead of asking whether the correlation coefficients support a general factor, he wondered how many factors must be postulated in order to account for the observed correlations. The power of this approach lay in its ability to establish in the case of any particular study whether or not one factor should be regarded as general. (Adkins, 1968, p. 24)

The British approach to the factor problem, i.e. the centroid method, is to measure g first and account for as much of the test variance as you can in terms of g alone. To test his own theory of intelligence Thurstone developed Multiple Factor Analysis; this method makes no hypothesis about the number of factors which will be produced. It tends to produce factors which all account for about the same proportion of variance (as opposed to one general factor), and rotates the factor loadings to simple structure.

Thurstone applied multiple factor analysis to a battery of tests administered to a sample of college students and a sample of eighth grade students. These studies yielded seven factors in common. Thurstone called these factors "primary mental abilities"; they include:

> S (Space) Visualization of geometric figures in different positions in space.
>
> N (Number) Quickness in making arithmetical computations of all kinds.
>
> P (Perceptual Speed) Quick noting of details.
>
> V (Verbal Meanings) Grasp of ideas and meaning of words.
>
> W (Word fluency) Speed in manipulating single and isolated words.
>
> M (Rote memory) Facility in memorizing words, numbers. letters and other simple materials.
>
> I (Induction) Ability to extract a rule common to several parts of a problem or test.
>
> These same factors have been identified again and again in later investigations, and others have been added to the list. (Tyler, 1974, p. 77)

The trend in American psychology has been to factor analyze test batteries which measure only one of the primary mental abilities, e.g. perceptual speed. This results in factors which are still more primary and more specific. For example, when a battery of tests measuring perceptual speed is factor analyzed, at least eight perceptual speed factors are commonly found (Tyler, 1965).

Guilford brought some organization to the rapidly expanding number of "primary abilities" by suggesting a three dimensional model for classifying abilities. His "Structure of Intellect" model contains space for 120 factors of intellect. Approximately 103 of these factors have been identified.

In Britain, Vernon has become the prime exponent of Spearman's theory of intelligence. Vernon's theory is called a hierarchical theory of mental organization. Like Spearman, this theory extracts the g factor first, and places it at the top of a hierarchy. Vernon expands on Spearman's work with group factors and has identified two broad group factors which fall at the next lower level in the hierarchy; these factors are v:ed, and k:m.

V:ed represents a complex of verbal-educational abilities which are important in all kinds of school work. Within this group factor, separate verbal and numerical abilities can be distinguished. K:m represents the complex of abilities that are important in understanding concrete and mechanical things. Within this group factor, spatial and mechanical abilities have been identified.

The lower levels in the hierarchy, i.e. levels below v:ed, and k:m, don't seem to be very useful.

> Vernon presents statistical evidence that in school, military or industrial situations, where applied psychologists work, the relevant criteria can be predicted fairly well by using only, g, v:ed, and k:m ratings. The other narrower group factors contribute so little to the total variance in test and criterion scores that they can be safely ignored. (Tyler, 1965, p. 86)

The reader won't be forced to choose between the American or the British models of intelligence. Both models appear to be correct; they both point to the need for a hierarchical theory of intelligence. The primary mental abilities suggested by Thurstone turn out to be correlated with each other, i.e. a person who scores high on one ability will be likely to score high on the other primary mental abilities. Because these factors are correlated, it is possible to apply factor analysis again to the primary mental ability factor scores. This second order factor analysis produces second order factors which have some of the properties of Spearman's g. For example, Rimoldi (1948) found three second order factors; Cattell (1963), Cattell and Horn (1966) found five second order factors.

Tyler (1965) concludes that

> The type of theory, fitting all the effects best is a hierarchical system similar to the one Vernon proposes. Intelligence is both one thing and many things. When we attempt to measure its general component, we always leave some portion of the intellectual performance of our subjects unaccounted for. When we attempt to measure narrower abilities separately--verbal, spatial, perceptual--we always find that something they have in common makes scores on separate traits correlate positively with one another. To describe an individual's mentality accurately we need to specify both _level_ and _pattern_. (pp. 93-94)

It would be simpler if intelligence were either g or primary mental abilities, but the data do not support this point of view. Historically, this is not the first time a debate was resolved in favor of both theories of a phenomenon. Physicists debated for nearly fifty years about the nature of light: was light composed of waves or particles? Data could be found to substantiate both hypothses. It was finally conceded that both theories were necessary to adequately explain the behavior of light; light sometimes behaved as a particle, and sometimes as a wave.

However, the problem of intelligence is not completely resolved. Spearman's theory suggests that there is one second order factor, g. As mentioned above, three to five second order factors have been isolated.

Cattell has done the most experimental work with these second order factors; he theorizes that "the g (general factor of intelligence) measured by intelligence tests is actually made of two factors" (Cited in Thornburg, 1973. p. 220). These factors are crystalized intelligence (G_c) and fluid intelligence (G_f). Cattell's theory gives both a contemporaneous and a developmental perspective of intelligence.

The contemporaneous aspects contain all of his basic concepts and will be discussed first. The main thesis is:

> that in a broad sampling of human abilities, there are two major dimensions, both included in the area semantically called 'intelligence'....At work in both the fluid and crystallized intelligence is that relation-perceiving, correlate educing capacity which Spearman first described as the essence of 'g'. (Horn, 1968, p. 554)

Intelligence is manifested by the use of three different types of behavioral functions: analage functions, concept formation and concept attainment, and the use of "generalized solution instrument functions", which Cattell refers to as "aids". Fluid and crystalized intelligence make different uses of these functions.

Analage functions "represent very elementary capacities in perception, retention, and expression, as these govern intellectual performance" (Horn, 1968, p. 343), e.g. span of attention. Analage functions are not much affected by learning and to some extent, operate in all intellectual performances. They involve central neural organizations which are a necessary part of all intelligent behavior.

Generalized solution instruments, i.e. aids, are learned functions used to compensate for the limitations of analage capacities. For example, breaking a seven digit telephone number into two chunks so that it can be remembered. "Aids are what Harlow described as 'learning sets', often what Piaget discusses as 'operations' what Bruner and his co-workers have treated as 'strategies'" (Horn, 1966, p. 555). Aids can be placed on a continuum of accessibility. Easily accessible aids are available to all members of a culture. Restricted aids are those which are available to a limited few, e.g. algebra, and calculus.

The third behavioral manifestation of intelligence is the concept formation function.

> The term concept, as used in the present theory, is in many respects similar to an aid. However, a concept is regarded as a category for classification of phenomenon, whereas, an aid is defined as a technique or method. In the formation of most concepts one must perceive the essential relations among phenomena and, on some basis of similarity, dissimilarity, etc., categorize different things as the 'same.' (Horn, 1968, p. 244)

Fluid intelligence is not a measure of hereditary potential but it is

> the most direct correlate of basic neural-physiological capacity, and is the purest behavioral representation of this....[Fluid intelligence is] a pattern of behavior resulting from the interaction of brain physiological capacity with a broad, common, environmental-developmental set of influences. (Horn, 1966, p. 554)

Two of the major influences on fluid and crystalized intelligence are physiological influences and acculturation. In fluid intelligence a large proportion of the variance is accounted for by physiological influences and a small proportion of the variance is attributed to acculturation.

Crystalized intelligence is a manifestation of the interaction between experience, education, and acculturation. A large proportion of the variance of crystalized intelligence is accounted for by acculturation, and a small proportion by physiological influences.

Developmentally, crystalized intelligence is shaped by acculturation. The culture chooses, from the thousands of concepts and aids available, those few concepts which are necessary for the survival of the culture.

> These constitute what might be called the 'intelligence of the culture'...the analage capacities of the individual are thus harnessed, as it were, by the dominant culture for the purpose of maintaining and extending the 'intelligence of the culture.' (Horn, 1968, p. 246)

Many of the concepts and aids learned by acculturation indicate intelligence. So, the factor which results from this pattern of influences is justifiably referred to as a kind of intelligence, i.e. crystalized intelligence.

Another process is operating on the individual at the same time as acculturation, i.e. incidental learning. Incidental learning is the result of the child's manipulations and experiments with his environment, and is not the result of efforts by those who would educate him. This incidental learning will produce, analage functions, concepts and aids. If these abilities indicate intelligence, "then the broad factor which involves them can be said to be a kind of intelligence." (Horn, 1968, p. 247), i.e. fluid intelligence.

Both fluid and crystalized intelligence use analage functions, and both demand an awareness of concepts and the use of aids. However, fluid intelligence is based more on the use of those analage functions and aids which are available in the immediate environment. While crystalized intelligence is based more on the recall of concepts which are not commonly available to all individuals.

> However, the major difference between Gf and Gc is that the concepts and aids involved in the former are of a kind that reflect relatively common experience acquireable anywhere in our physical world, whereas the concepts and aids which define crystalized intelligence more nearly represent degree of immersion in a particular culture. (Horn, 1966, p. 556)

Fluid and crystalized intelligence should produce different physiological changes in the central nervous system. Horn (1968) suggests that the incidental learning produced as the result of fluid intelligence is based on relatively simple neural patterns, which do not form an integrated cognitive structure. However, the intensive acculturation so characteristic of crystalized intelligence will produce a relatively complex pattern of neurons which is highly integrated into the cognitive structure.

When testing for fluid intelligence two areas should be sampled:

1. Those primary abilities which are "defined by the limits of analage functioning in the immediate situation." (Horn, 1966, p. 558)

2. Those primary abilities which involve the use of aids which could have been learned by anyone.

When testing for crystalized intelligence,

> [1] those primaries indicating the limits of the individuals acculturation, and [2 those] involving the use of aids which are clearly produced by the educational process would be hypothesized to define the crystalized general intelligence factor. (Horn, 1966, p. 558)

Developmentally, this theory of intelligence argues that at birth, only fluid intelligence exists. During childhood, crystalized intelligence begins to develop, and as the child ages, both fluid and crystalized intelligence improve rapidly. Fluid intelligence stops improving when physical growth ceases. It declines slowly, and then more rapidly as aging continues. The degenerative diseases of aging should produce greater changes in fluid intelligence than in crystallized intelligence, because the neural patterns associated with fluid intelligence are not well integrated into cognitive structure. Crystalized intelligence should improve into adulthood as long as acculturation stays ahead of the degeneration of analage functions associated with aging.

> The general conclusion to be drawn from these investigations is the effect that, indeed, two broad factors having the properties specified by the G_f-G_c theory are found among ability test performances. (Horn, 1968, p. 248)

Two aptitude variables were of special interest in the present study: general ability and the contrast between fluid and crystalized intelligence. Data on four other aptitude variables was collected for the present study: sex, age, race, and grade point average (GPA). The primary purpose for including these variables is to provide a better description of the sample characteristics.

The present study was not powerful enough to include these secondary aptitude variables as predictors in the proposed model of classroom learning. In fact the present study was not powerful enough to examine both general ability and the contrast between fluid and crystalized intelligence. Because of their importance, measures of fluid and crystalized intelligence were combined to measure general ability. (See Chapter III) This looses some valuable information, but the problem could not be avoided.

Review of the Dependent Variables

Introduction

The primary interest of the present study is classroom learning. Only two aspects of classroom learning were used as dependent variables: (1) initial learning, i.e. performance on a cognitive posttest, and (2) retention, i.e. performance on a parallel form of the cognitive test administered two weeks after the completion of the experimental unit.

Referent generality would have been increased if other aspects of classroom learning were included in the present study. Attitude toward the content of instruction, and transfer were the prime candidates for additional aspects of classroom learning. Attitude was eliminated as a dependent variable for the following reason: Attitude toward the instructional unit was confounded with attitude toward the course. That is, it was impossible to separate the student's attitude toward all the material he has received during the course, from his attitude toward the content of the instructional unit.

Transfer was eliminated as a dependent variable because the amount of time available for student posttesting was very limited, i.e. 30-45 minutes. It seemed much sounder to devote the available time to measuring cognitive performance well, rather than to split the testing time by also measuring transfer. The dependent variables used in the present study were initial learning and retention. These variables represent two aspects of classroom learning. Before these dependent variables can be reviewed, it is necessary to define what is meant by "classroom learning."

Constructs Needed for an Operational Definition of Classroom Learning

Few definitions of classroom learning were found by the Review of Literature. The definitions which were found were often inconsistent. Since classroom learning was not a well defined construct, the present author will operationally define classroom learning, and will base the measurement of the dependent variables on this operational definition. This definition was based on two constructs: (1) the distinction between meaningful and rote learning (Ausubel, 1968), and (2) the taxonomy of human capabilities developed by Gagné (1974). The sequel will review both of these constructs. The end product of this review will be an operational definition of classroom learning.

Meaningful Versus Rote Learning

Ausubel (1968) makes the distinction between rote learning and meaningful learning.

> Meaningful learning takes place if the learning task can be related in nonarbitrary, substantive, (non-verbatim) fashion to what the learner already knows, and if the learner adopts the corresponding learning set to do so.

> Rote learning occurs if the learning task consists of purely arbitrary associations, as in paired-associate, puzzle-box, maze, or serial learning; if the learner lacks the relevant prior knowledge necessary for making the learning task potentially meaningful; and also (regardless of how much potential meaning the task has), if the learner adopts a set merely to internalize it in an arbitrary, verbatim fashion (that is, as an arbitrary series of words). (p. 24)

In the classroom meaningful learning is clearly the dominant type of learning. "Both within and outside the classrom, meaningful verbal learning is the principle means of acquiring large bodies of knowledge" (Ausubel, 1968, p. 24).

> Meaningful learning is so important in the process of education because it is the human mechanism par excellence for acquiring and storing the vast quantity of ideas and information represented by any field of knowledge. (Ausubel, 1968, p. 58)

Despite the clear importance of meaningful learning to education and to the psychology of learning, there have been surprisingly few studies of meaningful learning. Rote learning has dominated the psychology of learning. Two of the classic textbooks on learning theory do not even mention the topic of meaningful learning (Hilgard and Bower, 1966; Hilgard and Marquis, 1961). Because of this emphasis upon rote learning tasks, much of the information on human learning was not appropriate for the present review.

Gagne's Taxonomy of Human Capabilities

Gagne (1974) suggests that there are five major categories of learned human capabilities: (1) verbal information, (2) intellectual skills, (3) cognitive strategies, (4) attitudes, and (5) motor skills. These learned capabilities constitute five different types of learning outcomes. Each of these capabilities would be an adequate dependent variable for the study of classroom learning. The present study focused on the first two of these capabilities (verbal information, and intellectual skills) because these capabilities seemed to have the widest application in education.

The remaining three capabilities were rejected as dependent variables because of the limited amount of educational time aimed at learning these capabilities. For example, a great deal of rhetoric is devoted to the goal of teaching students to think, i.e. cognitive strategies but very little time is actually spent in pursuit of this goal; Gagne and Briggs (1974) suggest that it may take months or years to learn cognitive strategies; it is debatable whether the goal is even achievable.

The same comments can be made about teaching attitudes; there is no doubt that attitudes are learned in school, but this type of learning occurs in a haphazard fashion, and an insignificant amount of class time is actually directed to the learning of attitudes. Motor skills are taught successfully and systematically in school. They were rejected as a dependent variable primarily because a small portion of a students 12 years in school is actually devoted to learning of motor skills.

Verbal Information. "Verbal information is man's primary method of transmitting accumulated knowledge to successive generations about the world and its peoples, about historical events and trends, about the culture of a civilization" (Gagne, 1974, p. 52). Gagne identifies four units of verbal information: a name, a fact, a principle, and a generalization. When an individual has learned a unit of verbal information he is able to state the information in propositional form, i.e. a sentence. Organized bodies of verbal information are commonly referred to as knowledge.

Verbal information performs three useful functions for the learner: (a) it serves as a prerequisite for further learning. (b) it is of practical importance to the learner during his entire lifetime. (c) "Organized and associated bodies of knowledge are believed to provide a vehicle for thought" (Gagne, 1974, p. 54).

Intellectual Skills. The capability learned from verbal information is, "to know that". The capability learned from an intellectual skill is "to know how". "An intellectual skill makes it possible for an individual to respond to his environment through symbols" (Gagne, and Briggs, 1974, p. 12).

Gagne (1970) has identified eight levels of intellectual skills (see Table II). These eight levels form a hierarchy of intellectual skills. Skills higher in the hierarchy require more intricate mental processes than skills lower in the hierarchy. In addition, higher level skills are composed of lower level skills. That is, skills lower in the hierarchy are prerequisites for learning higher level skills.

Gagne and Briggs (1974) believe that "The lower levels (1 through 4) do not normally play a substantial role in school learning." (p. 37) Discrimination learning (level 5) is necessary for learning higher level intellectual skills. Gagne (1970) believes that for the most part, discrimination learning does not play an important role in classroom learning at the eighth grade and high school levels.

Levels one through five of Table II are not relevant to classroom learning at the eighth grade and high school levels. The sequel will explore the possibility of using concepts, rules and problem solving

TABLE II

LEVELS OF COMPLEXITY IN INTELLECTUAL SKILLS

Level	Intellectual Skill	Verb Which Describes Intellectual Skill
8	Problem Solving (Higher Order Rule)	Generates
	requires as prerequisites:	
7	Rules (Including defined concepts)	Demonstrates Classifies
	requires as prerequisites:	
6	Concepts	Identifies
	which requires as prerequisites:	
5	Discriminations	Discriminates
	which requires as prerequisites:	
4	Verbal Associations	
	which requires as prerequisites:	
3	Chaining	
	which requires as prerequisites:	
2	Stimulus Response Connections (i.e., operant conditioning)	
1	Signal Learning (i.e., classical conditioning)	

Source: Gagne, R.M. and L.J. Briggs. Principles of Instructional Design. New York: Holt, Rinehart and Winston, 1974.

(levels six through eight of Table II) in an operational definition of classroom learning.

Concept learning "makes it possible for the individual to respond to things or events as a class" (Gagne, 1970, p. 172). "A concept is a capability that makes it possible for an individual to identify a stimulus as a member of class" (Gagne and Briggs, 1974, p. 40). For example, picking the blue object from a set of colored objects. Concept learning by Gagne's definition refers only to concepts with attributes which can be directly observed, i.e. concrete concepts. Concrete concepts are of fundamental importance for more complex learning. Piaget has suggested that concrete learning is a prerequisite to the learning of abstract concepts.

Concept learning is different from all lower levels of learning because it permits the learner to generalize the concept to objects which were not in the original learning situation. For example, once the learner knows the concept blue, he should be able to correctly identify any blue object he is presented with.

In contrast, defined concepts deal with more abstract observations than concrete concepts. Concepts are learned by definition when the attributes of the concept cannot be identified by pointing them out. "An individual is said to have learned a defined concept when he can demonstrate the 'meaning' of some particular class of objects, events, or relations" (Gagne and Briggs, 1974, p. 42). That is, the learner must be able to identify the referants of the words used in the definition. It is essential that the learner demonstrate the meaning of the concept. This demonstration is necessary to distinguish the learner who has rotely memorized the concept from the student who truly understands the concept in a meaningful way.

A defined concept relates two or more simpler concepts. For example, an uncle is the brother of a father. The two concepts being related are brother and father. A defined concept allows the learner to correctly identify examples of the concept; however in the process of demonstrating that the learner knows a defined concept, he must show how the attributes of the concept are related. Thus, a defined concept is really a classifying rule, and so is just a special instance of the intellectual skill called a rule.

Gagne (1970) suggests that

> rules are probably the major organizing factor, and quite possibly the primary one, in intellectual functioning. The S-R connection, once proposed as the unit of mental organization, has now been virtually replaced by the rule in the theoretical formulations of most psychologists....the preponderance of observed human behavior occurring in natural situations is rule governed. (p. 191)

"A rule is a learned capability which makes it possible for the individual to do something, using symbols (most commonly, the symbols of language and mathematics)" (Gagne, 1974, p. 61). More formally stated, "A rule is an inferred capability that enables the individual to respond to a class of stimulus situations with a class of performances" (Gagne, 1970, p. 191). The stimulus situation is related to the response by a class of relations. For example, to change an adjective to an adverb, the learner needs to add "ly" to the adjective. This rule can also be stated as adverbs equal adjectives plus an "ly" suffix. Under this rule the learner is responding to a class of stimulus situations, (all adjectives) with a class of relationships (adding ly) (see Table III).

> Defined concepts are not formally different from a rule, and are learned in much the same way....it is a particular category of rule whose purpose is to classify objects and events....Rules, however, include many other categories

TABLE III

THE CHARACTERISTICS OF CONCRETE CONCEPTS, DEFINED CONCEPTS AND RULES

Type of Intellectual Skill	Examples	Defining Verbs
Concrete Concepts: A common response to a class of Objects. Concrete concepts occur: by:		Identifies examples by pointing.
(1) Direct observation of attributes	square, triangle, red	
(2) when attributes are related by conjunction	A and B	
(3) generalizing to novel instances	cell membrane	
Prerequisitates: Discrimination of attributes.		
Performance: Make the same responses to different stimuli by identifying examples of the concept.		
Object Concepts: are the nouns of sentences, i.e. things.		
Place Concepts: are also nouns and sometimes prepositions	above, below ontop of, underneath, next to, the middle one	
Event Concepts: are generally represented by verbs.	take, stay, raise, put above, below,	
Object Position Concepts: the position of one object must be in relation to another object. These positional attributes can be pointed to in some manner.	besides, surrounding, right, left middle, in front of	
Object Qualities:	color, round, shape, square, pointed soft, hard, smooth, up down, outside, inside, far, near, right, middle, above, equal	
Relational Concepts: are		
Rules: a chain of concepts, i.e. two or more concepts are linked together.	Rules of syntax and punctuation.	Demonstrate a relationship between the referents.
Prerequisites: the referent concepts must be understood.		
Performance: a class of responses which shows how the referents are related.	Adjectives puly ly equals adverbs. Millimeter equals .04 inches.	
Two Concept Rule:	Liquids pour. Birds fly.	
Three Concept Rule: Two object concepts plus a relational concept.	Pint doubled is a quart	
Defined Concepts: a sentence must be used to identify a class of things. It is not possible to identify the entire class of the concept with concrete examples; it represents a general class which can not be adequately defined by a few examples.	obstacle, pivot, uncle, suburb	Demonstrate by classifying. The student must be able to identify the component concepts and show how they are related.
Some concrete concepts gain added meaning by being defined.	Three, circle, flower	

besides classifying. (Gagne and Briggs, 1974, p. 44)

The purpose of a defined concept is to distinguish between different ideas. The purpose of other rules is to enable the learner to respond to different situations by applying classes of relationships. These two types of rules serve different purposes for individual behavior, but they are not distinguishable in terms of their learning properties alone (Gagne, 1970).

The highest level of intellectual skill is problem solving or the construction of higher order rules. Problem solving is very similar to the learning of rules. The major difference is that the learner discovers the higher order rule or solves the problem for himself. The problem, also, must be one which the student has not encountered before. To solve the problem the learner must recall relevant subordinate rules and information and invent or discover a solution.

This section reviewed the eight levels of intellectual skills suggested by Gagne (1970) (See Table II). Only one of these levels i.e. rules is useful to an operational definition of classroom learning. Levels one through four were excluded from the operational definition because they do not play a substantial role in school learning. Level five, discrimination learning, was excluded because it does not play a large role in the classroom learning of eighth grade and high school students. Level six (concrete concepts) was excluded for the same reason as level five; most concrete concepts are learned before junior high school. Finally, level eight, i.e. problem solving, was excluded from the operational definition because it does not occupy a prominent place in the curriculum, i.e. it is not an educational outcome to which much class time is devoted. In contrast, the present author believes that the majority of class time at the junior high and high school levels is devoted to the learning of verbal information and rules, including defined concepts (Ausubel, 1968; Gagne, 1970).

Operational Definition of Classroom Learning

All of the constructs needed for an operational definition of classroom learning were defined above. The essential feature of this definition is that it realistically reflects the type of behavior commonly learned in eighth grade and high school chemistry classes. So classroom learning is defined as: a cognitive change which results from the student's exposure to a predominantly, meaningful learning task. The majority of the time this cognitive change is the meaningful learning of verbal information or rules.

> Meaningful learning takes place if the learning task can be related in a nonarbitrary, substantive (nonverbatim) fashion to what the learner already knows, and if the learner adopts a corresponding learning set to do so. (Ausubel, Novak, and Hanesian, 1978, p. 27)

Section Summary

The operational definition stated above identified two types of learning as essential features of classroom learning: the meaningful learning of verbal information, and the meaningful learning of rules. Two additional aspects of classroom learning were identified earlier in this review: initial learning and retention. This suggests that to adequately measure clasroom learning four dependent variables are needed: the initial learning of verbal information and rules, and the retention of verbal information and rules.

Unfortunately, the present study was not powerful enough to analyze four dependent variables. This problem was solved by forming a composite of verbal information scores and rule learning scores. Thus only two dependent variables were used in the analysis. Initial learning test scores for verbal information and rule learning were added together and referred to as initial learning. Retention test scores for verbal information and rules were also added together. The basic reason for forming this composite of verbal information and rules is to limit the amount of time needed for analysis and to keep the experimentwise error rate within bounds. Although questions about the learning and retention of verbal information and rules would be interesting, they are not, by themselves, very representative of classroom learning. For all of the above reasons the present author believes that the purposes of the study were better served by the use of a verbal information/rule composite.

Dependent Variable Caveat

Before proceeding with the review the reader should note that the name "initial learning" is a misnomer. The unit of instruction contained approximately 100 separate learning events, (see the concept checklist in the methods section of Chapter III) and covered approximately three weeks of instruction. The actual acquisition of any of these capabilities could have occurred at any point during the instruction; even minutes before the initial learning test was given. Thus, it is impossible to determine when these capabilities were actually learned. It might be more appropriate to call the dependent variables first retention test and second retention test. These labels were not used, because they were not as descriptive of the present author's intentions as the labels initial learnng and retention.

Reasons Why the ATI Paradigm Has Been Unsuccessful

Since 1957 when Cronbach first introduced the concept of ATI, researchers have been looking for replicable, significant ATI's. However, this search has been almost fruitless. Even supporter's of ATI have conceded this point. For example, Berliner and Cahen (1973) concluded their review of ATI research with "cautious optimism" (p. 85). Cronbach and Snow (1969) suggest that

> Progress toward the goal of identifying and understanding ATI has been slight...There are no solidly established ATI relations even on a laboratory scale and no real sign of any hypothesis ready for application and development...[However,] it is inconceivable to us that humans, differing in as many ways as they do, do not differ with respect to the educational treatment that fits each one best. To abandon the ATI model is to assume that there is only one path toward educational development, and that individual differences have no implication save the fatalistic one, of telling the educator that some pupils will advance more rapidly than others no matter what he does. (p. 193)

Cronbach and Snow (1969, 1977) and others fervently believe in the ATI paradigm. With outstanding scholars like these supporting it, why has the ATI paradigm been unsuccessful?

There are four major reasons why the ATI paradigm has been unsuccessful. Before this paradigm is condemned, these flaws should be remedied.

1. A high degree of empiricism pervades the research; a better conceptualization of the ATI paradigm is needed.

2. The present model for finding ATI's is the trial and error method; better models of ATI are needed.

3. The methodology to analyze ATI's is inadequate; new methods need to be developed.

4. The basic dimensions of ATI are not understood; the measurement of the treatment environment dimension in particular, needs much improvement.

Inadequate Conceptualization of ATI (High Degree of Empiricism)

To the present author this problem is clearly the most serious. Each of the three remaining problem areas would be reduced if the penchant for empiricism was culled from the ATI paradigm. Other authors agree (Cronbach, 1966; Cronbach and Snow, 1969, 1977; Rhett, 1972)

Salomon (1971) suggests that

> There is a great need for more conceptualization, to reduce the very high degree of empiricism prevailing in research on instruction....Generating ATI data that do not suggest any explanatory principles, or that are not aimed at formulating them has relatively little practical value or theoretical import. (p. 328)

Poor conceptualization of ATI experiments is really the root of the problem with the ATI paradigm. The treatments chosen for the experiment are rarely choosen because of the psychological functions which they utilize. This usually results in two treatments which are very similar in the psychological functions they compel students to use.

For example, Salomon (1971) suggests that

> The two treatments in an ATI study differ in operational procedures but there is rarely a rationale which explains what psychological functions determine treatment effectiveness for one group of learners and not for another. (p. 328)

Since the psychological abilities required by the treatment are almost identical, e.g. high verbal, it is not surprising that an ATI is not found.

One of the major steps for improving the conceptualization of the ATI paradigm is to abandon the "trial and error method" for finding ATI's. Alternative models of ATI have been suggested by: Salomon (1971), Rhett (1972), and Hunt (1975).

Inadequate ATI Models

The "trial and error" method of finding ATI's is the most common ATI model being used today. Three alternative models are superior to this method and will be discussed in the sequel.

First, let me describe the "trial and error" method. "Two treatments are designed, and a large number of aptitude measures tossed in with the hope that some may lead to an ATI. Fortunately, some measures actually do lead to ATI's." (Salomon, 1971, p. 328)

Bracht (1970) gives a more expanded definition of the trial and error method.

> Experimenters usually selected alternative treatments and through trial and error tried to find personalogical variables to interact with treatments. The analysis of an interaction effect was often an afterthought rather than a carefully planned part of the experiment, i.e., the alternative treatments were not developed with the ATI concept in mind. This approach has not been successful for finding meaningful interactions. (p. 639)

The three alternative models of ATI to be discussed are not mutually exclusive. They address different aspects of the ATI model; so it seems reasonable to combine the better aspects of each of these models into one revised ATI model.

Salomon's ATI Model. Salomon (1971) developed three complementary ATI models: (a) remedial model, (b) the compensatory model, and (c) the preferential model. Each model refers to a different treatment and aptitude domain. Each model performs a different function, measures a different kind of aptitude, and leads to a prediction of a different type of ATI. These models help to clarify some basic issues in ATI research.

For example, there is a long standing argument over whether to measure specific learning abilities or general abilities. Salomon's models show that the abiities selected for study are a function of the treatment which is to be applied.

The basic assumption of the remedial model is that "some crucial ingredient of knowledge is deficient or missing, and no progress in learning can be expected unless the deficiency is overcome" (Salomon, 1971, p. 329). Thus, remedial instruction is needed to eliminate the deficiency.

This model assumes that learning is basically hierarchical or sequential, and that student deficiencies can be overcome by experiencing more of the same kind of treatment. That is, the student needs more time to learn, not a different method of instruction. The remedial model also assumes that the best predictors of an ATI will be highly task specific, achievement tests. General abilities are not valuable in predicting ATI's because they are composed of subordinate capabilities, which themselves, need to be learned (Salomon, 1971).

Salomon (1971) suggests three conditions when it would be useful to use a remedial model.

> (a) when task specific capabilities actually account for a large portion of the variance in the learning outcome.
>
> (b) when the learning material is hierarchically or sequentially ordered.
>
> (c) when all the subordinate objectives on the hierarchy are learnable as a function of instruction. (p. 332)

Under the compensatory model the treatment compensates for each learner's deficiency by providing the mode of presentation that the learner cannot provide for himself. Under this model deficiencies are left untouched; only their debilitating effects are circumvented.

Treatments are not designed to eliminate deficiencies, but rather to compensate for the deficiencies which exist. At first glance, the compensatory model seems to conflict with the remedial model. However, the models apply to different situations so their is no real conflict.

For example, (1) when a large proportion of the variance in the learning outcome is accounted for by general ability, then use a compensatory model. When a large proportion of the variance in the learning outcome is accounted for by task specific capabilities, then use the remedial model. (2) When the treatment can compensate for a learner's deficiency, then use a compensatory model. When a treatment can eliminate deficiencies in the learner by training on subordinate capabilities, then use the remedial model (Salomon, 1971).

The preferential model tries to capitalize on what the student is already capable of doing. It focuses on his strong points, e.g. preferred style of information processing, rather than on his deficiencies. The preferential model is based on matching the requirements of the treatment with one of the learner's higher aptitudes.

The term aptitude takes on a different meaning in the preferential model. Here is it most closely related to the "abilities" mentioned by Fleishman and Bartlett (1969)

> which are seen as representing a class of 'mediating processes' and which manifest consistencies over tasks. This is to be distinguished from skills, which are more closely related to task specific capabilities of the kind mentioned by Gagne. (Salomon, 1971, p. 335)

The preferential model also uses the term "matching" differently. "Matching" for the preferential model suggests

> that when treatment A is found to correlate with an aptitude of type a, it is necessary to find what the low a scorers are

> better able to do. Hence, it is a search for an aptitude that correlates negatively with aptitude a and also with learning from treatment A. Only then is it possible to design an alternative to treatment A that will call into use the kind of aptitude that low a scorers possess. (Salomon, 1971, p.335-336)

In designing ATI research, it is important to remember that the function of the treatment should determine which of the above ATI models to use. For example,

1. When the function of the treatment is to make up for the lack of mastery of the necessary prerequisites, then use the remedial model.

2. When a general ability or psychological state is called for, but it is too costly or impossible to modify, then the function of the treatment is to compensate for the deficiencies of the learner by providing him with the necessary mediators.

3. When the function of the treatment is to use the learner's other aptitudes which are stronger than the traditional aptitudes needed for the task, then use the preferential model.

Table IV gives a good summary of the three models and their major characteristics.

<u>Rhett's ATI Model.</u> Rhett's (1972) model for ATI is based on "Task Analysis". Like Cronbach (1966), and Salomon (1971) Rhett (1972) argues for improved conceptualization in the design of ATI research, and less dependence on empiricism. According to Rhett (1972), the best way to insure a conceptual basis for an ATI study is to base the design on a task analysis of the behavior of interest.

> The position to be developed here is that the researcher should begin first with careful analysis of the tasks students are being asked to cope with, and then design treatments or instructional approaches only after task analysis data have been used to conceptualize individual difference variables (attributes) found to be related to performance differences. The opposite tactic of beginning with either treatments or attributes has not yielded powerful or clear cut procedures or relationships. (p. 271)

TABLE IV

SUMMARY OF SALOMON'S (1971) ATI HEURISTIC MODELS

The Model	The Function of the Instructional Treatments	The Major Differences Between Treatments	The Kinds of Aptitude Measures Used	Predictions
Remedial	Treatments lead to mastery of necessary deficient subordinate objectives.	Amount of time spent on reaching mastery; number of remedial instructional sessions.	Measures task specific mastery. More general abilities are transformed into instructional objectives and are dealt with as if task-specific capabilities.	Proficient learners experience interference or boredom with excessive remediation; low proficiency learners benefit since they attain necessary subordinate objectives.
Compensatory	Treatments provide the learners with the necessary mediators, organization of materials, modality and the like, which they cannot provide for themselves; or circumvent debilitating effects of certain psychological traits or states. It is not assumed that the deficiencies need to be remedied	The extent to which the treatments provide overtly what learners would have to provide for themselves or the extent to which they neutralize the effects of certain traits or states.	Measures of general abilities, modes of information processing, general states or traits.	High aptitudes experience interference when given treatments which provide them with mediators they can provide on their own. Low aptitudes benefit when mediators they are lacking are provided overtly.
Preferential	Treatments call upon and utilize learners' higher aptitudes, neither making up for deficiencies nor compensating for them.	Differences may be in content, structure, modality of presentation etc. Each alternative treatment plays on aptitudes in which the learner is more proficient.	Measures of general abilities, modes of information processing, or motivation.	Each learner learns best when an aptitude in which he is proficient is called upon.

Rhett's (1972) concern for task analysis derives from his concern for the ecological validity of experimental tasks. He notes that,

> experimenters have tended to utilize short term, artificially contrived, and relatively simple tasks, which are noticeable (and possibly significantly) different from the contexts to which they wish to relat their findings. (p. 273)

The reader should note that Rhett is not the only person concerned with the ecological validity of experimental tasks; see Snow (1974), Salomon (1971), Bracht and Glass (1968), Shulman (1970).

Rhett (1972) developed a two stage design for conducting ATI research. During the first stage the research question should be, "Is there a task performance difference among learners on a specific attribute?" The research question for the second stage should be, "If a task performance difference has been found, can this difference be eliminated by means of a carefully designed treatment" (p. 279)? Thus the steps for conducting ATI research according to Rhett's (1972) model are:

Step one--

(1.1) select and analyze task
(1.2) determine likely attributes from task analysis
(1.3) collect performance data on task

Step two--

(2.1) devise treatment strategies based on task characteristics and on learner attributes
(2.2) collect performance data on ATI. (p. 279)

Hunt's ATI model. Hunt (1975) has proposed another model of ATI called BPE analysis (Behavior-Person-Environment). The first step in BPE analysis is for the experimenter to:

1. Identify the behavior he is interested in, i.e. dependent variables;

2. Identify the type of environment, i.e. the treatment or independent variables;

3. Identify the person variables, i.e. the characteristics of the subjects he is interested in.

Hunt believes that behavior is jointly determined by the environment and the person, i.e. person and environmental characteristics interact to produce a behavior.

BPE analysis is a much more general way of looking at ATI's. Hunt and Sullivan (1974) believe that ATI is excessively restricted by its dependence upon a statistical definition of interaction. Hunt and Sullivan (1974) suggest that two other criteria for defining interactions are possible: a theoretical definition and a personal definition.

> From a theoretical viewpoint the proof of an interaction is in its logical consistency....Implicit in the theoretical criterion is the necessity for conceptualizing the process underlying the interaction....The personal criterion involves the question, 'Does it make sense and fit in with past experience?' Is it [the interaction] intuitively reasonable? (p. 120-121)

Under the personal criterion for interactions, an interaction is significant if it seems reasonable, or if the observer has seen evidence for this type of interaction in his past experiences.

The BPE model is more general than the ATI model because it suggests that three types of differential effects should be investigated: a person-environment interaction, an environment-behavior interaction, and a person-environment-behavior interaction.

The first type of differential effect, the person-environment interaction, is the effect commonly associated with the ATI paradigm: the environment interacts with the person to produce an effect, i.e. behavior (Hunt and Sullivan, 1974). Although behavior is not mentioned in this phrase, it is implied that any interaction must specify the behavioral effect to which it applies.

It is very important to remember that person-environment interactions and ATI's do not take place in a vacuum; they exist in relation to some behavioral effect. The ATI model does not make this point very clearly, but the BPE model constantly reminds the researcher to look for the behavior.

The second type of interaction identified by Hunt and Sullivan (1974) is the differential effect of Environment on Behavior, different environments will be superior for producing different behaviors. An educational environment-behavior interaction suggests that different ways of teaching will produce different effects. For example, Worthen (1969) found that the expository method of instruction was superior to discovery learning when initial learning was the behavior of interest, but that the reverse was true, when retention or transfer were the behaviors of interest.

The third type of differential effect, the person-environment-behavior interaction needs to be distinguished from the person-environment interaction. Both interactions involve behavior. The person-environment interaction only looks at one behavior, i.e. outcome. The person-environment-behavior interaction looks at several behaviors or outcomes, and predicts that the interactions that hold for one outcome may not be present for other outcomes. For example, McLachlan and Hunt (1973) found that low conceptual level students performed better on a "subjective integration" task using the lecture method; high conceptual level students performed equally well using either the discovery or lecture method. Worthen (1969) as mentioned earlier found an environment-behavior interaction for discovery versus expository methods. These two studies taken together suggest that a person-environment-behavior interaction may be present.

Hunt and Sullivan (1974) suggests the following principles for conducting BPE analysis:

1. The BPE model does not contain a standardized definition of person, environment, or behavior. It holds that different theorists have different conceptions of these constructs, and that all definitions are acceptable.
2. "If one rejects a differential approach, then he must either accept the general effects model or find another alternative for taking account of differential effects." (p. 109)
3. "BPE analysis is not a theory itself, but a way of thinking about theories." (p. 109)
4. The behavior an interaction applies to must always be stated.
5. Multiple criteria should be used to evaluate the effectiveness of an interaction, e.g. empirical, theoretical, and personal.
6. One of the most basic procedures for describing an interaction is that "the person characteristic and the environment characteristic be described in somewhat comparable terms." (p. 125) Person-environment relationships should not be characterized in absolute terms such as high, low, large, small. Such terms as congruence, match, or fit are required. (See Pervin,

1968; Stern, 1970; Hunt, 1971)

7. Although the theoretical approach (for designing ATI studies) is likely to be more productive, one may also use an empirical approach, or 'go fishing' with a statistical dragnet. (p. 7)

Inadequate ATI Methodology

It was mentioned earlier that there are several major flaws in the present ATI paradigm. Two of these flaws have been discussed: (1) inadequate conceptualization of ATI, and (2) inadequate ATI models. The next flaw to be discussed is: the methodology to analyze ATI's is inadequate. Cronbach and Snow (1969) support this proposition. They concluded that "most of the methodology commonly used in aptitude-treatment interaction (ATI) research was weak and often wholly inappropriate for the uses intended" (p. vii).

The present author has identified four major methodological problems which need to be overcome before ATI research can make much progress:

1. Most educational and psychological researchers are using the wrong statistical model, i.e. the general effects model.

2. The criteria for evaluating an effective ATI are inadequate.

3. Weak methods are being used to analyze ATI data, i.e. Analysis of Variance!

4. The external validity of most research is inadequate.

Inappropriate Statistical Model. Probably the biggest roadblock to successful ATI research is the myth of the general effects model which most researchers still cling to. This model treats interaction as error variance, and thus regards any ATI which is found as a nuisance rather than as useful knowledge. The general effects model looks for systematic variation among either treatment or among subjects, but not both. Proponents of the general effects model believe that interactions between the person and the environment limit the generalizability of inferences, and pose a threat to the establishment of general principles in education and psychology.

For example, Bracht and Glass (1968) suggest that

> Generalization is the ability to make general statements about the effect of some treatment. Interactions between the treatment variable and characteristics of subjects, however, may limit the generality of inference, depending on the type of interaction. (i.e. disordinal interactions) (p. 444)

Hunt (1975) strongly disagrees with Bracht and Glass (1968), and other proponents of the general effects model. He believes that "In psychology, the general effects model is a myth, and it (the general effects model) has severely limited the cumulative acretion of knowledge" (p. 211).

The fact that Hunt (1975) believes the general effects model to be a myth, does not mean that all experiments will yield differential results, i.e. interactions. In fact if the differential effects model were adopted universally, general effects would still be the dominant finding. At issue here is not the value of general effects, but rather the value of differential effects. If researchers continue to shut their eyes to differential effects, they will not find them, even when they are present.

Vale and Vale (1969) suggest that

> interactions are a part of scientific life, and the time is long past when we could make a defensible case for choosing to ignore them. They are not the poor relations of main effects; in many circumstances it is from interactions that the interesting information is derived. (p. 1043)

The present author suggests that the general effects model is a special case of the differential effects model and can be subsumed under it. For example, during the early twentieth century a great debate in physics revolved around the theory of relativity. Some physicists lined up in favor of the theory, others were opposed; very few were neutral. The debate was settled in favor of the theory of relativity, because the opposing theory, Newtonian physics, turned out to be completely explainable in terms of the theory of relativity, i.e. Newtonian physics was simply a subset of the theory of relativity.

Inadequate Criteria for ATI. The second major methodological ATI problem is: the criteria for identifying the existence of an ATI are inadequate. The most commonly cited criteria for identifying an ATI are the criteria established by Bracht and Glass (1968). They use two criteria. First, a significant disordinal interaction must be present, i.e. the regression lines for each treatment must cross. Second, the appropriate mean scores for each aptitude-treatment cell must be significantly different.

Unfortunately, most ATI researchers have adopted the Bracht and Glass (1968) criteria for an ATI, despite the existence of several other methods for identifying an ATI. Berliner and Cahen (1973)

> feel that the technique for detecting disordinal interactions proposed by Bracht and Glass (1968) is overly conservative and perhaps unnecessary. It should be noted here that we believe ordinal as well as disordinal interactions can be used to advantage in TTI (i.e. trait-treatment interaction) research. (p. 61)

Bracht and Glass (1968) believe that ordinal interactions are of little value to the researcher since they do not prescribe different treatments to different students. However, the reader should note that ordinal interactions are valuable in at least two different situations: (a) when the cost of the alternative "better" treatment is much more expensive than the poorer treatment, students might be assigned to the poorer treatment in order to save money. (b) When the payoff or benefit of the better treatment is not large enough to offset the increased cost.

Berliner and Cahen (1973) suggest the following criteria for identifying interactions.

> Ordinal interaction is detected when a test of parallelism of regression slopes is rejected and the regression lines do not cross. Disordinal interaction is detected when a test of parrallelism of regression lines is rejected and the regression lines cross within the range of the measured trait. (p. 61)

As mentioned earlier, Hunt (1975) is opposed to the Bracht and Glass (1968) criteria of interaction. He suggested two additional criteria for identifying interaction, namely the theoretical criterion, and the personal criterion. In addition Hunt suggests that

> there is no logical reason why we should not use as the statistical criterion for the validity of a principle (in this case the principle is ATI's) the proportion of persons to whom it applies, and if this were done, the necessity for a person-environment interaction view would become quickly apparent. (p. 212)

A primitive but probably effective criterion for identifying an interaction is simply to "eyeball" the table of cross tabulations. If the differences between means are not readily apparent, then even if the interaction is statistically significant, it probably will not be educationally significant.

Weak Data Analysis Methods. The third methodological obstacle to progress in ATI research is the easiest obstacle to surmount. It only requires a little effort from researchers to learn a new analysis tool. The method of choice for ATI research is the general linear model (Rhett, 1972; Bracht and Glass, 1968; Cronbach and Snow, 1969, 1977; Berliner and Cahen, 1973).

Analysis of variance (AOV) is the usual data analytical tool for ATI research. Regression analysis (general linear model) will always be as powerful or more powerful a tool than AOV. When the independent variables for an AOV are continous variables, they are reduced to categorical variables in order to perform the analysis. Thus, the level of measurement is reduced and information is lost.

Regression analysis does not change the measurement scale of the independent variables; it uses all of the information available. However, when the independent variables are truly categorical, e.f. sex, analysis of variance and regression analysis yield identical results.

Inadequate External Validity. External validity in ATI and other research is often inadequate or non-existent. The solution to this problem will be as difficult to implement as trying to lure researchers away from the charms of the general effects model. The solution requires a major shift in the researcher's beliefs about the nature of research!

Most researchers go to great pains to insure the internal validity of their experiment, but give very little thought to the external validity of their experiment. If ATI research is going to become an effective research paradigm, ATI researchers must strike a more equal balanace between internal and external validity.

The key element in the design of the present experiment is the concept of external validity. Campbell (1957), and Campbell and Stanley (1963) introduced the concepts of internal and external validity of experiments. "Internal validity is the basic minimum without which any experiment is uninterpretable" (Campbell and

Stanley, 1963, p. 175). It is basically a logical issue, and asks the question, "can we infer that the experimental treatments are responsible for the observed effects?" That is, can alternative explanations for the experimental results be ruled out by the data collected?

External validity is the ability to generalize from the experimental findings to a group of subjects and a set of conditions which were not included in the experiment.

Campbell and Stanley (1963) have identified two sets of variables which can threaten the internal and external validity of experiments. Each of these variables represents a threat to the validity of the experiment, because it is a rival explanation of the experimental findings.

The threats to internal validity include: history, maturation, testing, instrumentation, statistical regression, selection, experimental mortality, selection-maturation interaction. The threats to external validity are: reactive effects of testing, interaction of selection and experimental variables, reactive effects of experimental arrangement, and multiple treatment interference. If a source of external invalidity is found, it causes generalizations from treatment effects to be limited to a restricted population or a restricted set of conditions.

Bracht and Glass (1968) distinguish between two classes of external validity: population validity and ecological validity. Population validity deals with generalizing from the sample, to the accessible population, to the target population. The threats to population validity are: generalizing from experimentally accessible population to the target population, and the interaction of personalogical variables with treatment effects, i.e. ATI's.

"Ecological validity concerns the extent to which the habitats or situations compared in an experiment are representative of the population of situations to which the investigator wishes to generalize" (Snow, 1974, p. 272), i.e. will the experimental effects be found in other, similar experimental situations? Bracht and Glass (1968) list ten sources of external invalidity: problems of describing the independent variables, multiple-treatment interference, Hawthorne effect, novelty effect, experimenter effect, pretest sensitization, post-test sensitization, interaction of history and treatment effects, measurement of dependent variables, interaction of time of measurement and treatment effects.

Snow (1974) has extended the ideas of Bracht and Glass (1968) on external validity. Snow (1974) suggests that an emphasis on representative as opposed to systematic design of experiments would go a long way toward making present day Educational Psychology more productive. The terms "systematic" and "representative" were coined by Brunswick (1956); systematic design involves manipulating variables independently in orthogonal, factorial designs. A representative design is a design which has maximum generalizability, i.e. external validity.

Brunswick was led to the concept of representative design because current research methodology, i.e. systematic, factorial experimentation, was inappropriate for studying the phenomenon in which he was interested, i.e. human beings! "Brunswick seems to have felt that intelligent human beings were active, flexible, adaptive, processors of information available in a probabalistic, partially redundant environment" (Snow, 1974, p. 266). Brunswick believed that the use of AOV, which was developed for agricultural experimentation where the subject is passive, was forcing the experimental subject in psychology to adapt to the current level of research methodology.

Brunswick might suggest that

> We have so far failed to adjust [current] methodology to fit the adaptive, probabilistic functioning of human behavior or to derive molar descriptions of that behavior in multidimensional natural situations. He would say that most educational experiments are not externally valid, i.e. not ecologically valid, or representative. In the extreme, he might have paraphrased William Jennings Bryan, urging that we must not crucify human behavior on the cross classification of systematic factorial design. (Snow, 1974, p. 269)

Snow (1974) believes that treatment characteristics should be "regarded as multivariate and interrelated" (p. 273), and that when treatment characteristics are included in the analysis,

> factorial design may need to be supplanted by other, probably weaker methods....Quasi-representative design with respect to treatment characteristics requires methods that allow these characteristics to covary as they do in nature. (Snow, 19743, p. 273)

"Truly representative design with respect to ecological validity would sample randomly from the universe of treatments" (Snow, 1974, p. 273). However, true representative design is rarely possibly in educational research, so the experimenter must resort to quasi-representative designs. These designs compromise the characteristics of true representative designs, just as quasi-experimental designs compromise the characteristics of true experimental designs. In developing a quasi-representative design, "it seems most convenient to move from systematic to more representative designs rather than vice versa" (Snow, 1974, p. 274).

Quasi-representative design. In order to make an experimental design more representative it is necessary to manipulate three dimensions of the experiment: (a) increase the ecological representativeness, (b) increase the population representativeness, and (c) increase the referent generality (see Figure 2).

The steps to increase ecological representativeness will be discussed first.

> A minimum step toward representativeness is gained by moving the standard experiments to relevant contexts, such as school rooms...A far more important step is accomplished if the experiment can be embedded unobtrusively in the flow of events. (Snow, 1974, p. 274)

The next step toward ecological representativeness is to conduct a very systematic experiment in two or more places, or "to vary teachers, methods, context or material to be learned" (Snow, 1974, p. 277).

Intraexperiment and extraexperiment observations are the next steps toward ecological representativeness. Intra-experiment observation attempts to determine (a) how do the subjects perceive the treatment, (b) what did the subjects do during the experiment, and (c) how did the treatment affect the subjects, e.g. side effects.

Extraexperiment observations produce data about the situation before the experiment. "A pretest on the contents to be learned is not sufficient" (Snow, 1974, p. 279). Relevant data should include: (a) did the treatment produce disturbing effects on subjects, e.g. Hawthorne or novelty effects, (b) what is the social context of the experiment, and (c) what is the recent and concurrent instructional and social history of the students? Techniques exist for making both intra and extraexperiment observations.

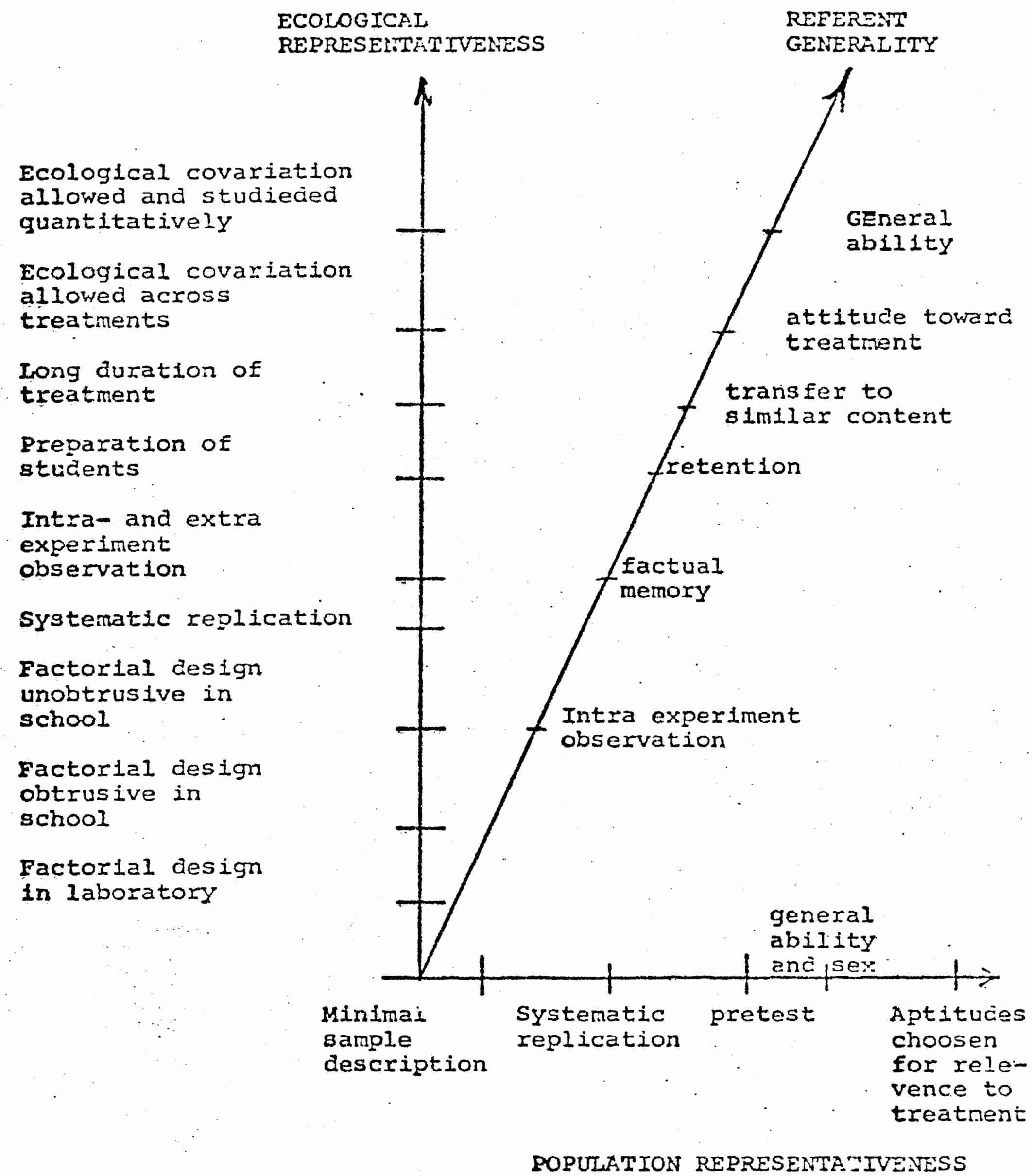


Figure 2. A Three Dimensional Model for Quasi-representative Design
Drawn from Snow's (1974) Figure 1, and Figure 2.

The ecological representativeness of an experiment will be increased if students are "adapted to the task so that it is as smooth and habitual as in ordinary school learning. Unnatural treatments...require adaptation of the learner to be properly evaluated" (Snow, 1974, p. 280), i.e. student behavior should be "tuned" so that it is normal when the experimental treatment begins.

Snow (1974) suggests that generalizations about school learning should be based on substantial periods of learning time. Treatments that last minutes or hours are not very representative of what actually occurs in school. However, if you extend a treatment in time, then you increase the possibility that extraneous influences are responsible for the experimental results, i.e. control is sacrificed to gain generalizability. Snow (1974) believes that at the present time, control is less important than representativeness.

The last step toward ecological representativeness is to allow treatments to covary naturally. When treatments are blocked into orthogonal designs, artificial conditions are often created which would not be found in natural settings. Snow (1974) suggests that in some studies powerful, factorial designs should be abandoned, in order to determine how phenomena behave in natural situations.

The second dimension of quasi-representative design is population representativeness. The steps for increasing the population representativeness should be much more familiar to the reader than the steps for increasing ecological representativeness. Snow (1974) suggests the following steps;

> the addition of replication, [i.e. subjects from different populations] and ATI analysis of pretests, general ability, and sex measures, each add information about generalizabi-

> lity to the experiment. Most informative in this respect are aptitudes chosen specifically for their relevance to the treatments under investigation. Even so, a measure of general ability should always be included. (p. 280)

The third dimension quasi-representative design should consider is "referent generality".

> referent generality is used here to designate the range or pervasiveness of the possible experimental outcomes measured in a given study...it implies that, other things being equal, we should prefer experiments that refer to 'larger' domains of future behavior. (Snow, 1974, p. 273-274)

Referent generality describes the domain measured by the dependent variables; it aids the experimenter in interpreting the meaning of generalizations. Snow (1974) suggests that "just as students and treatments must be characterized by many dimensions, we need to consider learning outcome as multivariate" (p. 273).

For example, if posttest achievement is the only dependent variable, then all generalizations must be limited to this narrow measure of school learning. The experimenter interested in school learning, would be on much safer ground in discussing his results, if he had several different measures of school learning to generalize from, e.g. dependent measures might include cognitive and affective posttests, measures of retention and transfer, and measures of any unintended side effects.

Shulman (1970) focuses on another aspect of external validity which he calls task validity, i.e.

> the actual mental operations or behaviors the subject is called upon to perform in the course of the experiment [should be] reasonably congruent with what takes place in the external domain of interest. (p. 378)

Shulman (1970) also suggests that there should be similarity between the psychologically meaningful aspects of the experimental situation and the situations which the experimenter is interested in generaliziing to.

For example, Shulman (1970) notes that most of the objectives of formal education can be categorized into verbal learning tasks, concept learning tasks, and problem solving tasks, and that most of the experimental work in these three areas has used the "trial" as its unit of analysis.

> By any means of analysis, the trial must stand as an experimentally created artifact, devoid of the barest semblance of external validity...where in the world of human beings attempting to learn new material, attain novel concepts or solve unfamiliar problems does one find the external analogue of a trial? (p. 378)

Shulman is arguing that the above experimental tasks lack task validity.

Inadequate Knowledge of Basic ATI Dimensions

The last flaw in the ATI paradigm to be discussed will require the most time to be eliminated because it requires an extensive research effort into the basic dimensions of the ATI paradigm. That is, considerable effort needs to be devoted to defining the aptitude and environment dimensions of the ATI paradigm. The primary question which needs to be resolved is: "What are the basic dimensions or factors needed to describe aptitudes and environments?"

Differential psychology has been working toward defining the basic dimensions of individual difference for 100 years; considerable knowledge of the aptitude domain is available. The problem in the aptitude domain is to determine which aptitude dimensions are relevant to the ATI paradigm in general, and more specifically, to the ATI paradigm in education.

Rhett (1972) believes that "relatively few investigators have managed to choose the most appropriate dimensions of learner characteristics" (p. 272). Cronbach and Snow (1969) are much stronger in their criticism of the aptitudes selected previously in ATI research. They conclude that the learner aptitudes selected have been simplistic and thus are

> unlikely to identify combinations of variables worth investigating. There is no instance where an ATI study defined in terms such as these [i.e. simplistic] using familiar "content" constructs from the Guilford or other such aptitude collections has lead to convincing evidence of interaction. (p. 184)

Rhett (1972) is in agreement;

> one of the reasons the previous work with specific abilities has not seemed to pay off may well be that abilities under consideration in a given experiment had no known or strong inferential relation to the specific task the subject was asked to cope with. (p. 276)

In summary, the problems with defining the aptitude domain limit its usefulness for ATI research.

However, Mitchel (1969) believes that the classification of environments and treatments is relatively primitive in comparison to the classification of individual differences. Shulman (1970) gives an even more pessimistic description of the problem.

> Aptitude-treatment-interaction will likely remain an empty phrase as long as aptitudes are measured in micrometers and environments are measured by divining rods...Social scientists are dramatically impotent in their ability to characterize environments. Generally, they do not even try. It should by now be a truism to point out that neither individuals nor groups can be adequately described without reference to some setting... The language of education and the behavioral sciences is in great need of a set of terms for describing environments that is as articulate, specific, and functional as those already possessed for characterizing individuals. (p. 374)

Because researchers lack a vocabulary for describing environments or treatments, they do not think of treatments as variables to be sampled from. Their thinking about treatments is generally confused, and "treatment dimensions have not been as carefully thought out as they might be" (Tobias, 1976, p. 64).

The eventual solution to this problem is to develop a classification of environments, based on the primary dimensions of the environment domain. Without this language progress on ATI research will be slow.

At the present time, four methods can be adopted to minimize some of the problems of working with the environment domain.

The first method is to design or select treatments on the basis of the psychological functions which they utilize. Treatments which utilize the same psychological functions cannot be expected to produce an interaction, because psychologically, the two treatments are very similar.

The second method is to let the characteristics of the experimental task determine the structure of the treatment. Rhett (1972) observed that

> From an examination of many of the treatments reported in the literature, there often seems to be only a tenuous relation between contrasting treatments and the task itself. It would often appear that selection of the treatments was based more on their contrast or oppositeness than on their actual relation to the task. (p. 275)

The third method for improving the selection of educational environments is to include the teacher as an environmental variable in the design of the experiment. Shulman (1970) concludes that

> Researchers must not ignore the teacher as an independent variable. Stephens (1967) in a compelling and disturbing review of research argued that no systematic effects for curriculum or program are observable in fifty years of educational research. He concluded that what determines the effectiveness of a program is that variable generally ignored or ostensibly randomized away--the teacher. In-

> stead of pretending that teachers are merely sources of error variance, researchers must use multivariate, experimental designs which include the teachers' educationally significant characteristics as factors. At the present time, researchers have no idea what these characteristics are. (p. 389)

The last methods for coping with ignorance of the environmental/treatment dimension is to design educational treatments on the basis of experimental evidence that learners actually perform differently on a given educational task, and that this performance is related to some learner aptitude. This is the method suggested by Rhett (1972) and discussed in the section on ATI models.

All of the evidence presented in this review suggests that it is to early to condemn ATI research for its lack of substantive findings. It would be more productive to look at this period in the history of ATI research as a developmental or formative period. Researchers are still learning the rules for conducting ATI research. Messick's (1970) comment seems most appropriate. We "are attempting to tally up the score when we haven't yet learned to play the game" (p. 214).

CHAPTER III

METHODOLOGY AND DESIGN

Target Population and Sampling Plan

Target Populations

The target population of the present study is all high school (i.e. 9th-12th grade students), chemistry, and eighth grade general science students in major metropolitan areas of the U.S. similar to Boston, Massachusetts.

Accessible Population

For the present study the accessible population is all high school chemistry, and eighth grade general science students in the metropolitan Boston area. Metropolitan Boston is defined as the cities and towns in the Boston Standard Metropolitan Statistical Area (SMSA) which is defined by the U.S. Census Bureau.

The Sample

Unfortunately, when the present study was conducted students were already members of existing classes; it was impossible to select students at random. So, the sampling unit for the present study was the teacher rather than the student. With the resources available to the present author, it was not possible to select teachers at random from a sampling frame. Lack of random sampling limits generalizations from the sample to the accessible population.

The teacher was selected as the unit of analysis because classes taught by the same teacher, and the students within the classes were not independent of each other. Teachers were randomly assigned to experimental and control groups. Five teachers were randomly assigned to the experimental group (one class dropped due to missing data). Four teachers and 15 classes were assigned to the control group (six classes dropped which did not begin the experimental unit). Table V describes characteristics of the overall sample. Table VI describes the characteristics of experimental and control groups.

Table V

CHARACTERISTICS OF THE OVERALL SAMPLE

Variables	Original Sample	Adjusted Sample
Communities in Sample	3	3
Schools in Sample	6	6
Teachers in Sample	9	9
Classes in Sample	27	27*
Students in Sample	541	505

*Two classes were dropped from the analysis due to missing information. Class 682 contained 14 students; Class 462 contained 22 students. All of the analysis in the present study were based on the adjusted sample.

TABLE VI

CHARACTERISTICS OF THE EXPERIMENTAL AND CONTROL GROUPS

Variables	Experimental Group	Control Group	Total Sample
Communities in Sample	2	3	3
Schools in sample	3	4*	6
Teachers in Sample	5	4*	9
Classes in Sample	12**	15**	27
Students in Sample	239	302	541
Sex			
Male	102 (8)***	148 (11)	250
Female	134 (5)	148 (11)	282
No Information	3 (1)	6	9
Grade Level			
8th	68 (14)	98	166
10th	9	42 (1)	51
11th	121	142 (21)	263
12th	41	20	61
Race			
White	213 (14)	120 (22)	333
Black	12	1	13
Other	11	1	12
No Information	3	180	183

*When the data was analyzed in the regression analysis, the data for teacher two was not included in the analysis because none of five classes began the unit of instruction. Thus only three schools and three teachers were actually included in the regression analysis for the control group.

**Two classes were dropped from the analysis due to missing data. Class 682 was dropped from the experimental group. Class 461 was dropped from the control group.

***The numbers in parentheses are the number of students in classes 682 and 461 which were dropped from the analysis.

Nine teachers volunteered to participate in the present study. These teachers taught a total of 27 different classes from six different schools in three different communities.

It was intended that all schools should be within the Boston SMSA; one of the communities is on the fringe of the Boston SMSA. However, it is similar to the neighboring communities which are in the Boston SMSA; so the present author will speak of the sample as representative of the Boston SMSA.

Three different size communities were selected for the present study: a large urban community (100,00), a moderate size suburban

TABLE VII

DEMOGRAPHIC CHARACTERISTICS OF COMMUNITIES IN SAMPLE

	Billerica	Woburn	Cambridge	Boston SMSA
Population	31,648	37,406	100,361	2,753,700
Sex: Male	15,965	18,112	49,089	1,303,156
Female	15,683	19,294	51,272	1,450,544
Age: 18 & Under	14,126	14,072	20,155	878,293
19 - 29	5,590	6,483	30,788	532,982
30 - 64	10,501	13,876	30,718	1,032,540
65 & older	1,431	2,975	11,700	309,885
Median age	22.6	26.2	26.8	29.1
Race: White	31,415	37,057	91,408	2,602,741
Black	153	230	6,783	127,035
Other	80	119	2,170	23,924
Median Income	$11,331.00	$11,748.00	$9,815.00	$11,449.00
Median school years completed:				
Males	12.3	12.4	12.7	12.4
Females	12.3	12.4	12.5	12.4

community (40,000), and a moderate size rural-suburban community (30,000). (Cambridge, Woburn, and Billerica.) See Table VII for additional details on these communities.

The Sampling Procedure

To obtain the sample of teachers, the present author first contacted the school superintendant for permission to do research in the school system; next the school principal and the department head were contacted. Finally, teachers in each department were contacted. Three out of the four school systems contacted agreed to participate in the study. The fourth superintendent expressed his interest in the study, but could not allow participation because his school committee had banned the use of group intelligence tests.

Data Collection Instruments

Four types of data collection instruments were used in the present study: The Classroom Environment Scale, a set of ability tests selected to measure general ability, two measurements of cognitive outcomes, and an instructional treatment description form.

The Classroom Environment Scale

The Classroom Environment Scale (CES) consists of the nine scales listed in Table VIII; the CES can be found in Appendix A. These scales are:

> designed to assess the atmosphere in a junior and senior high school classroom. The CES offers a method of evaluating the effects of course content, teaching methods, teacher personality, class composition, or characteristics on nine scales

TABLE VIII

BRIEF CES SUBSCALE DESCRIPTION

	Relationship Dimensions
1. INVOLVEMENT	measures the extent to which students have attentive interest in class activities and participate in discussions. The extent to which students do additional work on their own and enjoy the class is considered.
2. AFFILIATION	assesses the level of friendship students feel for each other, i.e., the extent to which they help each other with homework, get to know each other easily, and enjoy working together.
3. TEACHER SUPPORT	measures the amount of help, concern, and friendship the teacher directs towards the students. The extent to which the teacher talks openly with students, trusts them, and is interested in their ideas is considered.
	Personal Development Dimensions
4. TASK ORIENTATION	measures the extent to which it is important to complete the activities that have been planned. The emphasis the teacher places on staying on the subject matter is assessed.
5. COMPETITION	assesses the emphasis placed on student's competing with each other for grades and recognition. As assessment of the difficulty of achieving good grades is included.
	System Maintenance Dimensions
6. ORDER AND ORGANIZATION	assesses the emphasis on students behaving in an orderly and polite manner and on the overall organization of assignments and classroom activities. The degree to which students tend to remain calm and quiet is considered.
7. RULE CLARITY	assesses the emphasis on establishing and following a clear set of rules, and on students knowing what the consequences will be if they do not follow them. An important focus of this subscale is the extent to which the teacher is consistent in dealing with students who break rules.
8. TEACHER CONTROL	measures how strict the teacher is in enforcing the rules, and the severity of the punishment for rule infractions. The number of rules and the ease of students getting in trouble is considered.
	System Change Dimension
9. INNOVATION	measures how much students contribute to planning classroom activities and the amount of unusual and varying activities and assignments planned by the teacher. The extent to which the teacher attempts to use new techniques and encourages creative thinking in the students is considered.

Source: Moos, R. and E. Tricketts. Classroom Environment Scale. Palo Alto, California: Consulting Psychologist Press, 1974.

> which describe a classroom environment. (Consulting Psychologist Press, 1976, p. 35.)

Insel and Moos (1974) suggest that these scales can be grouped into three major dimensions:

> Relationship dimensions identify the nature and intensity of personal relationships within the environment. [The following scales are included in this dimension: Involvement, Teacher Support, Affiliation.]
>
> Personal development dimensions consider the potential or opportunity in the environment for personal growth and the development of self-esteem. [This dimension includes the following scales: Task Orientation, and Competition.]
>
> System Maintenance and system change dimensions assess the extent to which the environment is orderly and clear in its expectations, maintains control, and is responsive to change. [This dimension includes the following scales: Order and Organization, Rule Clarity, Teacher Control, Innovation.] (p. 181)

TABLE IX

INTERNAL CONSISTENCIES, AVERAGE ITEM-SUBSCALE CORRELATIONS AND TEST-RETEST RELIABILITITES FOR FORM R SUBSCALES

Subscales	Internal Consistency (N=22 Classrooms)	Average Item-Subscale Correlation (N=465 Students)	Six Week Test-Retest Reliability (N=52 Students)
Involvement	.85	.57	.87
Affiliation	.74	.48	.73
Teacher Support	.84	.54	.89
Task Orientation	.84	.53	.78
Competition	.67	.44	.81
Order & Organization	.85	.54	.85
Rule Clarity	.74	.48	.72
Teacher Control	.86	.57	.79
Innovation	.80	.50	.90
Mean	.80	.52	

Source: Moos, R. and E. Trickets. Classroom Environment Scale. Palo Alto, Calif.: Consulting Psychologist Press, 1974.

There are ten items in each scale of the CES, and items are scored either true or false. The CES takes from 15-20 minutes to complete. The profile stability of CES scales is extremely high for a six week test-retest interval; the average intraclass correlation was .95. Scale six week test-retest reliability ranges from .72 to .90. The average interval consistency for all scales was .80 (This is based on a K-R 20 estimate of reliability.) Scale reliabilities can be found in Table IX.

Ability Measures

The objective of this section is to combine several primary mental ability tests into a battery which successfully measures general ability. Cattell (1966) and Horn (1976, 1968) believe that general ability is a composite composed of fluid and crystalized intelligence. Most general ability tests are heavily loaded on crystalized intelligence. Snow (1977) suggests that Cattell's theory of intelligence, "or related hierarchical views have finally become popular because they fit existing data rather well offering some hope of parsimony" (p. 68).

The present author based the general ability measure used in the present study on Cattell's theory of intelligence. That is, the proposed measure of general ability should reflect both fluid and crystalized intelligence. Table X shows those primary mental abilities which measure either pure crystalized or pure fluid intelligence. For example, a test which is a pure measure of fluid intelligence will have a high factor loading on the fluid intelligence factor, and a low loading on the crystalized intelligence factor.

The major problem in constructing a measure of general ability which reflects both fluid and crystalized intelligence, is to identify those primary mental abilities which measure either pure fluid or pure crystalized intelligence. Table X presents the results of four factor analytic studies which identified those primary mental abilities which were pure measures of either fluid of crystalized intelligence. The present study used the results presented in Table X as a guide to the primary mental abilities which best measured either pure fluid or pure crystalized intelligence.

Horn (1968) gives the following definitions for the primary mental abilities listed in Table X.

1. CFR - Figural Relations: this primary ability measures eduction of a relation when this is shown among figures, as in the matrices test.

TABLE X

FACTOR LOADINGS ON FLUID AND CRYSTALIZED INTELLIGENCE

Primary Ability	Factor Loadings from Research Studies 1		2		3		4	
	G_f	G_c	G_f	G_c	G_f	G_c	G_f	G_c
CFR	.48	-	.57	.01	.48	-.08	.50	.10
Ms			.50	.00				
I	.55	-	.41	.06	.55	.12		
V	-	.69	.08	.68	.08	.69	.15	.46
EMS	-	.43	-.08	.43	-.08	.43		
N	.20	.29	.21	.29	.20	.29		

1. Horn, 1965
2. Horn, 1968
3. Horn and Cattell, 1966
4. Cattell, 1963

Source: Horn, J.L. "Organization of Abilities and the Development of Intelligence." Psychological Review, 1968, 75, 242-259.

2. Ms - Memory Span: reproduction of several numbers or letters presented briefly either visually or orally.
3. I - Induction: eduction of a correlate from relations shown in a series of letters, numbers, or figures as in a letter series test.
4. V - Verbal comprehension: advanced understanding of language, as measured in a vocabulary or reading test.
5. EMS - Experiential Evaluation: solving problems involving protocol and requiring diplomacy, as in a Social Relations test. (p. 249).
6. N - Number Facility: "The ability to perform basic arithemetic operations with speed and accuracy." (Ekstrom, French, and Harmon, 1976, p. 115)

Ideally, a measurement of general ability based on the fluid-crystalized intelligence theory should include at least one measure of each primary mental ability listed in Table X, with the exception of N. N seems to measure both fluid and crystalized intelligence. However, it was not possible to include a measure of each of these abilities in the general ability test. Guilford (1977) found that EMS generally had low factor loadings, and he did not have a copy of the test to give to the present author. Ms was not included due to lack of testing time. Data on the remaining three abilities (CFR, I and V) in Table X were collected.

It is extremely desireable to have at least two tests of each primary ability in the test battery. This wil increase the reliability of measuring each primary ability by eliminating test specific factors from the analysis. The present study used four measures of CFR, and two measures of V. However, time limited the present study to one measure of I (Horn, 1968).

Tests of CFR. Form A of Cattell's Culture Fair Test (Scale 2) was selected to measure CFR in general, and fluid intelligence especially. This test is composed of four scales. The matrices test is the only scale which directly measures CFR, but the total test scores has a very high loading on fluid intelligence (.78). This was the best measure the present author could find of fluid intelligence.

Reliability and validity for the Culture Fair test are reported in Tables XI and XII. The total test score reliability and validity for form A is quite adequate (see Tables XI, and XII). However, the reliability for each of the four scales of A is low.

There are two forms of the Culture Fair test (Form A and B); the test manual strongly recommends that both forms be used in order to estimate IQ. Only Form A was used in the present study; there was not enough time to administer both forms. When only one form of the Culture Fair test is used, this lowers the reliability of the test from .84 to .77. Since IQ was not used as data in the present study, this loss of reliability did not have serious consequences.

The total testing time for Form A is 12.5 minutes. However, by the time students finished reading directions and asking questions, the actual testing time was approximately 25 minutes.

Tests of Verbal Comprehension (V). Tests from the "Kit of Factor Referenced Cognitive Tests" (Ekstrom, French and Harmon, 1976) were selected to measure Verbal Comprehension(V), and Induction(I). This kit of tests measures 23 different cognitive factors. Each of these factors has been found in at least three different factor analyses. Each cognitive factor is represented by at least three different marker tests. Marker tests are useful because they have usually been well established, and there relationship to other cognitive factors is known. Ekstrom, French and Harmon (1976) strongly recommend that the researcher include at least two marker

TABLE XI

RELIABILITY OF THE ABILITY TESTS USED TO MEASURE
FLUID AND CRYSTALIZED INTELLIGENCE

Ability Test	Number of Items	Time	Reliability Coefficient		
			Alpha	Equivalence*	Test-Retest
Culture Fair Test-Scale 2					
(Form A)	46	12.5	.77	.67	.73
Test 1: Series (G-1)	12	3.0		.43	
Test 2: Classifications (G-2)	14	4.0		.30	
Test 3: Matrices (G-3)	12	3.0		.69	
Test 4: Conditions (G-4)	8	2.5		.58	
V-1 (Part 1)	18	4.0	.75**	.94	
V-2 (Part 1)	18	4.0	.65**	.84	
V-1 (Part 1) + V-2 (Part 1)	36	8.0	.78**		
I-1 (Part 1)	15	7.0		.84	

*Equivalence reliability was calculated by correlating parallel forms with each other.
**These correlations were calculated from a random sample of 100 high school students in the present study.

TABLE XII

VALIDITY COEFFICIENTS FOR THE CULTURE FAIR TEST, V-1, V-2 AND I-1

*Correlation With Variables in the Present Study	Culture Fair IQ (Part A)	V-1	V-2	V-1+ V-2	I-1	**Full Scale Culture Fair Test
Culture Fair Scales						
Test 1: Series (G-1)	.64	.21	.27	.26	.33	.76
Test 2: Classification (G-2)	.72	.13	.26	.21	.22	.54
Test 3: Matrices (G-3)	.61	.15	.22	.20	.27	.76
Test 4: Conditions (G-4)	.65	.19	.23	.23	.25	.51
Culture Fair IQ	-	.21	.33	.29	.37	-
Total Test Score						.85
V-1	.21	-	.64	.93	.22	
V-2	.22	.64	-	.87	.20	
V-1 + V-2	.29	.93	.87	-	.23	
I-1	.37	.21	.20	.23	-	
***Factor 2	.87	.20	.39	.31	.41	
***Factor 3	.09	.93	.61	.88	.14	
***Factor 2 + Factor 3	.59	.82	.70	.85	.36	
Fourth Term Grade	.25	.19	.25	.24	.30	
Final Grade	.30	.21	.30	.27	.38	
Student's Age	.11	.41	.29	.40	.07	
Correlations with Variables from Other Studies ****						
Science Grades (7th grade)						.43
Arithmetic Proficiennсy						.47
English and Math Achievement						.46
Raven Matrices						.51
Otis Beta						.49
Pintner General Ability						.69
Metropolitan Reading Test						.56
Abstract Reasoning						.78
WISC Verbal						.62
WISC Performance						.63
WISC Full Scale						.72
Average Concurrent Validity						.70

*These correlations were based on the data obtained from the present study. The correlations were calculated from the estimated covariances; the sample size ranged from 372 to 448 with the exception of correlations which involved I-1. The sample size for these correlations ranged from 130 to 162.

**These correlations were reported in Catell, 1973, p. 11

***These variables are factor scores produced from a factor analysis of the independent variables in the present study.

tests for each cognitive factor that the researcher is interested in. Thus, ideally, two marker tests for V and two marker tests for I should be included in the present analysis. However, time limitations prevented the present author from including two marker tests for I.

Verbal comprehension (V) is defined as the "ability to understand the English language" (Ekstrom, French, and Harmon, 1976, p. 163). This is an extremely well established cognitive factor. Ekstrom et al. (1976) report that it has been

> found in more than 125 studies. [They suggest that] there may be separate Verbal Comprehension factors for each language...and that this factor contrasts with the ideational fluency and word fluency factors which are not specific to a given language (p. 163).

The present study selected two of the five marker tests for V available in the Kit of Factor Referenced Cognitive Tests; these marker tests are described as V-1 (a 4 choice synonym test) and V-2 (a 5 choice synonym test which uses a different format than V-1). (Directions for V-2 were changed slightly.) Both of these tests are suitable for grades 7-12, and both tests are divided into two parts which are administered separately. Each part contains 18 items and takes 4 minutes to complete. Equivalence reliability can be obtained by correlating part 1 with part 2. However, time limitations demanded that only part one of each test be administered. The reliability and validity of these tests is listed in Tables XI and XIII. The internal consistency reliability of these tests was based on a random sample of 100 high school students in the present study. This reliability is .75 for part 1 of V-1, and .65 for part 1 of V-2. Since the analysis for the present study eventually added scores on V-1 to the scores on V-2, the present author believes that these reliabilities are adequate. The reliability for this composite test based on the Spearman Brown prophecy formula is .78.

Tests of Induction. Induction (I)

> identifies the kinds of reasoning abilities involved in forming and trying out hypotheses that will fit a set of data. Induction appears to be a two step process requiring both concept formation and hypothesis testing....inductive ability is probably involved in concept learning tasks. (Ekstrom, et al, 1976, p. 79)

Figure classification seems to be the most prominent subfactor of induction.

Of the three Induction marker tests, listed in Ekstrom et al, (1976), the present author selected Letter Grouping (I-1) for use in the present study. This marker test was most similar to the tests used by Cattell to validate the fluid-crystalized intelligence theory. In I-1 "five sets of four letters each are presented. The task is to find the rule which relates four of the sets to each other, and to mark the one which does not fit the rule" (Ekstrom, et al., 1976, p. 80). This marker test is divided into two parts; each part contains 15 items, and takes 7 minutes to complete. This test is suitable for grades 8-16. There was not enough time to administer both parts of I-1, so the present author only used part 1 of I-1 in the present study.

The reliability and validity of I-1, is contained in Tables XI and XII. The equivalent form reliability of both parts of I-1 is .84. The present author did not calculate the internal consistency reliability for part 1 of I-1 because I-1 was not used in the final analysis of the present study. I-1 was dropped from the analysis because only 165 students completed I-1; this is 32% of the total sample.

I-1 was the last test administered in each class. Teachers were instructed to skip I-1, if they did not have enough class time to complete the test. Unfortunately, most classes did not have enough time to finish this test.

The test score on all ability measures used in the present study was the total raw score for each test. No correction for guessing was applied to any of the raw scores.

Design of the Unit Test

The present study designed two pseudo-parallel unit tests; these unit tests were designed to measure classroom learning at the completion of one unit of high school chemistry. Teachers selected acid-base theory as the experimental unit of instruction.

Test 1 was administered to the experimental group, and test 2 was administered to the control/replication group to measure initial learning for the experimental unit of instruction. Test 1 was also administered to the control group as a pretest of knowledge on the experimental unit of instruction. Thus, the experimental group and the control group received different tests of initial learning. In order for this to be a valid comparison it is necessary to show that the two forms of the unit test were approximately parallel. That is, the two test forms were measuring the same theoretical construct; i.e., initial learning for the experimental unit of instruction.

The following three steps were used to insure that the two unit tests were approximately parallel, these steps also insured content validity:

1. Define the domain of information covered by the unit test.

2. Construct parallel tables of specification and unit tests.

3. Item analysis of the two test forms.

Definition of the Subject Matter Domain. The first step in the design of the unit tests was a survey of the subject matter covered by the experimental unit. The present author reviewed three high school and one eighth grade text books which contained units on acid-base theory. This review yielded a total of 113 terms, i.e., facts, concepts, rules, skills; these terms were placed in a "concept checklist" survey. (See Appendix B)

The purpose of the concept checklist is to define the subject matter domain for an instructional unit on acid-base theory. The concept checklist asked each teacher to rate each term for its importance in a unit on acid-base theory. The ratings each teacher gave to each concept are in Appendix B. The author used these ratings to select "important" terms which should be included in the subject matter domain, i.e., the subject matter domain was defined as all of the terms which the teachers rated as important. When the subject matter domain was defined, terms were randomly selected from the domain for inclusion in both forms of the unit test. An adequate domain definition is absolutely essential for constructing parallel forms.

Two criteria were used to select terms for the subject matter domain. In order to insure content validity, only important terms (as judged by the teacher ratings) were included in the test domain.

(1) All terms should have an average rating of 2.0 or less. That is, on the average teachers perceived this term as moderately important. (When the distribution of ratings for any term was very skewed [greater than 1.0] the median was used instead of the average.) (2) Terms which met the first criterion were dropped from the subject matter domain if any of the six high school teachers gave them a rating of 4 or 5, i.e. irrelevant.

Thus, any high school teacher could veto the inclusion of any term in the subject matter domain. The first criterion insures that only important terms are included in the test domain, and the second criterion insures that there is considerable agreement among the teachers on each term in the test domain. One high school teacher was not in the study at the time the concept checklist was completed. So, the averages in Appendix B are based on 6 ratings rather than 7. The ratings of the two eighth grade teachers were not analyzed at this time.

Sixty-two of the terms on the concept checklist met the first criterion for inclusion in the test domain. Fifty-four of these terms met both criteria, and thus the test domain contains 54 terms (see Appendix C).

Appendix C lists the 54 terms contained in the test domain. These terms were classified by type of learning outcome and by the appropriate grade level. The grade level of each term was determined by using the concept checklist ratings each eighth grade teacher gave each term. In order for the term to be classified as appropriate for eighth grade students, the term must meet the two criteria listed above; in addition both eighth grade teachers had to rate the term as "very important", i.e. a rating of 1 on the concept checklist (criterion #3). This criterion was adopted for two reasons: (1) The eighth grade test only contained 20 items; since the test was short, the present author felt that all test items should measure essential information which all students should know, i.e. a rating of 1. (2) Since there were only two eighth grade teachers in the study, the present author believed that a more valid eighth grade test would result if both teachers agreed on the test domain.

Twenty-two of the fifty-four terms in the test domain met criterion #3 above, and were classified as appropriate at the eighth grade level. There was a surprising degree of agreement between the two eighth grade teachers on which terms were inappropriate. Of the thirty-two terms in the test domain which were classified by criterion #3 as inappropriate for the eighth grade level, thirty-one of these terms were rated between 3 and 5 by both teachers. That is, the teachers agreed 97% of the time on the terms which were inappropriate for eighth grade students.

Appendix C shows that 20 items were needed for the eighth grade test; only twenty-two terms were classified as appropriate for the eighth grade level. In order to increase the pool of eighth grade terms, the eight terms which met criterion #1, but did not meet criterion #2 were reviewed. Two of these eight terms also met criterion #3, and were included in the test domain. Both of these items were rejected by criterion #2 because one teacher had given them a rating of 4. These two terms were added to the test domain in order to increase the pool of eighth grade terms. This slight violation of the veto principle established earlier, seems justified by the need to increase the size of the eighth grade term pool. The two terms added to the test domain were items 19 and 50. This increases the test domain to 56 terms.

Table of Specifications

> A table of specification relates outcomes to content, and indicates the relative weights to be given to each of the various areas....The purpose of this table is to provide assurance that the test will measure a representative sample of the learning outcomes, and the subject-matter topics to be measured. (Gronlund, 1977, p. 27)

Two tables of specification were used to construct parallel forms of the unit test. The outcome dimension of each table was the same; the content dimension was a stratified random sample of 40 terms selected from the test domain constructed above.

The outcome dimension of the table of specification measured three different outcomes: (1) learning of factual information (53%), (2) defined concept learning (32%), and (3) rule learning (15%). The percentage of each type of outcome was selected by the present author as representative of the outcomes observed in the textbooks being used. Since defined concepts are a special type of rule, Table XIII shows that for high school students 52% of the test is devoted to learning verbal information, and 48% is devoted to rule learning. The reader should note that these proportions were different for the eighth grade test: 75% of this test was devoted to verbal information, and only 25% was devoted to rule learning.

The present author believes that these percentages reflect the amount of time devoted to the different learning outcomes in school. The terms in the test domain provide some support for these assertions.

TABLE XIII

GENERAL FORMAT FOR THE TABLE OF SPECIFICATIONS USED IN THE CONSTRUCTION OF THE UNIT TEST

	Learning Outcomes							
Grade Level	Verbal Information N	%	Defined Concepts N	%	Rules N	%	Total N	%
Eighth Grade	15	37.5	5	12.5	0		20	50
High School	6	15.0	8	20.0	6	15.0	20	50
Total	21	52.0	13	32.5	6	15.0	40	100

N is the total number of unit test items which measured each type of learning outcome.

The present author believes that these percentages reflect the amount of time devoted to the different learning outcomes in school. The terms in the test domain provide some support for these assertions. For high school students 54% of the terms in the test domain were classified as verbal information. For eighth grade students 71% of the terms in test domain were classified as verbal information (see Appendix C).

Table XIII describes the general format for both tables of specification. It shows that each test will contain 40 items, i.e. questions. This total was based on the assumption that a student could answer one item each minute. Table XIII shows that the eighth grade students completed the first 20 items of a 40 item test. The test items designed for the eighth grade students had a lower reading level than high school test items, and these items were designed to be easier than the high school items. In general, the eighth grade items did not demand the sophistication that the high school items required. One of the major problems in writing test questions was to make the eighth grade questions easy enough for eighth grade students, but not so easy that the correct answer was obvious to the high school students.

Table XIII was converted into a table of specification by selecting the terms for the content dimension from terms in the test domain. Stratified random sampling without replacement of the test domain items was used. Each cell of Table XIII was treated as a strata, and a random sample of the corresponding terms in each cell of the test domain was taken. The eighth grade cells were sampled first. Eighth grade terms which were not selected for the eighth grade test were available for selection on the high school test.

For example, Appendix C contains the Table of Specification for Test 1. The verbal information-eighth grade cell of this table lists the 15 terms which were randomly selected from the correspon-ding cell of the test domain. Terms #19 and #52 were not selected from the test domain. These two terms were still available for selection when terms were sampled for the verbal information-high school cell. The six terms selected for this cell are listed in Appendix C. Neither term #19 or #52 was selected for this cell. But they were available for selection to this cell. Random selection of terms continued until all cells were filled. At this point the table of specification was complete.

The table of specification was used to guide the writing of test questions. Gagne's conception of verbal information and rule learning was used as a basis for writing test questions. The criteria for these different learning outcomes were discussed in

Chapter II.

For example, term #85 in test 1 is in the rule learning-high school cell. Rule learning requires that the student be able to demonstrate the rule he has learned. In this case, term #85 requires that the student demonstrate that he has learned the rule (intellectual skill) or rules for performing an acid-base titration. Term #85 was written as test question 36; this question required that the student demonstrate an acid-base titration by selecting the steps for this procedure in the correct order, i.e. demonstrate the rule for titration.

The table of specification is a guide for writing the stem of a test question. The test constructor is left on his own in constructing the test responses. Appendix D contains Test 1 and Test 2 with their respective answers.

Item Analysis. The last step in designing the unit tests was an item analysis of each test. The purpose of an item analysis is to look at each test item and determine if the item is reliable and valid. The following indices were used to judge the quality of each item.

1. Part-whole correlation
2. Discrimination index
3. Difficulty index

Items which are low on any of these indices should be revised or eliminated. An item analysis should contain approximately 400 subjects; with fewer subjects, item characteristics may change.

Neither of the unit tests was pretested; classes which had completed the experimental unit were not available for a pretest.

Eighth grade students were not included in the item analysis of either test.

Test 1 was administered to the experimental group at the completion of the unit on acid-base theory. An item analysis of this test was performed for the high school students in the sample (N = 130). The difficulty index and the discrimination index for each item are listed in Appendix D. The average discrimination index for test 1 was .356, and the average difficulty index was .365. The formulas for the discrimination index and difficulty index are listed in Appendix E. None of the items in test 1 had a negative discrimination index; however, the discrimination index for three items was less than .20. Grounland (1977) recommends that the discrimination index for a test of this length should be at least .20.

Test 2 was administered to the control group at the completion of the experimental unit; only high school students were included in the item analysis (N = 90). The only difference between the administration of test 1 to the experimental group and test 2 to the control group was that the control group was pretested with test 1 before the unit of instruction began.

An item analysis was also performed on the 40 items in test 2. The difficulty index and the discrimination index for each item are listed in Appendix D. The average discrimination index for test 2 was .388, and the average difficulty index for test 2 was .353. Only one of the items in test 2 had a negative discrimination index; four other items had a discrimination index less than .20, i.e. 35 of the 40 items in test 2 had a discrimination index greater than .20.

Ordinarily, questions with a low or negative discrimination index would be dropped from the test. However, in the present experiment it was necessary for the two test forms to be approximately parallel. This means that the two tests would have approximately equal means, and standard deviations. Items with poor discrimination were not dropped because this would result in tests with different numbers of items.

Reliability. The coefficient alpha reliability for test 1 is .805 (see Table XV). This was calculated using the Kuder-Richardson 20 formula; the coefficient alpha formula reduces to the KR-20 formula when items are scored dichotomously. Coefficient alpha for test 2 was .756. Test-retest reliability with a two week period between testing was .631; this is simply the correlation between the initial learning test and the retention test for the experimental group. (N = 124).

Validity. Several measures of validity were collected. The content validity of both tests was insured by sampling at random from a list of terms which the teachers considered to be important. The table of specifications helped to insure content validity by measuring two different types of learning outcomes.

Two measures of concurrent validity were collected (1) the correlation between unit test scores and fourth quarter grades, and (2) the correlation between unit test scores and final grades. (See Table XIV).

The final measure of test validity was a teacher rating of the validity of the unit tests. Teachers were asked, "How well do you think the unit test measured the student's knowledge of acids and bases?" The ratings ran from very well (1) to very poorly (5). This

TABLE XIV

VALDITY COEFFICIENTS FOR TWO FORMS OF THE UNIT TEST

	Initial Learning Test Score				Retention Test Score	
	Experimental Group		Replication Group		Experimental Group	
	Correlation	N	Correlation	N	Correlation	N
Fourth Quarter Chemistry Grades	.589	121	.581	182	.669	76
Final Chemistry Grade	553	109	.540	183	.683	69
Age	.386	171	.448	182	.284	133
Grade Level	.444	177	.511	184	.339	140

TABLE XV

DESCRIPTIVE DATA FOR THE TWO FORMS OF THE UNIT TEST

	Test 1	Test 2
Mean	25.21	25.88
Standard Error of Mean	.549	.563
Standard Deviation	6.26	5.34
Median	25.00	27.00
Standard Error of the Median	.577	.866
Range of Test Scores	11 to 38	10 to 35
Average Discrimination Index	.356	.388
Average Difficulty Index	.365	.353
Reliability (KR-21)	.805	.756
Reliability (Parallel Forms)*	.631	.631
Concurrent Validity**	.571	.560
Number in Test Group	130	90

*This is the correlation between Test 1 and Test 2 for the same subjects There was a two week interval between testings.

**This is the average of two validity coefficients reported in Table XIV: the correlation between fourth quarter grades and unit test scores, and the correlation between final grades and unit test scores.

question is contained in the treatment description form in Appendix F. The average teacher rating of the unit test was 2.78, i.e. slightly better than "fairly well". The standard deviation of this rating was 1.2.

Table XV summarizes all the information presented on test 1 and test 2. A comparison of the characteristics of test 1 with test 2 showed that these characteristics were very similar for both tests. The present author concluded that there was enough evidence to demonstrate that the two tests were approximately parallel. In order for the results from the control group to be useful, it was essential that test 1 and test 2 be approximately parallel.

The Treatment Description Form

The last data collection instrument administered in the present experiment was the treatment description form (see Appendix F). This form was designed by the present author. The data for this form was collected approximately 1 week after the experiment ended. For the experimental group this was one week after the retention test was administered. For the control group this was one week after the initial learning test was administered. For some teachers this data was collected as soon as the day after the experiment ended, but for other teachers this data was collected as late as a week after the experiment ended.

The data for this form was collected during a personal interview with the teacher which lasted approximately 30 minutes. Four types of information were collected at this time.

1. a description of the length and type of instruction each class received.
2. a description of class behavior during the experiment.

3. teacher demographic data.
4. a rating of the unit test.

This information will be discussed in the sequel.

Research Design

The present study is a nonexperimental study of classroom learning and retention. As such, no variables were manipulated; the primary emphasis of the present study was representativeness rather than systematic control. As mentioned earlier Brunswick (1956) coined the terms representative and systematic design. A representative design has maximum generalizability, i.e. external validity. Whereas systematic design emphasizes control of the independent variables, and thus tries to maximize internal validity. The present emphasis in educational psychology is heavily weighted toward systematic design and internal validity. Snow (1974) and others believe it would be a more productive research strategy to strike a more equal balance between the requirements of internal and external validity.

Barker (1965) suggests that systematic experimentation may even destroy the phenomenon under study. For example, Barker, Dembo, and Lewin (1941) began a series of studies which have been verified in many different forms. They demonstrated that experimenter induced frustration lead to regressive behavior in children. However, Fawl (1963) searched naturalistic observations of children's behavior in hopes of confirming Barker's previous findings. Fawl (1963) found that frustration occurred rarely for children in naturalistic settings, and when it did occur, the children rarely responded with regressive behavior!

Barker (1965) suggests that

> It appears that the earlier experiments simulated frustration very well as we defined and prescribed it for our subjects (in accordance with our theories); but the experiments did not simulate frustration as life prescribes it for children. (p. 5)

Thus, this line of research has generated a great deal of reliable information about the phenomenon of "simulated frustration", i.e. experimenter induced frustration, but little information about naturally occurring frustration.

The present study has tried to maximize representativeness. This emphasis on representativeness demanded a nonexperimental design. The purpose of the present study is to test a model (or theory) of classroom learning. Snow (1974) identifies two opposing methods for building theory in psychology. The first method, the method of choice for physics, builds psychological theory by the:

> successive accumulation of factors; the investigator starts with a simple experiment and complicates it in successive studies by adding independent or contextual variables, hoping to reach an understanding of complex behavior. This is the method that experimental psychology has followed for decades....[The alternative, the method of choice in biology, is the method] of successive omission of factors, in which complex, perhaps naturally occurring treatments that are found really effective in at least one context, are then disected by systematic experiments to find out how and why they work. (p. 278)

Cattell (1966), Sells (1966), and Pearboom (1971) argue in favor of adopting the method of successive omission of factors. They emphasize the importance of ecologically oriented and non-manipulative research in psychology. They argue that behavior is complex, multi-dimensional and probabalistic, and that "stripping the environment down to a minimum in order to control, to determine the role of a very few variables, may be a potentially self defeating process"

(Snow, 1974, p. 268).

Thus two lines of reasoning suggest that a nonexperimental study of classroom learning is likely to be more productive than an experimental study of classroom learning: (a) representative design as suggested by Snow (1974), and (b) theory building by the successive omission of factors (Snow, 1974; Catell, 1966; Sells, 1966).

As suggested earlier truly representative design is rarely possible in educational settings. So the present study has adopted a quasi-representative design. These designs try to maximize three variables: (a) ecological representativeness, (b) population representativeness and (c) referent generality (see Figure 2). These three variables were the controlling variables in the design of the present study.

Ecological Representativeness

The primary objective of using "general classroom instruction" as a treatment is to observe classroom learning in as natural, and unreactive a way as possible. This treatment and other procedures discussed in the sequel insures that the present study has high ecological representativeness.

The present study meets all of the conditions for ecological representativeness described in Figure 2, and in the Review of Literature. Starting with the most basic criterion for ecological representativeness, the present study was:

1. Conducted in a natural, representative environment--i.e. high school and eighth grade classrooms.
2. Unobtrusive--for the most part students did not know an experiment was being conducted.
3. Systematic replication--data were collected

from six schools, three towns and nine different teachers.

4. Extra-experiment observations were collected before and after the experiment began: Ability, CES, and Teacher opinions of the test. The most serious flaw in the ecological representativeness of the present study was the lack of intra-experiment observation. That is, no data were collected while the unit of instruction was taught. This could have been obtrusive, and reactive, and so this type of data was not sought.

5. Students were prepared for this unit of instruction. School was in session for approximately 30 weeks before the experiment began, i.e., before the unit of instruction was taught.

6. The unit of instruction lasted approximately three weeks; this is representative of a normal unit of instruction, and does not represent a temporary phenomenon.

7. The treatment (unit of instruction) was taught using the teacher's prefered methods and the media available.

Population Representativeness

High school and eighth grade students were chosen as the subjects for the present experiment for three reasons. Each reason was an attempt to insure population validity.

1. The present author believed it was very important in ATI research to choose subjects who were representative of people in general. This insures that all levels of aptitude are represented in the study, and thus avoids the problems caused by restricting the range of the variables under study.

2. Next to the white rat, students in introductory psychology are probably the most studied subjects in psychology. Thus, most psychological generalizations should be restricted to these populations. Neither of these subjects is particularly representative of Homo Sapiens. However, this doesn't stop psychologists from using

these subjects to make generalizations about man in general. The present author hoped that high school and eighth grade students would provide a sounder base for generalizations.

3. The most desirable pool of subjects for the present study would contain a random sample of people in general; this would insure a high degree of population validity for the present study. However, there was no practical way to gather these subjects together. High school and eighth grade students were the most representative subjects to which the present author had access.

The population representativeness of the present study was also high (see Figure 2). Specifically,

1. The subjects for the present experiment were drawn from 6 different schools and two different grade levels.
2. Data were collected on age, race, sex, ability and pretest knowledge.
   [The pretest was only given to the control group.]
3. General ability X CES interactions were examined.
4. However, aptitudes were not chosen on the basis of their relevance to the unit of instruction due to insufficient basic knowledge. The aptitudes chosen should relate to <u>any</u> type of classroom instruction.

Referent Generality

The referent generality of the present experiment was moderate. Information on transfer was not collected due to limited testing time available from the schools. Attitude information probably would not be specific to the unit taught.

Task Validity

Task validity (Shulman, 1970) has been described earlier. Task validity is high; the learning tasks used in the experimental unit of instruction were no different from the learning tasks encountered in other chemistry units.

In addition, treatments were not categorized artificially into nominal categories such as: discovery-versus reception but rather data were gathered quantitatively on the instructional treatment (See the class descriptions in Table XX).

Threats to Internal Validity

The present study is internally valid if the outcomes studied are a function of the instructional treatment and not other causes. That is, the research design adopted by the present study should prove that initial learning was produced by the instructional treatment alone, and not other causes. If other causes for the initial learning can be found, then the internal validity of the experiment must be questioned.

The research design for the present study is shown in Figure 3. R indicates that teachers were randomly assigned to the experimental and control groups. The dashed line indicates that the study used intact groups; the intact groups were classes. The reader should note that classes were not assigned at random. O_1 and O_2 indicate that some observations were made on both groups before the instructional treatment was begun. These observations were the ability and CES tests mentioned earlier. X indicates when the classes received the instructional treatment. (X) indicates instruction but not the experimental unit. O_3 and O_6 are different forms of the initial learning test administered after the instructional treatment. O_4 is a pretest of the information taught in the instructional unit, and O_5 is a retention test of the material learned during the instructional treatment. (It is the same measure as O_6.)

$$
\begin{array}{cccccc}
R & O_1 & X & O_3 & (X) & O_5 \\
\hline
R & O_2 & (X) & O_4 & X & O_6
\end{array}
$$

Figure 3. Research Design for the Present Study

Campbell and Stanley (1963) list eight classes of extraneous variables which are potential threats to internal validity. A study high in internal validity will control all of these threats. Each of these threats to internal validity will be discussed in the sequel.

History. History refers to events occurring in the environment during the same time as the instructional treatment, i.e. events external to the instructional treatment. For example, history variables include short duration, unusual events, which last minutes or a few days, like the Cuban missle crisis, the 1968 blackout, a bomb scare one morning, or institutional events like a prom, a play or the beginning of vacation. Unusual external events of longer duration are also possible history variables, e.g. racial unrest lasting weeks or months possibly caused by busing, or integration efforts; a teacher strike, or seasonal variations such as the coming of spring.

History variables also include events within the instructional treatment, i.e. internal events. For example, short term internal events that are history variables include: a discipline problem on a particular day or series of days; a substitute teacher for a few days. History variables which are long term internal events, include: inadequate instructional materials for one class but not another; no heat in one classroom but in others.

> Limitations on internal validity by virtue of history are dealt with by using a control group which can be expected to have the same external or historical experiences during the course of the experiment as those of the experimental group. If both groups experience the same history, then this factor becomes less important. (Tuckman, 1972, p. 75)

The $O_3 - O_4$ comparison provides a test for history variables. Since both groups have had the same history, any difference between the groups must be due to the instructional treatment.

Maturation Variables. Maturation refers to the process of change which occurrs within experimental subjects as a result of biological or psychological changes that vary with the passage of time, e.g. developmental changes in the subjects. Maturation is a problem for studies that extend for long periods of time. However, short term and biological changes in the subject can also cause maturational changes, e.g. boredom, hunger, fatigue.

> The use of a control group composed of comparable persons who can be expected to have the same or similar maturational and developmental experiences will enable the experimenter to make conclusions about the experimental treatment independent of the confounding maturation effect. (Tuckman, 1972, p. 75)

The $O_3 - O_4$ comparison is also used to test for maturation effects. Since both groups are composed of subjects with comparable maturational experiences, any difference between the groups cannot be due to maturational variables.

Intrasession history also needs to be controlled, i.e. the irrelevant, unique events of an experimental session or class become rival hypotheses for explaining the control-experimental comparison.

> All those in the same session share the same intrasession history, and thus have sources of similarity other than X. [the treatment] If such sessions have been assigned at random, the correct statistical procedure is the same as that for the assignment of intact classrooms to treatments. (Campbell and Stanley, 1963, p. 184)

Testing Variables. "Testing refers to the effects of taking a pretest on the subsequent posttest performance of individuals" (Tuckman, 1972, p. 75). For many types of pretests the subject will do better on the posttest simply because he has taken the pretest. This is refered to as reactivity. Some measurements are more reactive than others. Intelligence tests and achievements tests are often very reactive, e.g. a 3-5 point I.Q. gain due to retesting.

The O_3 - O_6 comparison provides a means to assess the effect of pretesting. If the pretest has affected O_6, then O_6 should be greater than O_3.

Instrumentation Variables. Instrumentation refers to a change in the experimental tests, measurements or observations from one occassion to another. Mechanical instruments and paper and pencil tests are not very susceptible to instrumentation effects. Observers or raters are very susceptible to instrumentation effects. Practice, boredom, fatigue or expectations can influence observations or scoring procedures. Data collection procedures, observations and measurements should remain constant across time and across groups.

All of the observations of the present study were paper and pencil tests; if the administration procedures were followed by each data collector, at each administration of the tests, instrumentation should not effect them, i.e. intrasession history should be the same in all classes. Adequate reliability and validity are often enough to refute the hypothesis of instrumentation bias. Using alternate forms for the pretest and posttest also helps to refute the instrumentation bias hypothesis (Tuckman, 1972).

Statistical Regression Effects. This effect refers to the statistical fact that groups which are chosen for their extreme scores on a pretest will be closer to the overall mean on a posttest. That is, extreme high scorers on a pretest will have lower scores on a posttest, and extreme low scorers will have higher scores on a posttest. This phenomenon occurs because chance factors are more likely to influence extreme scores than average scores, and luck or misfortune is not likely to bless the same person on a second testing.

Regression effects only occur when subjects have been selected for their extreme scores. Since subjects and teachers were not selected for their extreme scores, regression effects are unlikely in the present experiment.

Selection Bias. Selection bias occurs when the subjects in the experimental and control groups are different on some relevant variables. When this occurs it is impossible to determine if a difference between the experimental and control groups is due to the treatment, or due to the subjects which were selected for each group. That is, the observed outcomes may be due to initial differences between the groups rather than due to the treatment. Thus, the outcomes observed might have occurred without the treatment.

Randomly assigning subjects to treatments is the best way to control for selection bias. Randomization assures group equality at the time of randomization. However,

> the assurance of equality is greater for large numbers of random assignment than for small . . . randomization . . . is a less than perfect way of assuring the initial equivalence of such groups. It is nonetheless, the only way of doing so, and the essential way. (Campbell and Stanley, 1963, p. 185)

In the absence of random assignment to groups, selection bias can be partially controlled by demonstrating that the groups were initially equivalent on relevant variables. Selection bias can also be checked by comparing the $O_3 - O_4$ comparison with the $O_6 - O_4$ comparison. If these comparisons are approximately equal, then selection bias cannot be used to explain the observed group differences.

Experimental Mortality. Experimental mortality refers to the loss of data from subjects who dropped out of the study. If subjects who drop out of the study are different from those who remain, then the results of the posttest could be biased. Posttest bias will result when dropping out is related to the dependent variable. For example, if students dropped out of an instructional treatment because it was too difficult, the treatment might show an effect because only the more able students remained to be posttested.

Differential mortality between the control group and the experimental group is also a rival hypothesis. Mortality can be eliminated as a rival hypothesis by comparing $O_3 - O_4$ with $O_6 - O_4$. If this comparison is approximately equal then mortality is ruled out.

Internal Validity Summary

In summary, three comparisons must be satisfied before the internal validity of the present study can be confirmed. The first comparison is a comparison of O_3 with O_4. It states that there is no difference between the initial learning of the experimental group and the pretest knowledge of the control group. This comparison will be called Null hypothesis A: $O_3 - O_4 = 0$.

The second comparison is a comparison of the difference between the initial learning and pretest knowledge of the control group. It is called Null hypothesis B: $O_6 - O_4 = 0$.

The third comparison is a comparison of the initial learning of the experimental group with the initial learning of the control group. If there was no selection or mortality bias, these two groups should have learned approximately the same amount from the instruction. Thus Null hypothesis C is: $O_6 - O_3 \neq 0$. All three of these null hypotheses must be rejected before the internal validity of the experiment can be confirmed.

Chapter I refered to the Internal Validity Hypothesis (H_{IV}). This hypothesis cannot be tested by one comparison, but rather requires that three different null hypotheses be rejected before the internal validity of the present experiment is confirmed. These three hypotheses were refered to above as Hypothesis A, B, and C.

Threats to External Validity

Threats to external validity limit the generalizability of a study to specific populations, treatment variables, settings and measurement variables.

> The problems of internal validity are solvable within the limits of the logic of probability statistics; the problems of external validity are not solvable in any neat, conclusive way. Generalization always turns out to involve extrapolation into a realm not represented in one's sample . . . logically, we cannot generalize beyond (the limits of this sample). But we do attempt to generalize by guessing at laws and checking out some of these generalizations in other equally specific but different conditions. (Campbell and Stanley, 1963, p. 187)

Four threats to external validity will be discussed in the sequel:

<u>The Interaction of Testing and Treatment</u>. If this interaction is present, then the treatment will either be more effective or less effective due to pretesting. When the pretest is highly unusual it is more likely to interact with the treatment than when it is a fairly common occurrence. The best way to control for this interaction is to avoid a pretest.

In the present study, the $O_3 - O_4$ comparison controls for this interaction, but does not measure it. This interaction cannot be ruled out as a limitation on the $O_6 - O_4$ comparison.

<u>The Interaction of Selection and Treatment</u>. If this interaction is present, then any experimental results should be restricted to that population which is uniquely described by the subjects in the experimental and control groups. This interaction implies that there is something unique about the sample of subjects studied which is responsible for the treatment results. For example, treatment results might apply to rural subjects, but not urban subjects.

There is no way to test for the presence of this interaction; a complete description of sampling procedures is the best way to determine the extent of this interaction.

Reactive Effects of the Experiment. Whenever subjects are aware that they are in an experiment, or their normal routine is disrupted by the experiment, then subjects may react differently to the treatment, than in a similar nonexperimental situation. The best way to avoid this problem is to keep the experimental situation as normal as possible, and to keep the experiment as unobtrusive as possible.

Multiple Treatment Interference. This occurs when the subject experiences more than one treatment during the experiment. The combination of treatments may produce results different than if the subject had experienced the experimental treatment alone. For example, students in school usually take more than one subject on any one day. Even though these other courses are not experimental, they could have an interfering effect on the experimental treatment.

Analysis

Multiple Regression Analysis

Hypotheses one through eight were tested using multiple regression analysis. Multiple regression analysis is commonly based on one of the three following analytical strategies: (a) simultaneous model (b) the hierarchical model, or (c) stepwise regression (Cohen and Cohen, 1975). The simultaneous model analyzes all of the independent variables at the same time; each independent variable is treated equally. This model is appropriate

> when we have no logical or theoretical basis for considering any variable to be prior to any other, either in terms of a hypothetical causal structure of the data or in terms of its relevance to the research goals. (Cohen and Cohen, 1975, p. 98)

The hierarchical model is an alternative analytic strategy to the simultaneous model. The hierarchical model enters independent variables into the regression equation "cumulatively according to some specified hierarchy which is dictated in advance by the purpose and logic of the research" (Cohen and Cohen, 1975, p. 98). That is, independent variables are entered in the regression equation in a series of cumulative steps. These cumulative steps form a hierarchy. For example, assume there are three independent variables, A, B, and C. At step one a regression equation is calculated based on variable A. At step two a regression equation is calculated on variables A + B; and at step three, a regression equation is calculated on variables A + B + C.

R^2 (the squared multiple correlation) is the proportion of the dependent variable variance which is accounted for by all of the independent variables in the model. Thus, a hierarchical analysis produces a series of R^2's: one R^2 for each step in the hierarchy. As independent variables are added to the hierarchical model, the cumulative R^2 increases. This hierarchical procedure makes it possible to calculate the relative proportion of dependent variable variance accounted for by each independent variable (X_i) in the model. This proportion is calculated by subtracting R^2 at step 2 from R^2 at step 1 ($R^2_2 - R^2_1$); this increase in R^2 is called the squared semiparital correlation (sr^2_i).

Thus sr_i^2 equals the increase in the squared multiple correlation (R^2) when variable X_i is added to the previous independent variables in the regression equation. This increment in R^2, due to adding variable X_i to the regression equation, equals the proportion of the dependent variable (Y) variance accounted for by X_i. So the hierarchical model provides a way to partition the Y variance into the proportion of variance accounted for by each of the independent variables. In fact this is the only method to partition the Y variance when the independent variables are correlated.

The major limitation to this approach to variance partitioning is that the proportion of Y variance accounted for by each independent variable depends upon that variables place in the hierarchy. That is, variables entered first in the hierarchy are likely to account for a greater proportion of the Y variance than variables which are entered later in the hierarchy. So sr_i^2 is relative to each specific ordering of the independent variables.

The major task in using the hierarchical model is to determine the order of the independent variables. If a rationale for ordering the independent variables cannot be found, then the hierarchical model should not be used. In this case its results would be totally misleading, and the simultaneous model is the method of choice.

The major advantage of the hierarchical model is that once the order of the independent variables is determined, the total Y variance accounted for by the regression equation can be partitioned among the independent variables. Thus, it is extremely important that the hierarchy of the independent variables is determined by the purpose and logic of the research design.

Two methods are commonly employed to determine the hierarchical order of the independent variables: causal priority, and research relevance. Causal priority demands that independent variables which are either temporally or logically prior to other independent variables were grouped together into "functional sets" (Cohen and Cohen, 1975, p. 125). A functional set is a set of independent variables which were grouped together because of their substantive content or because of the function they perform in the logic of the research. For example, the nine scales of a personality questionnaire might be grouped together into a "personality set" and represented as a research factor by set P or a number of different variables might be grouped together into a covariate set and represented as the research factor COV.

Setwise Regression Analysis

The present study grouped the independent variables into five functional sets. These sets were entered in the regression equation in the following order:

1. a covariate set (COV)
2. an ability set (A)
3. a classroom environment set (CE)
4. an interaction set (A X CE)
5. a developmental interaction set (Grade Level X CE where CE stands for the classroom environment set (G X CE)

Each of these sets corresponds to one of the research hypotheses stated earlier with the exception of the covariate set.

There are three major reasons for basing the analysis on sets rather than on the separate independent variables.

1. The most important reason for the present study was that testing sets of variables for significance rather than separate independent variables helps to control the experimentwise error by decreasing the number of significance tests performed.

2. In some cases the primary interest of the study is the research factor constituted by the set of variables, not each independent variable. For example the covariate set in the present study.

3. It is often conceptually easier to discuss a set of variables as opposed to a number of independent variables.

The method of analysis for sets is similar to the hierarchical method for individual independent variables. That is, at each stage of the hierarchy a set of variables is added to the model, and the increment in R^2 due to adding the set of variables to the equation is calculated. If this increment (sR^2) is significant, it indicates that at least one of the variables in the set accounts for a significant proportion of the variance of the dependent variable. If a significant increment is found, a test for each independent variable in the set is calculated. However, if a set of independent variables is not significant, no t tests on the sets constituent independent variables are permitted.

For example, when the ability set A is added to the regression equation, the equation states that Y=COV+A. The R^2 calculated from this equation is symbolized by $R^2_{Y.COV,A}$. The R^2 calculated on the basis of the covariate set alone (Y=COV) is symbolized by $R^2_{y.cov}$. This increment is symbolized as I_A, i.e. the increase in R^2 due to the addition of set A to the regression equation. I_A is identical to the squared semipartial correlation for set A (sR_A^2) (The notation for the above R^2 will be explained in the sequel.)

I_A is tested for significance using the F distribution. If this increment is significant, it indicates that at least one of the ability variables in set A accounts for a significant proportion of the Y variance, and the regression coefficient for each ability variable is tested for significance with a t test. If I_A is not significant, then no significance tests are performed on the individual variables of set A. The logic here is the same logic as the protected t test developed by Fisher (also called LSD test). For each of the research sets tested, all of the individual t tests are under the protection of the overall setwise F test. The individual variables contained in each set can be examined for significance only if the sets significance is established by its F test.

Cohen and Cohen (1975) recommend the above procedure for the following reason.

> Since the number of sets is typically small, the investigationwise Type I error does not mount up to anywhere nearly as large a value over the tests for sets as it would over the tests for the frequently large total number of independent variables. Then, the tests of single independent variables are protected against inflated setwise Type I error rates by the requirement that their set's F meet the alpha significance criterion. Further, with Type I errors under control, both the F and t tests are relatively powerful (for any given n and F^2 [effect size]). Thus, both types of errors in inference are kept relatively low and in good balance. (p. 163)

Occasionally, it may happen that a set has a significant F, but none of its independent variables yield a significant t.

> A technically correct interpretation is that collectively (setwise) there is sufficient evidence that there is something there, but individually, not enough evidence to identify what it is. A risky but not unreasonable resolution of this dilemma is to tentatively interpret as sig-

> nificant any independent variable whose t is almost large enough to meet the significance criterion; whatever is lost by the inflation of the Type I error is likely to be compensated for by the reduction of Type II error, and the resolution of the apparent inconsistency. (Cohen and Cohen, 1975, p. 165)

Analysis of Partial Variance (APV)

The present study tested the 8 research hypotheses using analysis of partial variance; (Cohen and Cohen, 1975) this is a generalized form of analysis of covariance. This analysis was done using setwise hierarchical multiple regression analysis. Almost all of the limitations, assumptions, and logic of analysis of covariance (ACV) apply to the analysis of partial variance (APV). Because many readers will be more familiar with ACV than analysis of partial variance, the sequel will begin with a discussion of ACV, and then broaden this perspective to include the APV.

The purpose of both types of analysis is to statistically control irrelevant sources of variation. There were several irrelevant sources of variation in the present experiment. They exist primarily, because the present experiment was forced to use intact groups (classes) in the experiment; as opposed to randomly assigning students to each class.

The variables which measure these irrelevant sources of variation are called covariates. The purpose of a covariate is to statistically control irrelevant sources of variation. This control is achieved by removing variance due to the covariates from the dependent variable. This is accomplished by regressing Y on the covariates; this regression equation results in a predicted Y based on the covariates ($\hat{Y}$). This predicted $\hat{Y}$ is then subtracted from the observed values of Y($Y-\hat{Y}$); the result is a new dependent variable Y'. Y' has had all of the variance due to the covariates subtracted from it; it is thus commonly referred to as the residual Y variance or the covariate adjusted Y variance.

The ACV is simply a form of setwise hierarchical multiple regression. The covariate set is entered first, and then the research factor set is entered in the equation.

It is important to emphasize that the dependent variable being analyzed in ACV is not Y but a new variable Y', which has been adjusted by the covariate set. Strictly speaking it is the residual Y variance left after the variance attributed to the covariate set has been subtracted ($R^2 - R^2_{COV}$). ACV should be used only when for logical and substantive reasons, the focus of the research interest is on adjusted Y variance, not on Y variance in general. It is also important to note that the research factors of interest are also changed by removing the variance of the covariate set. The new independent variables have also been adjusted by the covariate set, e.g. A.COV.

The following assumptions should be met to perform an ACV. (a) no restriction is placed on the type of variables in the covariate set. (b) The research factor set must be qualitative, or nominal, i.e. it represents group membership. (c) There is no interaction between the covariate set and the research factor set. This is referred to as the homogeneity of regression hypothesis. That is, the relationship between Y and the covariate set is the same for all groups in the population. If this is true, then the same adjustment can be made to each of the groups analyzed by the ACV. If this hypothesis is false, then the adjustment made to all groups will be an overadjustment for some groups and an underadjustment for other groups. This hypothesis is tested by actually entering a (Covariate X Research factor) set in the analysis. If it is non-significant then the ACV is valid.

As suggested earlier Analysis of Partial Variance (APV) is a more general form of ACV. The only difference between the two methods is that assumption #2 of ACV (listed earlier) is not needed. In APV there is no restriction on the type of data used as a research factor i.e. the independent variables in the research factor set may be quantitative as well as nominal.

The Covariate Set. The purpose of the covariate set is to adjust the Y variance for extraneous sources of variation that may bias the results. When variation is controlled statistically by a covariate, it is important that this variance be irrelevant to the objectives of the experiment. If this variance is not removed, it offers an alternative interpretation of the results. A valid covariate must meet the three following conditions:

1. It is an extraneous source of variation that affects Y, but is irrelevant to the objectives of the experiment.

2. The covariate is a determinant or cause of Y; Y is not a cause of the covariate. This is assured when the covariate observations describe the subject at a point in time prior to the observation of Y.

3. If the covariates are related to the research factors, then the flow of causality must be from the covariate to the research factor. "ambiguity may arise in nonexperimental research or quasi-experimental research where preexisting groups make up [the research factor]." (Cohen and Cohen, 1975, p. 395)

If there are differences between classes (the intact groups) on Y, then part of the reason this difference exists is because of the covariates. Thus it makes sense to remove this irrelevant variance from

Y and to examine the residual variance that results when the variance is adjusted for the covariates. Assumption #3 above assumes that when the covariate set is related to the research factor set, it is because the covariate set is causally prior to the research factor set, i.e. the covariate set causes the differences in the research factor set. To the extent that this assumption is false, the covariate set steals variance from the research factor set, and thus underestimates the variance of the research factor set.

Table I lists the major research factors which could influence (cause) classroom learning. Because students were not randomly assigned to classes or teachers, all of these factors are rival alternative hypotheses to the research hypotheses discussed earlier. In order for the results of this study to be unambiguous all of these factors need to be eliminated as potential rival hypotheses.

Given the nature of the intact groups, the best way to deal with these rival hypotheses would be to eliminate these differences using APV with each of the factors in Table I as covariates. Unfortunately, there is not enough data to do this for all these factors. This is particularly true for the national, community and school factors. For example, there are so few schools and communities represented in either the experimental group or the replication group, that this information is redundant with the other covariates used in the analysis.

However, since teachers were assigned at random, this factor should be equated for the experimental and replication group. Thus, its variance is controlled experimentally, and it should not be a rival hypothesis.

An examination of the data presented in the next section and in Table XXXII suggests that there are large differences between classes on

Y, and that students were probably assigned to classes and teachers on the basis of ability. Thus, it is essential to statistically adjust Y for these class differences. Table XX presents the class variables on which data were collected. Three of these variables were used as co-variates: (a) grade level, (b) total instructional time, and (c) clas-size.

Grade level is the distinction between the eighth grade classes and the high school classes; it is a dummy variable coded 1 for eighth grade and 0 for high school. Grade level probably accounts for the largest difference between the classes. Of all the variables in the analysis grade level was expected to have the largest correlation with Y. That is, it was expected that high school students would do better on a posttest than eighth grade students. This is true for the replication group, but only approximately true for the experimental group. Ability has approximately the same relationship to Y as grade level does for the experimental group (see Table XVI).

The instructional time (IT) is approximately the total time students were exposed to the instruction. It is the product of the number of class periods spent on instruction and the length of each period in minutes. Teachers were very good in reporting the number of class periods spent on instruction. (This is based on the teachers records.) The approximation occurs because no record was kept of the actual length of each period.

For example, in the course of several weeks events within each class probably occurred to reduce the time spent on instruction for that class period, e.g. announcements from the office, students late to arrive, disruptive students. Thus, the reader should consider

TABLE XVI

CORRELATION BETWEEN GRADE LEVEL, ABILITY AND POSTTEST FOR THE EXPERIMENTAL AND CONTROL GROUPS

	EXPERIMENTAL GROUP		CONTROL GROUP	
INDEPENDENT VARIABLES	POSTTEST	N	POSTTEST	N
GRADE LEVEL*	-.529	179	-.650	184
ABILITY FACTORS				
F2**	.185	140	.527	149
F3***	.535	140	.445	149

*GRADE LEVEL is a dummy variable. Eight grade students were coded 1; high school students were coded 0.

**F2 was computed from a factor analysis of the independent variables and represents nonverbal ability.

***F3 was computed from a factor analysis of the independent variables and represents verbal ability.

instructional time (IT) to be the maximum amount of time available, not the actual time spent on instruction. In reality, these figures are probably within 5% of each other, and probably affected all classes to the same degree.

The third covariate is class size; it is the total number of students in each class during the instructional unit. Class size was chosen as a covariate because it is a fundamental social characteristic of a group, and could have an impact on learning. It also could be a determinant of some of the CES scales, e.g. affiliation, competition.

The major student variables which could influence Y are listed in Table I. The present study collected information on ability and demographic characteristics. Ability was the major research factor in the present study. The other variables in the student factor set could be used as covariates, or more importantly as variables in the research factor. It was beyond the scope of the present study to collect and analyze this information. Extensive demographic information on the student's characteristics was collected. This information was not used for covariates because of a possible relationship to the variables in the research factor set.

The Research Factor Set. Four sets were included in the research factor set: an (1) Ability set, (2) a Classroom Environment set, (3) The Ability by Classroom Environment Interaction set (A X CE), and (4) the Grade level by CE Interaction set (G X CE).

The Ability Set. Two variables were included in the ability set; these two variables were the result of a factor analysis of the independent variables used in the present study (See Chapter IV): the data were the four subscale scores from Cattell's Culture Fair test, and two vocabulary tests. These factors will be referred to as factor 2 (F2) and factor 3 (F3). They are the second and third factors from the factor analysis, and are entered in the regression equation in terms of their eigenvalues (characteristic roots) from the factor analysis. The ability set was entered before the CE set because the present author considered ability to be causally prior to CE, and secondly ability is more important than the CE set.

The Classroom Environment Set. The classroom environment set (CE) was entered in the regression equation after the ability set. This set contained three variables; these variables were the result of the factor analysis of the nine CES scales used in the present study. The factors will be referred to as Factor 1, Factor 4 and Factor 5. They were entered into the regression equation in terms of their eigenvalues (characteristic roots).

The Ability by Classroom Environment Interaction Set (A X CE). This set contained six variables; these interaction terms were all of the combinations of the ability set with the classroom environment set. It is important to note that these terms carry the interaction information only when the variance due to ability and CE has been partialed prior to entering the interaction terms in the equation.

There are several different ways to interpret a significant interaction; they focus on different properties of the interaction, but ultimately mean the same thing.

> 1. Two variables are said to interact in their accounting for variance in Y, when they have a joint effect over and above any additive combination of their separate effects.
>
> 2. An interaction is a joint or conditional relationship between the research factors. For example, the relationship between factor A and Y is conditional upon the value of factor B, or the relationship between B and Y is conditional on the value of A.
>
> 3. When the interaction is significant, we can conclude that, the Y on A regression line slope changes with or depends on the value of B. Equivalently, the Y on B slope changes with or depends on the value of A. (Cohen and Cohen, 1975, p. 280)

When there is no interaction the research factor of interest operates uniformly at all values or levels of the other factor, i.e. it is an average effect which is independent of the other research factors. However, when a significant interaction is present, statements about research factor A must be qualified by specifying the value or level of research factor B that it applies to.

For example, if there was a significant interaction between grade level and ability, then the slope of the Y on ability regression is different for eighth grade and high school students. That is, the relation between ability and Y is conditional upon the grade level of the students and the average regression line does not describe either group. If this interaction is not significant, then the relationship between ability and Y is the same for eighth grade and high school students. High school students may score better on Y than eighth grade students, but the relationship between ability and Y is the same for both groups.

The above example described an interaction between a quantitative research factor and a qualitative research factor. A similar interpretation can be made for the interaction between two qualitative variables. Both of these situations are common in the research. However, the interaction between two quantitative variables can also be analyzed, and a similar interpretation made. The major difference between this situation, and the interaction between a quantitative and qualitative variable is the graph of the results. The first example above produced two regression lines, i.e. one line for each grade level. When the interaction is between two quantitative variables, the graphic results call for a family of regression lines, i.e. a different regression line will be drawn for each value of the quantitative variable.

For example, the present study is investigating the interaction of two quantitative variables: ability and classroom environment. If there is a significant A X CE interaction, then a different regression line should be drawn for each value of CE. This situation can be simplified by selecting a high, medium and low value of CE, and drawing regression lines for these values. In spite of these differences, the interpretation of a significant interaction remains unchanged. For the above example, the relationship between Y and ability is dependent on the type of classroom environment perceived, or equivalently, the relationship between Y and perceived classroom environment is dependent upon the ability of the students.

The Grade Level by Classroom Environment Interaction Set. This set contains three variables; the interaction between grade and each of the variables in the Classroom Environment set. The triple interaction Grade X Ability X CE was not used in the equation because of the low power of the significance test, and because testing this term would lower the power of other significance tests in the set.

Error Rate Investigationwise

The error rate is the probability of a result being falsely declared significant, i.e. the probablity of a type I error. When an experiment only tests one comparison, then the error rate is simply the significance level alpha. However, the error rate changes when an experiment tests several comparisons, or hypotheses. For example, if an experimenter tests 100 hypotheses at alpha equals .05, then for any single hypothesis there are only 5 chances in 100 of making a type I error. However, for all 100 comparisons, there is a 99.4% chance that at least one comparison will be falsely declared significant. So, in calculating the error rate, it is important to determine the unit of analysis on which the error rate was calculated.

Three different conceptual units for error rates are comonly discussed: the error rate (a) per comparison, (b) per hypothesis, and (c) per experiment or investigation. The error rate per comparison was discussed previously. The error rate per hypothesis is the traditional conceptual unit for error rate. It is the probability that any one of the hypotheses in the experiment will be falsely declared significant. However, Ryan (1962) and many statisticians have argued for a larger conceptual unit, the error rate per experiment or investigation.

The present study used the investigationwise error rate to determine the significance level for the experimental hypotheses. The investigationwise error rate is the probability of one statement being falsely declared significant. (See formula #10 APPENDIX E). The present experiment was testing four hypotheses on three different samples (experimental group, replication group, and retention group). Thus, the present experiment was actually making 12 different comparisons.

The investigationwise error rate for three different significance levels is listed in Table XVII. It is desirable for the investigation-

TABLE XVII

INVESTIGATIONWISE ERROR RATE FOR THREE DIFFERENT SIGNIFICANCE LEVELS*

Significance level per comparison	Investigationwise error rate
.01	11%
.05	46%
.10	72%

*These rates are based on testing 12 independent comparisons.

wise error rate to be as low as possible; this could be accomplished using alpha equal to .01. However, it is also desirable to find significant results when they exist, i.e. high power for each test. The need for a low error rate and high power conflict with each other.

Power is the probability that a statistical test will yield statistically significant results. Clearly, the experimenter would like power to be as large as possible. Unfortunately, for any given sample size power decreases as alpha increases. Thus the present experiment adopted the alpha equals .05 significance level in order to increase the power of the statistical tests. The investigationwise error rate is 46%. (See Table XVII). That is, there is a 46% chance that at least one of the 12 hypotheses tested will be falsely declared significant. (This is an approximation based on the assumption that the hypotheses are independent, which they are not.)

Power Analysis

Power is the probability of finding a significant result when it exists. "An analysis which finds that the power is low should lead one to regard...negative results as ambiguous" (Cohen, 1969, p. 4). Under conditions of low power, failure to reject the null hypothesis cannot have much substantive meaning since there was not much chance of finding significance to begin with. Thus, it seems imperative to calculate the power of the statistical tests of an experiment before the data are collected. Hypotheses with low power should be abandoned or the experiment should be modified to improve the power.

Power is a function of three variables: (1) sample size, (2) alpha, and (3) effect size. When these three variables are specified the power of the statistical test is uniquely determined. The major problem in a power analysis is to determine the effect size. In general terms effect size is the proportion of variance of the dependent variable accounted for by the independent variables under study. If other variables are also being studied, effect size is the proportion of Y variance accounted for after the appropriate variables have been partialed from Y. This consideration of partialed variables will result in smaller effects sizes being important. In terms of proportion of variance Cohen (1969) suggests that .01 is a "small effect", .06 is a "medium effect", and .14 is a "large effect". In general the larger the effect you are looking for, the greater the power the test will have.

The present study was designed for a sample size of 100, with alpha equal to .05, and a medium effect size of .06 was expected. The power of the main research hypotheses under these conditions was approximately .5. The power of the interaction hypotheses was too low. So, the desired sample size was raised to 150 in order to improve the power of the interaction hypotheses tested.

Regression Statistics

The following statistics were used to describe the results of the regression analysis: (a) standardized regression coefficient, (b) raw score regression coefficient, (c) squared semi-partial correlation, (d) squared-partial correlation and (e) standard error of b_i.

The Standardized Partial Regression Coefficient (Bi).

> The multiple regression model requires the determination of a set of weights for the k independent variables, which, when used in the linear regression equation, minimizes the average squared deviation of the estimates $\hat{Y}$ from the observed score. (Cohen and Cohen, 1975, p. 449)

That is, if d is the residual or deviation of the predicted $\hat{Y}$ from the observed Y $(Y - \hat{Y})$, then regression analysis determines a set of weights for the independent variables which keeps d^2 to a minimum. These weights are the set of standardized partial regression coefficients, beta's (B_i).

The beta's are regression coefficients for a set of independent variables that have been standardized, i.e the independent variables have been changed so that they have a mean of zero and a standard deviation of one. Beta's are "partial" regression coefficients because when the beta weight was calculated the effects of all other independent variables in the question were held constant, or partialed from Y.

Another interpretation of the beta's is that they are population values or parameters, in contrast to the raw score regression coefficients (b_i) which are sample estimates of the beta's (B_i) (Kerlinger and Pedhauzer, 1973). In either case the beta's are weights for each independent variable which produce a composite score (Y). This composite has the maximum correlation possible with the dependent variable, based on the set of independent variables. B_i technically should be written as $(B_{yi.\ 1,2,3..(i),..k})$.

The Raw Score Partial Regression Coefficient.

> The raw score partial regression coefficient $b_i =$ $(b_{yi.\ 1,2,3,\ (i)..k})$ is the constant weight by which each value of the variable is multiplied in the multiple regression equation which includes all k independent variables. Thus b_i is the average or expected change in Y for each unit increase in X_i when the value of each of... the other independent variables is held constant. (Cohen and Cohen, 1975. p. 92)

The raw score regression coefficient is analagous to beta, but is applied to raw score data as opposed to standard score data. "b_i"

can also be applied to data in deviation score form, i.e. $(X_i - \overline{X})$. (b_i is also a partial regression coefficient.)

There are several ways to calculate b_i; the most common method is to convert the beta's into b_i by multiplying each beta by the following fraction: $(s.d._y/s.d._i)$.

<u>The Partial Correlation Coefficient</u>. "A partial correlation is the correlation expected between two variables when a third variable is held constant" (Nunnally, 1978, p. 170). The third variable is held constant or partialed statistically by subtracting the variance of the partialed variable from variables 1 and 2. This partialing process creates two new variables which have been residualized on the third variable.

For example, to calculate the partial correlation between Y and X_1 with the effects of X_2 held constant (symbolized by $pr_{y1.2}$), the variance of X_2 is subtracted from Y; the residual Y variance = $(Y - X_2)$. The variance of X_2 is subtracted from X_1; the residual X_1 variance = $(X_1 - X_2)$. Now that the effects of X_2 has been removed from both variables, the Y residual is correlated with the X_1 residual. The result is a partial correlation. The partial correlation process is similar to the partialing process used in the ACV discussed earlier.

When the effects of one variable are partialed (as in the above example) this is called a first order partial correlation, or regression coefficient. When it is necessary to partial the effects of more than one variable from a relationship, the method described above applies, and these partials are referred to as higher order partial correlations or regression coefficients. The order of the partial corresponds to the number of variables partialed from the relationship.

The notation for partial correlation is unusual and should be explained. The variables whose relationship are being studied appear before the dot in the notation; variables which are being partialed or held constant appear after the dot. Thus $pr_{yl.234}$ is the partial correlation between Y and X_1 with the effects of variables 2, 3, and 4 held constant. This is a third order partial correlation. "$b_{Y1.234}$" is a third order regression coefficient.

The partial correlations described in the sequel are higher order partials with the effects of all independent variables held constant except the variable X_i. The symbol pr_i will be used to describe this relationship, and always refers to $pr_{Yi.1,2,3..(i)..k}$ or $b_{Yi.1,2,3...(i)...k}$. The parentheses around i indicates that its effects have not been removed. The squared partial correlation pr^2_i is interpretable as a proportion of variance; it is the proportion of the residual Y variance accounted for uniquely by X_i. When the partial for a set is calculated, this is symbolized by a capital R, e.g. pR^2_A.

The Semipartial Correlation Coefficient. The semipartial correlation is also referred to as a part correlation. In partial correlation the effects of the partialed variables were removed from both variables. In the semipartial correlation the effects of the partialed variable are removed from only one of the variables.

The first order semipartial correlation between Y and X_1 with the effects of X_2 partialed from X_1 is specified by $sr_{Y(1.2)}$. In general the present analysis is only interested in the highest order semipartial denoted by $sr_{Y(i.\ 1,2,3...(i)...k)}$. This semipartial will be abbreviated to sr_i. The outer set of parentheses after Y, indicates that the effects of all the variables after the dot have been partialed from variable i, but not from Y. As before, the inner parentheses around i indicate that its effects have not been removed. Capital letters, as opposed to numbers, indicate that sets, rather than variables were partialed, e.g. $sR_{Y(A.B)}$ indicates that the effects of Set B have been partialed from Set A, but not from Y.

The squared semipartial correlation sr_i^2 is the proportion of the total Y variance uniquely accounted for by X_i. As mentioned previously sr^2_i is the increase in R^2 when X_i is added to the other independent variables. In fact the squared multiple correlation, R^2, can be partitioned into a series of higher order squared semipartial correlation coefficients. For example, for $R^2_{Y.123} = r^2_{y1} + sr^2_{Y(2.1)} + sr^2_{y(3.2,1)}$. If sets are being partialed, the $R^2_{Y.ABC} = R^2_{YA} + sR^2_{Y(B.A)} + sR^2_{Y(C.B,A)}$. As mentioned earlier, partitioning R^2 into a series of sr^2 is the only way to uniquely partition the Y variance when the variables are correlated. A simpler but equivalent notation for partitioning R^2 is $R^2_{Y.1,2,3} = r^2_{Y1} + I_2 + I_3$.

The Data Collection Phase

The Data Collection Schedule

Data collection actually began when the present author visited superintendents looking for permission to use his school system in the present study. This phase began during mid-November, 1977. Due to Thanksgiving vacation, and Christmas vacation all schools and teachers were not recruited until the middle of February 1978.

The next phase of the study involved finding a unit of instruction which all nine teachers were planning to teach. A unit on acid-base theory was agreed to by all of the teachers by the first week in March, 1978.

Ability Testing Phase. For each class all of the ability tests were administered on the same day during a regular class period. It was intended that the ability tests be given on approximately the same day for all classes. However, this did not happen; ability testing began on March 14, 1978, and was completed by April 3, 1978.

Two events caused this delay: 1. the principle reason for this time delay was an inadequate supply of ability tests; when ability tests were ordered from the test publisher, the publisher did not notify the present author that they did not have enough tests on hand to fill the order. This prevented all teachers from administering the ability tests at the same time. There were only enough test booklets to test half of the group at one time. So the first testing session began on March 14 to March 20; the second testing session began on March 27 and ended on April 3.

2. Easter vacation fell in the middle of this testing period on April 26. With the exception of three classes tested on April 20, no tests were administered during the week prior to Easter. Thus, Easter probably did not influence the validity of the test but it did lengthen the span of time needed to complete the ability tests.

The regular classroom teacher administered all of the student tests including the ability tests. Each teacher was provided with a set of directions for administering the ability tests. (See Appendix G) These directions included a general description of standardized testing procedures and emphasized the need for following the test directions exactly. Each teacher also received a briefing from the present author on the testing procedures. The teachers all felt confident that they could administer the ability tests correctly, and all refused the present author's offer to administer the ability tests for them.

Each teacher was provided with a stopwatch or an accurate bell timer. (accurate to three seconds in three minutes) The teachers had no difficulty administering the tests. However, several observations about the testing situation should be noted: (a) about half of the classes (14 out of 25 classes taught by 5 teachers) did not have enough time to complete the induction ability test (I-1); so this test was dropped from the analysis. (b) All of the students in the eighth grade classes of the experimental group were diagnosed as having learning disabilities. (The present author did not discover this fact until the unit was half over.) These students really enjoyed completing the Culture Fair Test; apparently it was one of the only standardized tests they ever succeeded at. (c) In general, students were unfamiliar with the format of the Culture Fair Test, and getting started on these tests required more administrative time than planned. This was the main reasons students didn't have time to complete the induction test.

CES Testing Phase. The Classroom Environment Scale was administered to each class between March 30, 1978, and April 7, 1978.

(One class completed the CES on April 11; this delay was caused because the class did not take the ability tests until April 3.) The CES is an untimed paper and pencil test; the directions for the test are written on the test booklet. When students had difficulty with the directions the teacher read the directions aloud, and helped the students individually when necessary. Normally, the test takes 15 to 20 minutes to complete.

In general, the teacher did not play an important part in the administration of the CES. However, there was one important exception; the three Learning Disabled, eighth grade classes found it extremely difficult to read the CES. The teacher read the directions to them, and then read each statement to the class. These students also had difficulty writing the answers on the answer sheet provided, and they wrote their answers directly on the test booklet.

Pretesting Phase. It was extremely difficult to match the administration of the pretests (in the control group) with the administration of the posttests (in the experimental group) so that they occurred on approximately the same day. The experimental group teachers taught the unit of instruction in its normal sequence. However, the control group teachers were not always able to postpone the unit of instruction so that the their pretests corresponded with the posttests of the experimental group.

The pretest was administered on the first day of the unit of instruction; it took approximately 15 minutes to complete the administration of the pretest. This made the pretest an unusual event, but not an extremely incongruous event, i.e. it seemed logical to students. Pretests were administered to the 14 control group classes from May 3 to May 30, 1978, i.e. approximately the whole month of May. Six classes were pretested from May 3 to May 8; eight classes were pretested from May 17 to May 30, 1978. It was difficult for most teachers to alter their scheduled time for teaching the unit of acid-base theory. (Four out of the nine teachers were able to change their schedule to met the needs of the experiment.)

A student with no knowledge of chemistry would be expected to receive a score of approximately 10.0 on the pretest by guessing. (This is based on the binomial distribution and assumes that the probability of answering any of the 40 questions correctly is .25; this is a slight overestimate.) A pretest score greater than 14.5 would occur by chance only five times out of hundred. Sixty out of 231 students had pretest scores greater than 14.5. Thus, approximately 25% of the students in the control group must have learned information about Acid-Base theory which helped them on the pretest. This percentage was suprisingly high to the present author.

Posttesting Phase. The posttest for the experimental and control groups took a class period to complete. The teacher administered the posttest on the last day of the unit of instruction. With the exception of one class which took the posttest on April 28, all of the posttests were administered to the experimental group between May 22 and June 1. That is, 11 out of the 12 experimental classes completed the posttest within 10 days of each other.

The posttest for the control group was administered between May 31 and June 16. That is, all of the control group classes completed the posttest within 17 days of each other. The most serious limitation on posttest validity was that, for four out of the nine classes taking the posttest, this was very close to their last academic task of the school year.

Retention Testing Phase. The retention test was a parallel form of the posttest which took approximately a class period to complete. It was administered by the regular classroom teachers.

The retention test was scheduled to be administered two weeks after the posttest, i.e. the retention interval was 14 days. However, only five out of the ten classes were close to this retention interval (four at 14 days; one at 15 days) One class had a retention interval of seven days; this occurred because school was ending and the teacher could not postpone the retention test. The remaining four classes had retention intervals of 20 days. The two teachers involved could not fit the test into their schedules before this time. The average retention interval for nine classes was 15.3 days.

Instructional Treatment Description

As described earlier, educational researchers are generally ignorant of the basic dimensions of the instructional treatment. It was for this reason that the present author adopted the following operational definition of instructional treatment. The instructional treatment on acid-base theory consisted of all means the teacher would normally use to promote student learning. The only restriction placed on the teacher's behavior was to teach normally. No limitations were made on media, methods or instructional time.

However, instructional time was considered in choosing the unit of instruction. The criteria for choosing the Acid-Base unit of instruction were:

1. The unit should last between 10 and 15 days of instruction; this length of time was representative of other units, and was long enough to have an effect on the student.

2. All teachers had to be planning to teach the unit.

3. The unit had to be completed by May 26 in order to allow time for a two-week retention test.

The reader should note that the present author originally intended to control the amount of instructional time each student received. With so many different teachers and grade levels, this turned out to be impossible. Each teacher wanted to cover the material at the pace most suited to their classes. Instructional time must be controlled in order to make valid comparisons between classes. This control was achieved by analysis of partial variance.

The length of a class period varied fom 40 minutes to 50 minutes; so, instructional time is more accurately measured in minutes of instruction rather than days of instruction.

In order to make the instructional treatment as natural as possible, teachers were requested to keep the experiment secret from their students. Teachers were not very successful at concealing the experiment from their students. Fifty percent of the classes knew an experiment was being conducted (see Table XVIII). However, only one out of 20 classes behaved differently (teacher self-report) than normal.

During the instructional treatment five of the nine teachers (11 out of 20 classes) had something unusual happen which could invalidate the results of the instructional treatment. These events are listed in Table XIX. All of these events were normal disruptions of school life. Since 55% of the classes experienced a disruption during the instructional treatment, the present author suggested that disruptions were the normal state of affairs in most classes, at least in the spring.

TABLE XVIII

REACTIVE EFFECTS OF THE EXPERIMENT

	Teachers Response to Question		
Question*	Yes	No	Total Classes
Did the Class Know an Experiment Was Being Conducted?			
Experimental Group	7	4	11
Replication Group	3	6	9
Total	10	10	20
Did the Class Behave Differently During the Experiment Than They Usually Behave?			
Experimental Group	1	10	11
Replication Group	0	9	9
Total	1	19	20
Did anything Unusual Happen During the Experiment Which Might Make the Results Invalid?			
Experimental Group	8	3	11
Replication Group	3	6	9
Total	11	9	20

*These questions were asked during a personal interview with the teacher. The data were recorded on the Treatment Description Form.

TABLE XIX

UNUSUAL EVENTS WHICH OCCURRED DURING THE INSTRUCTIONAL TREATMENT

Event	Number of Classes Effected
1. A variety show put the students in a party mood. The students who participated missed some classwork to be in the show.	3
2. Some students missed class to participate in field trips for other classes.	1
3. There was a two day interruption in the instructional unit for achievement testing.	4
4. A new class schedule was adopted during the instructional unit in order to make up for the time missed because of snow storms. Students had trouble adjusting to this new schedule.	3

*Eleven out of twenty classes had an unusual event occur during the instructional unit.

The single class which reacted specifically to the study was angry at the intrusion into their class. This class knew that an experiment was being conducted, and the teacher believed that they behaved differently than normal. However, the learning and retention scores of this high school class were not perceptibly different from the other high school classes in the experimental group. So, the present author concluded that the reactions of this class may have affected their attitudes, but these reactions did not have a perceptible effect on their learning or retention.

Problems in Describing Instructional Treatments. Instructional treatments have generally been classified into categories such as:

discovery learning, lecture, discussion, etc. This has generally been an unsuccessful approach. (Snow, 1974; Cronbach and Snow, 1977) Several reasons can be found for this lack of success in defining instructional treatments with nominal categories.

1. Probably, the most critical flaw is that instructional treatments are not qualitatively different phenomenon but are quantitatively different. For example, all teachers who use a discovery approach do not do exactly the same thing in the classroom, i.e. some teachers utilize more or less discovery learning, but still will label their teaching method as discovery learning. Thus, it would be more appropriate to quantify the degree to which a teacher uses discovery learning, rather than assume that all teachers who used discovery learning are doing exactly the same thing. Considerable information is lost by categorizing these basically quantitative instructional treatment variables.

2. Tobias (1976) suggests that instructional treatments are basically multivariate not univariate in nature (Cattell, 1966; Snow, 1974). That is, it takes more than one variable or dimension to accurately describe any instructional treatment/environment.

For example, two teachers who devote exactly the same amount of time to discovery learning, will perform differently in terms of other variables. To accurately describe the instructional treatments/ environments these teachers create, it is necessary to use more than one dimension. One of the main reasons that researchers use univariate descriptions of their instructional treatments, is a general ignorance concerning the basic dimensions along which instructional treatments can vary (Stephens, 1967).

3. Instructional treatments should describe the psychological functions, i.e. processes, a student is expected to utilize in learning from each type of treatment environment (Salomon, 1971). Instructional treatments which utilize the same psychological processes in each student e.g. high verbal ability, are unlikely to produce different results.

A Model for a Multivariate Description of Instructional Treatments. At the present time, the major dimensions for simply describing instructional treatments/environments or for explaining learning are unknown. The following four dimensions are suggested as a basis for a multivariate description of instructional treatments. These dimensions were suggested only as a way of describing instructional treatments; they were not intended as an explanation of classroom learning because it is not clear what theoretical constructs underlie each dimension. They were suggested only so the present author can better describe the instructional treatments which occurred during the present experiment. The four dimensions are: (a) modes of instruction (method), (b) instructional media, (c) psychosocial environment, and (d) instructional style.

It is suggested that any instructional treatment can be described using these four dimensions; however, the present author has no way of determining if more dimensions should be included or if some dimensions are redundant. Or even if the suggested dimensions are measuring fundamental properties of learning environments as the author suggests.

The modes of instruction were suggested by Gagne (1970). A mode of instruction represents a situation in which media is used it is the arrangement or organization of media in relation to a student. Gagne (1970) lists six major modes of instruction; this is not an exhaustive list.

1. Tutoring session -- self-directed reading sessions supervised by the tutor.
2. Lecture -- verbal communication from teacher; lacks individual guidance of learning.
3. Recitation class -- student recites what he previously learned, and he is evaluated by the teacher with feedback.
4. Discussion class -- the student applies previously learned information to situations; teacher tries to encourage transfer of learning.
5. Laboratory -- students learn information by manipulating real objects.
6. Homework -- self-instruction to learn new information, or practice previously learned material.

Instructional media are the components of the learning environment which communicate with or stimulate the learner. Educational psychology (1973) lists nine specific types of media:

1. Instructional objects
2. Social models -- learning from human behavior
3. Oral communication
4. Printed language media
5. Pictures and diagrams
6. Motion pictures
7. Instructional television
8. Programmed instruction
9. Computer assisted instruction

The psychosocial environment is the perceived environment of the learner; it is what Murray called beta press. Moos suggests that three different dimensions are being measured.

Instructional style is the ways in which the teacher controls the learning environment as determined by objective methods, not student perceptions. Murray would describe this as an alpha press. The teacher's personality is probably related to instructional style.

Data on the Instructional Treatments. Data on the first three instructional dimensions discussed above were collected on the treatment description form after the treatment was completed (see Appendix F). No information was collected on instructional style because objective measures of instructional style can be very reactive. This would limit the external validity of the present study.

Table XX presents information on the three instructional dimensions listed above. This table shows that there was considerable variability between classes in the amount of instruction received. Instructional time ranged from seven days to 16 days, i.e. 350 minutes to 656 minutes. This instructional time was divided among the following four instructional modes: lecture, lab, problem solving and group discussion. All classes were assigned homework, but no information was collected on the amount of time each student spent doing homework. For all classes, except the eighth grade classes in the control group, the dominant mode of instruction was lecture. No classes took any field trips, and none of the classes received other types of instruction than the modes listed above. These observations were based on the data collected from the treatment description form.

Information on the instructional media used in each class

TABLE XX

A MULTIVARIATE DESCRIPTION OF THE INSTRUCTIONAL TREATMENT

Class #	Ability Group	Text	Minutes of Instruction: Days	Total	Lect.	Film	Lab.	Prob.	Disc.	Average Factor Scores: Z1	Z4	Z5	Z2	Z3
Experimental Group														
111	0	1	8	400	250	50	50	50	0	-.31	.60	.00	.28	.45
112	1	1	7	350	150	50	100	50	0	.87	.12	.13	.37	.84
113	0	1	8	400	250	50	50	50	0	-.19	.79	-.17	.21	-.01
114	0	1	8	400	250	50	50	50	0	-.12	.62	.25	.01	.53
131	0	1	10	500	300	0	50	150	0	.28	.19	-.49	.16	.04
141	1	1	10	450	157	45	158	90	0	1.17	-.86	-.21	.60	1.03
271	0	1	13	585	244	0	195	146	0	-.53	.87	-.07	.17	.13
272	0	1	13	585	244	0	195	146	0	-.63	.30	-.18	.04	.31
273	0	1	13	585	244	0	195	146	0	-.56	.48	-.10	.35	.64
681	-	*	10	400	200	0	140	40	20	1.09	.56	-.13	.70	-1.62
682	-	*	10	400	200	0	140	40	20	.66	.56	.44	-2.20	-1.24
683	-	*	10	400	200	0	140	40	20	.97	.73	-.16	.14	-1.52
Replication Group														
351	0	1	16	656	287	41	123	123	82	-.41	-.04	-.74	.30	.23
352	0	1	16	656	287	41	123	123	82	.15	.35	.04	-.27	.66
353	0	1	16	656	287	41	123	123	82	.48	.00	-.51	-.18	.02
461	1	0	15	645	430	0	215	0	0	-.18	.04	-.17	.42	.64
463	1	0	15	645	430	0	215	0	0	-.22	-.51	-.49	.65	.60
591	-	*	9	360	72	0	180	0	108	-.71	-.82	1.10	-.28	-.25
592	-	*	9	360	72	0	180	0	108	-.19	-.58	.64	-.30	-.55
593	-	*	9	360	72	0	180	0	108	-.37	-.61	.55	-.48	-.33
594	-	*	9	360	72	0	180	0	108	-.41	-.90	.44	-.67	-.55

Ability group: 1 = honors section; 2 = college section Text: 1 = high school chemistry text; 2 = a different high school chemistry text * the two eighth grade teachers used different text books was limited to the amount of time spent viewing films, and a review of the text books used by each class. Only eight out of the twenty classes viewed a film. The film usually lasted the entire class period. All but two of the high school classes were using the same text book. The eighth grade classes in the experimental and control groups used different approaches to teaching chemistry, and used different textbooks. From discussions with teachers, the present author suggests that the dominant media for all classes was oral communication. None of the classes used programmed instruction or computer assisted instruction.

The perceived psychosocial environment of the learner was measured by the CES. The nine CES scores were factor analyzed, and three CES factors and two ability factors were produced. The average factor score for each class on each of the three CES factors is contained in Table XX. The CES was designed for junior high and high school students, so it is reasonable to compare all classes on the CES factor scores.

The CES factor scores reported in Table XX have a mean of 0 and a standard deviation of 1. So that a score of 0.0 represents the 50th percentile and is an average score. A score of -1.0 corresponds to the 15th percentile and is a very low score. Classes this low on a factor have very little of what the factor measures. A score of 1.0 on a factor corresponds to the 85th percentile and is a very high score. Classes this high on a factor have a great deal of what the factor is measuring. Since very little is known about what type of environment produces learning, the reader should not place value judgements on factor scores. A low factor score is just as likely to produce learning as a high factor score. These factor scores represent the average perception of students in each class.

These factor scores will be discussed in more detail in Chapters 4 and 5. At this time the reader should note that the range on each of the three factors is approximately one standard deviation above and below the mean. The range for factor I is -.71 to 1.17; the range of factor IV is -.9 to .87; the range of factor V is -.7 to 1.1. The present author concludes that there is a large amount of variability between classes in the average perception of the classroom climate.

Missing Data

In any study of naturalistic settings, e.g. classrooms, a certain amount of missing data or incomplete cases should be expected. Missing data occurs primarily due to a lack of control over the classroom situation. As more observations on each subject are made, the chances of losing data increase. In educational settings missing data commonly ranges between 30% and 40% of the subjects, i.e. between 30% and 40% of the subjects will be missing at least one piece of information.

Several factors should be considered in determining if this amount of incomplete data is acceptable: (a) the number of observations made on each subject, (b) the number of different occasions on which subjects are observed, (c) the difficulty of retesting the students on whom data is missing, e.g. self-administered paper and pencil tests would be easier to obtain on retesting than individual

IQ tests, (d) the number of subjects to be tested. As a, b, and d increase the number of students with missing data will probably increase.

For example, the reader should expect a much lower proportion of cases with missing data from a study which collects one paper and pencil test score on each of 50 students, than a study which collects highly idiosyncratic data on five occasions from 1000 students. The first study has 50 chances to lose an observation, with the possibility of at least one retesting. The second study has 5,000 (five occasions times 1,000 students) chances to lose an observation, with little possibility of retesting because of the idiosyncratic testing situations.

The present study tested students on three or four different occasions (ability test, CES test, pretest, and posttest). Data on the three ability tests were collected on the same occasion. Since most students would be present for the entire testing period if they were present at all, these three observations should be considered as one observation. Data was collected on 541 students. Because the ability tests were timed, they would be difficult to retest. Posttests would be moderately easy to obtain on retest; CES would be very easy to obtain on a retest.

An estimate of the upper limit for a response rate for the present experiment can be obtained by observing a single classroom of 20 students. If any of these students are absent on a testing day, then their data will be lost. If 19 out of the 20 students in this class were present for all three testing occasions, then the result would be missing data on three of the 20 students, i.e. 15%.

Two additional factors should be considered: (a) Most teachers used the posttest score for the students grade; so students were more likely than average to attend class on this day. (b) Once an ability test was missed, it would be extremely difficult and unlikely that the teacher would take the extra time to retest the student. These two factors probably balance out with each other. So that, an upper limit on the expected response rate should between 85% and 90% (assuming the teacher collects all of the posttests.)

The upper limit described above assumes an absenteeism rate on any normal class day of 5%. Absenteeism in public schools for any normal day can be as large as 25% to 30%. The larger the absenteeism rate in a school, the greater the probability of missing data. The same logic can be used to estimate a lower limit for response rate. With an absenteeism rate of 20% per day, four students from the above class are expected to be absent on any given day. This yields an overall ressponse rate between 40% and 50%. The response rate for each teacher is presented in Table XXI.

Missing data occurred in the present study for four reasons: the first two reasons discuss missing dependent variables, the second two reasons discuss missing independent variables.

Students Who did not Begin the Unit of Instruction. One-hundred and four students in six classes who began the study did not begin the instructional unit because there was not enough time left in the school year for three weeks of instruction. The independent variables were collected for these students, but no dependent variables were available since the students never began the instruc-

TABLE XXI

MISSING DATA BY TEACHER FOR THE INITIAL LEARNING SAMPLE

	Experimental Group Teachers							Replication Group Teachers						
	1	3	4	7	(8)*	8	Group Total	2	5	(6)*	6	9	Group Total	Sample Total
1. Classes which began study	4	1	1	3	3	-	12	5	3	3	-	4	15	27
2. Total of students in study	70	12	14	75	68	-	239	82	62	60	-	98	302	541
3. Classes in study after adjustments* (N=505 students)	4	1	1	3	-	2	11	5	3	-	2	4	14	25
4. Classes which began unit	4	1	1	3	-	2	11	0	3	-	2	4	9	20
5. Students who began unit	70	12	14	75	(68)	54	225	0	62	(38)	38	98	198	423
6. Students who finished unit	60	12	13	50	(68)	54	189	0	62	(37)	37	98	197	386
7. Students who took ability tests	59	11	10	69	(62)	50	199	56	43	(58)	37	90	226	425
8. Students who took CES test	59	10	10	69	(35)	31	179	63	54	(54)	35	93	245	424
9. Students who took ability and CES test	52	9	10	67	(33)	30	168	46	38	(52)	34	86	204	372
10. Students who took unit test	60	11	11	47	(50)	37	166	0	53	(37)	37	94	184	350
11. Students with complete data	48	8	8	46	(30)	27	137	0	33	(34)	34	82	149	286
12. % of students with complete data who finished unit	80	67	77	92	(44)	50	73	0	53	(92)	92	84	76	74
13. Students who took pretest	0	0	0	0	0	0	0	48	57	(35)	35	91	231	231

*Two classes were dropped from the analysis. Class 682 (N=14) was dropped because of missing data. Class 462 (N=22) was dropped because they never began the unit of instruction or completed the pretest.

tional unit.

The two teachers involved taught six classes: both teachers were in the control group. Teacher #2 taught five classes (82 students); all of these classes received a pretest, but did not start the unit of instruction because the term was about to end. Teacher #6 taught three classes; one of these classes (22 students) did not have enough time remaining in the school year to complete the instructional unit. Because this class was in the control group, it was scheduled to receive a pretest. However, teacher #6 misunderstood the purpose of the control group, and did not administer the pretest to this class because it would not receive the unit of instruction. No pretest scores were available for this group.

All six of the above classes were dropped from the regression analysis because they lacked dependent variables. When a dependent variable is missing, the only choice open to the experimenter is to drop that case from the analysis. These students were dropped from the analysis due to the length of the school year. This was not related to performance on the unit of instruction, but may be related to the ability level of the classes. This loss of subjects is regretable, but can probably be considered a random event, since it was not related to the instructional treatment the students would have received.

Students Who did not Finish the Unit of Instruction. The second reason for droping students from the analysis is also related to the time of year whe the experiment was conducted. In general high schools in Massachusetts have the policy of letting high school seniors who have jobs leave school during the third or fourth week in May. Unfortunately, many of the classes were just finishing the unit of instruction at this time. So that, most of the seniors (35 out of 42) in the present study, left school before the unit of instruction was completed. This loss affected three of the eight teachers (#1, #4, and #7) who finished the unit of instruction. (See line 6 of Table XXI.) All three teachers were in the experimental group.

High school chemistry is generally a junior level course. However, 16.3% of the high school students in the sample (61 out of 375) were seniors, and 13.3% of the high school students in the sample (50 out of 375) were sophomores. Classes with many seniors usually had few sophomores and vice versa. Seniors who were missing a posttest were dropped from the analysis. The loss of these seniors from the analysis is not related to the unit of instruction, but to school policy. There was no reason to believe that seniors behave differently on a unit of instruction than juniors; so the present author concluded that this loss of subjects was a random event that did not affect the generalizations of the study.

Two students left school without completing the unit of instruction (one student from teacher #7 and one from teacher #6). See line 6 of Table XXI. It is not known why these students left school, but they are such a small percentage of the total sample, that they do not pose a threat to the generalizability of the present study.

<u>Students Systematically Missing Independent Variables.</u> In general there was no systematic trend among classes missing independent variables. (See lines 7, 8 and 9 of Table XXI.) Some

classes had more students present for ability testing while other classes had more students present for the CES. However, the pattern of missing data for two teachers was suspicious. For teacher #5, 11 more students took the CES than the ability test, and for teacher #8, 27 more students took the ability test than the CES. The average discrepancy between students taking the CES and Ability tests for the remainig seven teachers was a difference of 1.9 students per teacher.

The present author examined the CES and ability scores of the three classes taught by teacher #5. Class 353 did not present a problem; of the 18 students who took the CES, 16 students had taken the ability tests. Classes 351 and 352 were the classes contributing to the discrepancy observed above.

In Class 351, 16 out of 20 students completed the CES, and 15 out of 20 completed the ability tests. However, only 11 students completed both the ability and CES tests. This is not a systematic error, but the normally expected result. A total of nine students were absent on either testing day, and each student was absent only once.

In Class 352 only 11 out of the 20 students who took the CES also completed the ability tests. This discrepancy was attributed to a low response rate for the ability tests; only twelve students out of the 22 in class completed the ability tests.

Class 352 looks suspicious; did something systematic cause 45% of the class to be absent on the day the ability test was administered? No systematic influences were found to explain this high absentee rate. All three classes of teacher #5 received the ability tests on the same day, Friday, March 17 (St. Patricks day). Absentee rates in the other two classes were 20% and 25%. All three classes have approximately the same ability level, and class size. The present author concluded that the 45% absentee rate was a chance fluctuation, which could not be reduced by retesting.

The independent variable response rate for teacher #8 also looked extremely suspicious. In class 681 only 55% of the class (16 out of 29) completed both the ability test and the CES. In class 682 only 21% of the class (3 out of 14) completed both the Ability and the CES tests. In class 683 only 56% of the class (14 out of 25) completed both the Ability and CES tests. In all three classes this low response rate is due to a very low response rate on the CES. The average response rate for these three classes was 49.7%; the average response rate for all classes to the CES was 81.7% (see Table XXII).

The present author suggested that the low response rate for the CES in these three classes was due to the low reading ability of these classes. The present author suggested that the students were present for the test but were unable to read and follow the directions for the CES. These conclusions are based on: (1) All of the students in these three classes have been diagnosed as learning disabled. This implies a reading level below average for their grade. (2) The teacher read all of the questions on the CES aloud to the students in each class. She did this in response to a specific request from students in class 682. (3) Most of the students in the three classes were unable to use the answer sheets provided, and wrote their answers directly on the test booklet. Even using these procedures many of the students were unable to

TABLE XXII

THE RESPONSE/ABSENTEE RATE FOR ALL INDEPENDENT AND DEPENDENT VARIABLES

			Percentage of Students Completing Each Test				
Class number	Class size	Culture Fair	V-1 and V-2	CES	Pretest	Posttest	Retention Test
Experimental Group							
111	17	82.4	58.8	82.4	-	76.5	58.8
112	19	94.7	94.7	94.7	-	100.0	89.5
113	18	88.8	88.9	72.2	-	88.9	88.9
114	16	93.8	93.8	87.5	-	75.0	75.0
131	12	91.7	91.7	83.3	-	91.7	50.0
141	14	71.4	71.4	71.4	-	78.6	64.3
271	23	95.6	95.6	87.0	-	52.2	56.5
272	26	100.0	100.0	88.5	-	61.6	0.0
273	26	96.1	96.1	100.0	-	73.1	0.0
681	29	96.7	100.0	55.2	-	69.0	90.0
682*	14	85.7	92.9	28.6	-	92.9	92.9
683	25	92.0	88.0	60.0	-	68.0	80.0
Group Average							
Replication Group							
121	16	81.2	81.2	87.5	62.5	0.0	-
122**	17	76.5	0.0	58.8	35.3	0.0	-
123	14	100.0	100.0	78.7	50.0	0.0	-
124	16	93.8	93.8	81.2	81.2	0.0	-
125	19	73.7	73.7	78.9	63.2	0.0	-
351	20	75.0	75.0	80.0	95.0	90.0	-
352	22	54.4	54.5	90.1	90.9	81.8	-
353	20	80.0	80.0	90.0	90.0	85.0	-
461	20	100.0	100.0	100.0	95.0	100.0	-
462**	22			86.4	0.0	0.0	-
463	18	94.9	94.9	83.3	88.9	94.9	-
591	25	96.0	96.0	96.0	88.0	96.0	-
592	24	87.5	87.5	91.6	87.5	100.0	-
593	24	100.0	100.0	91.6	100.0	100.0	-
594	25	88.0	88.0	100.0	96.0	88.0	-
Group Average							
Total Average							

* Class 682 was dropped from the analysis due to missing data.

** Class 122 was not given V-1 and V-2 because the teacher did not have time to complete these tests.

***Class 462 was dropped from the analysis because the did not have time to begin the unit of instruction. They also did not complete a pretest as planned.

complete enough of the CES for the present author to score the form. (4) Class 682, which had the lowest CES response rate (21%) also had the lowest verbal score of all the eighth grade classes. (5) Despite all these problems, all three classes scored as well on the posttest as the control group eighth grade classes, and all three classes were within four points on the posttest of three high school classes.

Class 682 had complete data on three students out of 14. With such a low response rate, it seems appropriate with the problems listed above, to drop class 682 from the analysis. The present author believed that this is too few cases to base a class average on, and that there was no way to know how representative these scores are of the general sample. Dropping this class imposes some limitation on generalizations, but this is preferable to the muddy interpretation that could result from including this class in the analysis.

The response rates on the CES of the other two classes were low, but there was not sufficient evidence to drop them from the analysis. Their posttest performance was surprisingly good. There may be some bias in the subjects who completed the CES. For example, if reading was a problem, then the better readers may have been more likely to complete the CES. However, the teacher did read the CES to all students. Since you could expect a 20% to 25% absentee rate the bias is probably not very great. This leaves approximately 20% of the classes who could not or would not (due to frustration) complete the CES. The present author believed this was a reasonably small bias, and the possibility existed that most of the missing CES forms were due to a legitimate absence.

Unknown Sources of Missing Independent Variables. This section discusses the general issue of missing independent variables. The previous discusion of response rates and the data of Table XXI give the reader the impression that much more data was missing than was actually the case. Table XXIII gives a much clearer picture of missing independent variables than Table XXI does. For example, of the 2,164 observations made on the 541 subjects, only 195 observations were missing, i.e. 13.6% of the independent variables. However, 144 subjects were missing at least one independent variable. That is 26% of the sample was excluded from the analysis due to a missing value. However, some of these subjects were also dropped due to a missing dependent variable.

Missing Data on the Retention Test. Table XXIV presents an analysis of the missing data for the retention sample; this analysis is similar to the analysis of Table XXI. Two types of data are missing: (1) missing dependent variables, and (2) missing independent variables. Missing dependent variables are usually more serious because there is no way to estimate these missing scores.

In the original experimental group only 162 out of 239 subjects were available at the time of the retention test. When class 682 was dropped from the analysis this proportion became 148 out of 225 students. (The reasons for dropping this class were discussed previously.) So, for the adjusted sample, only 65.7% of the students were available at the time of the retention test.

Students were not available for the retention test for two reasons: (a) Teacher #7 did not have time to administer the retention

TABLE XXIII

THE FREQUENCY OF MISSING INDEPENDENT VARIABLES FOR EACH CLASS

		Subjects Missing Data on the							
Class #	Class Size	Only the CES	Only the Culture Fair	Only V-1	Only V-2	Only on Both V-1 and V-2	All Ability Tests	Both CES and Ability	Total of any Missing Data
Experimental Group									
111	17	2	0	0	3	0	3	1	9
112	19	0	0	0	0	0	0	1	1
113	18	4	0	0	0	0	1	1	6
114	16	1	0	0	0	0	0	1	2
131	12	2	0	0	0	0	1	0	3
141	14	0	0	0	0	0	0	4	4
271	23	3	0	0	0	0	1	0	4
272	26	3	0	0	0	0	0	0	3
273	26	0	0	0	0	0	1	0	1
681	29	12	0	0	0	0	0	1	13
682*	(14)	(9)	(1)	0	0	0	0	(1)	(11)
683	25	9	0	0	0	0	0	2	11
Group Total	225	36	0	0	3	0	7	11	57
Replication Group									
121	16	2	0	0	0	0	3	5	0
122**	17	(7)	0	0	0	13	0	17	4
123	14	3	0	0	0	0	1	4	0
124	16	3	0	0	0	0	1	4	0
125	19	2	0	0	0	0	3	7	2
351	20	4	0	0	0	0	5	9	0
352	22	1	0	0	0	0	9	11	1
353	20	0	0	0	0	0	2	4	2
461	20	1	0	0	0	0	0	1	0
462***	(22)	(3)	0	0	0	0	(1)	(5)	(1)
463	18	2	0	0	0	0	0	3	1
591	25	1	0	0	0	0	1	2	0
592	24	2	0	0	0	0	3	5	0
593	24	2	0	0	0	0	0	2	0
594	25	0	0	0	0	0	3	3	0
Group Total	280	23	0	0	0	13	30	76	10
Grand Total	505	59	0	0	3	13	37	21	133

*Class 682 was dropped from the analysis due to missing data. **None of the students in this class received V-1 or V-2.
***Class 462 was dropped from the analysis because they never began the unit of instruction.

TABLE XXIV

MISSING DATA BY CLASS FOR THE RETENTION SAMPLE

	Class Number												
	111	112	113	114	131	141	271	272	273	681	682	683	Sample Total
Taught by teacher no.	1	1	1	1	3	4	7	7	7	8	(8)	8	-
Students in each class	17	19	18	16	12	14	23	26	26	29	(14)	25	225
Students who began unit	17	19	18	16	12	14	23	26	26	29	(14)	25	225
Students who were graduating seniors*	4	0	2	4	5	1	9	(9)	(6)	0	(0)	0	25
Students available for retention test	13	19	16	12	7	13	14	0**	0**	29	(14)	25	148
Students who took retention test	10	17	16	12	6	9	13	0	0	26	(13)	20	129
Students with complete data	6	16	11	11	4	5	11	0	0	14	(3)	12	90
% of students with complete data who were available for retention test	46	84	68	92	57	38	79	0		48	(21)	48	61***

* Graduating seniors customarily leave school to take jobs during May.
** These two classes completed the unit of instruction but did not have time to take the retention test.
***Class 682 was dropped from the analysis. The mean value for all classes was 62.1% with a s.d. of 18.9%.

test to two of his classes: classes 272 and 273. This happened because the school year was ending. This accounted for a loss of 52 students. (b) Twenty-five seniors who began the unit of instruction were excused from class to find employment, and thus were not available at the time of the retention test.

Nineteen of the 148 (12.8%) students who were available for the retention test were absent the day the test was given. So that only 129 students in the adjusted sample (57.7%) actually took the retention test.

The other type of missing data was missing independent variables. As discussed previously there was only one pattern to the missing independent variables; teacher #8 had a very low response rate for the CES. This was probably due to a low reading level. Other than this pattern, missing independent variables and missing dependent variables seem to be the result of absenteeism on the test date. No pattern or explanation for absenteeism was discovered. It seems to be a normal phenomenon; it may be more comon in some schools than in others. But it was not related to the treatment.

The percentage of students in each class that were used in the retention analysis ranges from 38.4% to 91.6%; the overall class average was 62% of each class was used in the analysis, and 60.8% of all students who were available for the retention test were used in the analysis. That is, 39.2% of the students were missing at least one independent or dependent variable.

The present author is concerned about this high percentage of missing data, but the loss of information appears to be random, and is probably the result of doing research in naturalistic settings like schools. The present author concluded that the missing information in the present study was the result of random patterns of absenteeism in classrooms, and warns future researchers to be wary of too many testing occasions.

Demographic Characteristics of the Sample

Table XXV presents the demographic characteristics of the experimental group, control group and the combined adjusted sample. The data for the two classes which were dropped from the analysis (class 682 and class 462) were not included in this table. The majority of the information is self-explanatory. However, the reader should note the large number of no-information responses for race, LD and ESL. The author did not receive this information from two teachers who taught a total of 180 students.

Table XXVI presents the average value of the dependent and independent variables for the experimental, control group, and total adjusted sample. The reader should note that many of the independent variables were perceptibly different for the two groups.

Demographic Characteristics of Teachers

Table XXVII presents the demographic characteristics of the nine teachers who participated in the study. All of the teachers had a masters degree. All of the teachers were white. There was a wide range on all of the variables in Table XXVII. Age ranged from 29 to 50; the average age was 33.1. Years of teaching ranged from 2 to 20 with an average years of teaching experience of 9.8 years. Years of teaching chemistry ranged from one year to 20 years; the

TABLE XXV

SAMPLE DEMOGRAPHIC INFORMATION

	Experimental Group	Control Group	Total Sample
Adjusted Total	225	220	505
<u>Sex</u>			
Male	94	137	231
Female	129	137	266
No Information	2	6	8
<u>Age</u>			
13	31	61	92
14	23	34	57
15	7	30	37
16	84	89	173
17	60	45	105
18	10	8	18
19	0	2	2
20 and over	1	1	2
No Information	9	10	19
Average	15.7	15.2	15.4
<u>Grade</u>			
8th	54	98	152
10th	9	41	50
11th	121	121	242
12th	41	20	61
<u>Race</u>			
White	199	98	297
Black	12	1	13
Other	11	1	12
No Information	3	180	183
<u>L.D.</u>	55	1	56
No Information	0	180	180
<u>ESL</u>	13	5	18
No Information	0	180	180

TABLE XXVI

MEAN AND STANDARD DEVIATION OF ALL INDEPENDENT AND DEPENDENT VARIABLES FOR THE EXPERIMENTAL GROUP, REPLICATION GROUP AND COMBINED MODELS

	Experimental Group			Replication Group			Combined Sample		
Variable	Mean	S.D.	N	Mean	S.D.	N	Mean	S.D.	N
Total Sample			239			302			541
Students Dropped*			14			22			36
Adjusted Total			225			280			505
Pretest				12.10	4.88	231			
Posttest	23.65	6.31	166	21.41	6.76	184			
Retention Test	21.42	4.88	129						
Factor 2	.268	.653	168	-.188	.827	204	.018	.786	372
Factor 3	.086	1.126	168	-.053	.844	204	.010	.980	372
(Factor 2 + Factor 3)	.354	1.240	168	-.241	1.128	204	.028	1.299	372
Fair I.Q.	114.3	14.95	208	105.6	17.3	240	109.6	16.8	448
V-1	9.56	5.03	205	9.43	3.76	227	9.49	4.40	432
V-2	9.15	3.23	206	7.51	2.96	227	8.29	3.19	433
(V-1 + V-2)	18.76	7.58	204	16.94	6.10	227	17.80	6.89	431
Factor 1									
Factor 4									
Factor 5									
Involvement	5.4	2.8	179	4.1	2.5	245	4.7	2.7	424
Affiliation	6.4	2.5	179	6.5	2.3	245	6.5	2.4	424
Teacher Support	7.2	2.0	179	6.1	2.4	245	6.6	2.3	424
Task Orientation	8.1	1.5	179	7.3	1.8	245	7.6	1.7	424
Competition	5.6	1.8	179	5.5	1.8	245	5.5	1.8	424
Order and Organization	7.7	2.2	179	5.2	2.4	245	6.3	2.6	424
Rule Clarity	7.2	2.0	179	6.2	2.3	244	6.6	2.2	423
Teacher Control	3.8	2.0	179	4.3	2.6	245	4.1	2.4	424
Innovation	4.4	2.4	179	4.7	1.9	245	4.5	2.1	424
Fourth Quarter grade	76.4	13.9	160	79.6	12.7	195	78.1	13.3	355
Final Grade	80.8	11.1	147	79.9	10.7	196	80.3	10.8	343
Age	15.7	1.5	216	15.2	1.6	270	15.4	1.6	486

*The 14 students in the experimental group were dropped from the analysis because of missing independent variables. The entire class was dropped from the analysis. The 22 students in the control group were in a class which never collected any dependent variables due to lack of time remaining in the school year.

TABLE XXVII

THE DEMOGRAPHIC CHARACTERISTICS OF THE TEACHERS IN THE SAMPLE

	Mean	S.D.	N
Race			
White			9
Black			0
Sex			
Male			4
Female			5
Age	33.1	6.5	9
Years of Teaching Experience	9.8	7.6	9
Years of Teaching Chemistry	7.3	5.3	9
Credits Beyond Bachelor's Degree	54.6	20.4	9

average was 7.3 years. The number of credits beyond the bachelors degree ranged from 30 credits to 90 credits; the average number of credits was 54.6. The present author's impression was that these teachers had better academic credentials than the average teacher, and they may have been the better teachers in their school. (No evidence was collected on this point.)

Sample Data Averaged Across Teachers

Table XXVIII presents the data on the dependent and independent variables averaged across each teacher. The average posttest performance across teachers is fairly consistent; however, differences between teachers are apparent. The classes of the eighth grade teachers were surprisingly consistent (18.0 versus 17.1) in posttest performance. The most surprising aspect of Table XXVIII is the comparison between retention scores and posttest performance. Very little information was forgotten; this was consistent across teachers. The other surprising finding was the degree of prior knowledge some classes showed at the pretest. The expected pretest score was 10.0. The classes of two teachers did much better than chance (Teacher 5 and Teacher 6).

Tables XXIX, XXX and XXXI present an analysis of the demographic characteristics of the classes taught by each teacher, and the average value of the raw data for each teacher. These tables are included in Appendix H. This data is include so that the reader can judge how closely these classes resemble classes he might be interested in.

TABLE XXVIII

THE INDEPENDENT AND DEPENDENT VARIABLES FOR EACH TEACHER

	Teacher Number										
	Experimental Group						Replication Group				
Variables	1	3	4	7	8*	Group Total	2	5	6**	9	Group Total
Number of classes	4	1	1	3	2	11	5	3	2	4	14
Students per teacher	70	12	14	75	54	225	82	62	38	98	280
Pretest											
Mean							10.2	15.0	16.4	9.8	12.1
N	-	-	-	-	-	-	48	57	35	90	230
Posttest											
Mean	23.6	21.9	29.8	27.3	17.8	23.6	-	23.6	29.1	17.1	21.4
N	60	11	11	47	37	166	0	53	37	94	184
Retention											
Mean	22.6	21.5	24.3	22.1	19.2	21.4					
N	55	6	9	13	46	129	-	-	-	-	-
Factor 2											
Mean	.22	.16	.61	.19	.44	.27	-.35	-.06	.52	-.43	-.19
N	52	9	10	67	30	168	46	38	34	86	204
Factor 3											
Mean	.50	.04	1.03	.34	-1.60	.09	-.17	.26	.62	-.40	-.05
N	52	9	10	67	30	168	46	38	34	86	204
Factor 1											
Mean	.18	.28	1.17	-.58	1.03	.09	.34	.12	-.19	-.43	-.09
N	52	9	10	67	30	168	46	38	34	86	204
Factor 4											
Mean	.48	.19	-.87	.53	.64	.43	-.17	.04	-.21	-.73	-.37
N	52	9	10	67	30	163	46	38	34	86	204
Factor 5	.07	-.49	-.21	-.12	-.14	-.09	-.42	-.42	-.31	.69	.07
Mean	52	9	10	67	30	168	46	38	34	86	
N											204

*One class (#682) taught by teacher 8 was dropped from the analysis due to missing independent variables.

**One class (#462) taught by teacher 6 was dropped from the analysis due to missing pretests.

Sample Data Averaged Across Classes

Tables XXXII, XXXIII and XXXIV present the student data on the independent and dependent variables averaged across classes (see Appendix I). It is included for comparative purposes only.

First Order Correlation Coefficients for all Variables

Tables XXXV, XXXVI, and XXXVII present the first order correlation coefficients for all cases, for the experimental group, and the control group. Correlation coefficients for all the variables collected in the study were calculated. These correlations use all of the available information by using estimates of the covariances. These tables are contained in Appendix J. The principle reason for including these tables is to illustrate the large degree of multicolinearity between variables, and to provide basic descriptive information to the reader.

CHAPTER IV

RESULTS

Preliminary Analysis: An Internal Validity Check

The purpose of the present study was to test different explanatory models of classroom learning. Before these models of learning could be tested, it was necessary to show that learning had occurred, and that the observed learning was a result of the unit of instruction. That is, the internal validity hypothesis (H_{IV}) suggested in Chapter I had to be rejected. H_{IV} states that

> The experimental group which received three weeks of instruction on a chemistry unit, performed no better on a test of initial learning than the control group which received no instruction on the experimental unit.

The Research Design section of Chapter III demonstrated that three null hypotheses needed to be rejected in order to reject H_{IV}. These hypotheses were referred to as null hypothesis A, B, and C.

> H_A: There is no difference between the initial learning (test 1) of the experimental group, which has received an average of 459.5 minutes of instruction, and the control group which has received no instruction on the experimental unit.

H_A was tested with a t test for independent groups. The unit of analysis for this test was the average test score of the students pooled over teachers. The teacher was selected as the unit of analysis because students within classes were not independent of each other, and classes taught by the same teacher were not independent of each other. The t value for this hypothesis was 3.28 with 6 d.f. The observed significance level for this test was .017. Thus null hypothesis A was rejected. It was concluded that the experimental group learned more than the control group.

However, null hypotheses B and C also must be confirmed before it can be concluded that the instruction provided was the cause of the observed learning. Null hypothesis B is a comparison between the pretest and posttest scores of the control group. The teacher was also the unit of the analysis for this comparison. The appropriate test statistic is the Fisher randomization test or the second best choice is the Wilcoxin test. These non-parametric tests were selected because the homogeneity of variance assumption of the paired t test could not be met. Null hypothesis B states that:

> H_B: There is no difference between the initial learning (test 2) of the control group, i.e. posttest performance, and the pretest (test 1) performance of the control group.

The pretest and posttest average scores of three teachers were available to test this comparison. The limited number of teachers makes it extremely difficult to test this hypothesis. The randomization test calculated the observed significance level at .125; however, the reader should note that this is the smallest significance level possible with only three teachers. That is, there was only one chance in eight that all three posttest averages would exceed all three pretests. The binomial test gives the same conclusion. There were too few degrees of freedom to apply the Wilcoxin test.

Additional information can be used to rule out the null hypothesis of no pretest-posttest difference. Nine classes completed both the pretest and the posttest. For all nine classes the posttest class average was at least six points higher than the pretest class average. The reader should note that these class averages were not independent.

At the student level, nine out of 139 students with complete data did worse on the posttest than on the pretest. An additional 14 students only gained between one and three points at the posttest. However, the remaining 116 students with complete data, gained at least four points on the posttest. The maximum gain was 25 points. With this additional evidence the present author was willing to conclude that the students in the control group had higher posttest scores on the average than pretest scores.

Hypothesis C tests the $O_3 - O_4$ versus $O_6 - O_4$ comparison suggested in the Research Design. This comparison could not be tested directly because there was no way to match the experimental and control group teachers. So, this comparison was tested by comparing the posttest performance of the experimental and control groups. If there was no effect of testing, selection or mortality, then these two groups should have approximately equal posttest performances. H_C states that:

> The posttest means (test 1) for the experimental group teachers will not be equal to the posttest means (test 2) of the control group teachers.

H_C was tested using a t test for independent samples. The t value calculated was .345; with six degrees of freedom, the observed significance level was .37. The present author concluded that there was not enough evidence to reject null hypothesis C, and it was concluded that the posttest performance of the experimental and control groups was approximately equal.

Since all three internal validity checks were confirmed, the present author concluded that the students learned during the unit of instruction, and that this learning was caused by the unit of instruction.

Factor Analysis

The present study contained 15 independent variables: the nine CES scores, four I.Q. scores from the Culture Fair Test, and two Vocabulary scores (Ekstrom, et al., 1975) These 15 scores were factor analyzed for two reasons: (a) a factor analysis will reduce the number of independent variables to be tested, and thus increase the number of degrees of freedom available for the error term. (b) A factor analysis will eliminate any redundancy between the independent variables; Cohen and Cohen (1975) and Cronbach (1975) both support the idea of using factor analysis in conjunction with regression analysis.

A maximum likelihood factor analysis of all cases pooled was performed on the above independent variables. ($N = 375$) Factor selection was limited to variables with eigenvalues (characteristic roots) greater than 1.00. Initial communality estimates were squared multiple correlations.

This analysis selected five factors which accounted for 49.51%

of the total variance (common variance) of the correlation matrix. (The unrotated factor matrix is contained in Table XXXVIII, Appendix J.) However, only approximately 64% of the total variance was reliable variance. (See Appendix J for this calculation.) The remaining 36% of the variance should be considered random error. Thus it can be seen that the five factors account for most of the reliable variance available. (See Appendix J for a replication of the above factor structure.)

The five factors were rotated to simple structure using the varimax rotation with gamma equal to 1.00. The rotated factor matrix is contained in Table XXXIX. Factor scores were calculated for each subject; the factor coefficients are in Table XL, Appendix J. The factor scores used in the experimental and control group regression analysis were calculated from these factor score coefficients.

Hypothesis One

Null hypothesis one states that:

> General ability is not a significant predictor of initial classroom learning when differences in initial classroom learning have been adjusted by a set of covariates. That is $I_A = 0$. Model 1: L = COV + A

An analysis of partial variance was performed to test this hypothesis. Table XLI shows that the covariate set (Grade Level + Instructional Time + Class size) accounted for 29.1% of the initial learning variance in the experimental group.

This proportion of variance was tested for significance with an F test; the calculated F value with 3 and 133 degrees of freedom was

TABLE XXXIX

ROTATED FACTOR MATRIX FOR THE INDEPENDENT VARIABLES*

Variable	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Communality
Student Involvement	.6888	.082	-.114	.377	.044	.6368
Student Affiliation	.634	.013	-.062	.049	-.002	.4088
Teacher Support	.679	.071	.129	.225	-.148	.5559
Competition	.071	-.049	-.043	.133	.274	.1017
Order and Organization	.205	.162	-.029	.749	.035	.6316
Rule Clarity	.176	-.096	.029	.433	.374	.3683
Teacher Control	-.175	-.135	-.144	.028	.964	1.0000
Innovation	.636	.064	-.090	-.188	.161	.4775
G1	.054	.624	.115	.024	-.079	.4128
G2	-.012	.521	.059	.024	-.091	.2835
G3	.019	.566	.063	.055	-.027	.3288
G4	.113	.545	.156	.003	-.013	.3348
V-1	-.134	.200	.962	.003	-.084	.9904
V-2	-.010	.330	.601	.039	-.124	.4870
Eigenvalue (VP)	1.885	1.501	1.400	1.392	1.249	7.427
Total Variance Accounted For	12.57%	10.01%	9.33%	9.28%	8.33%	49.51%
Common Variance	25.38%	20.21%	18.85%	18.74%	16.82%	100.00%
Squared Multiple Correlation	.778	.661	.968	.722	.986	

TABLE XLI

REGRESSION MODEL OF INITIAL LEARNING FOR THE EXPERIMENTAL AND REPLICATION GROUPS

	Experimental Group (N = 137)								Replication Group (N = 149)							
SET	R^2	sr_i^2	pr_i^2	K_A	K_B	F	Alpha	Power at a=.05	R^2	sr_i^2	pr_i^2	K_A	K_B	F	Alpha	Power a=.05
Covariate Set	.291				3	(133)* 18.26	.000	.99	.486				3	45.7	.000	.999
Ability Set	.389	.098	.138	3	2	(131) 10.53	.000	.99	.577	.091	.176	3	2	(143) 15.32	.000	.999
CE Set	.458	.069	.113	5	3	(128) 5.43	.002	.94	.600	.024	.056	5	3	(140) 2.76	.046	.667
(A X CE) Set	.504	.046	.085	8	6	(122) 1.89	.090	.71	.622	.021	.053	8	6	(134) 1.25	.280	.50
(G X CE) Set	.504	.000	.001	14	2	(119) .04	.999	.02	.639	.017	.045	12	3	(133) 2.09	.100	.54
(COV X R) Set	.566	.063	.126	12	12	(112) 1.34	.210	.77	.653	.031	.051	12	8	(128) 1.45	.200	.66

*The number in parentheses is the degrees of freedom for the denominator of the F test.

18.260. The observed significance level was less than .0001. The power of this test was greater than .99. The present author concluded that the covariate set accounted for a significant proportion of the initial learning (L) variance. That is, the covariate set removed 29.1% of the irrelevant initial learning variance from the analysis. Thus, the covariate set was very effective in removing some sources of irrelevant information from the analysis.

The ability set (Factors 2 and 3) accounted for an increment of 9.8% of the total initial learning variance (sR^2_A). This increment was tested with an F test. An F of 10.53 with 2 and 131 degrees of freedom had an observed significance level less than .0001. The power of this test was .987. So, it was concluded that the Ability set accounted for a significant proportion of the total initial learning variance.

However, the initial learning variance (L) was adjusted for differences in the covariates. This adjustment removed 29.1% of the initial learning variance from the analysis. A more suitable measure of the relationship between ability and initial learning is the squared partial correlation coefficient pR^2_A. (specifically, $pR^2_{YA.COV}$). As mentioned previously both A and Y were adjusted for differences in the covariates.

For the present analysis pR^2_A equals 13.8%; that is, the ability set accounted for 13.8% of the <u>adjusted</u> initial learning variance. Since the same significance test is used, for both the partial and semipartial correlation this proportion is also significant. Thus, it was concluded that H_1 was rejected and that the Ability set accounted for 13.8% of the covariate adjusted initial learning variance.

That is, when grade level, instructional time and class size were held constant, student ability accounted for 13.8% of the variance in initial learning.

Replication of Hypothesis One

Hypothesis one was also tested using the control group data. The major difference between these tests was that the control group received a pretest. No evidence was found to support the hypothesis of a pretest effect. Nevertheless, the reader should be aware that these were not exactly comparable groups. However, an educationally significant result should be capable of replication in spite of this limitation. When results are not replicated, it casts doubt on the stability and generalizability of the findings.

An analysis of partial variance was also performed on the control group data. Table XLI shows that the covariate set accounted for 48.6% of the total variance of initial learning. This R^2 was tested with an F test with 3 and 145 degrees of freedom. F equals 45.7. The observed significance level was less than .0001, and the power of the test was .999. It was concluded that the covariate set is effectively adjusting the initial learning variance. The reader should note that the covariate set accounted for almost twice as much of the initial learning variance in the control group as it did in the experimental group. (This could be due to the greater number of eighth grade students in the control group sample.)

The ability set accounted for an increment of 9.1% of the total initial learning variance, or 17.6% of the covariate adjusted initial learning variance. With 2 and 143 degrees of freedom the calculated F value of 15.32 had an observed significance level less than .0001. The power of this test was .999. It was concluded that ability accounted for a significant proportion of the covariate adjusted initial learning variance, and H_1 was rejected.

Student ability was confirmed by both analyses as a significant predictor of covariate adjusted initial learning. The magnitude of this relationship is approximately the same in both samples 13.8% of the experimental group, and 17.6% in the control group. Thus student ability was concluded to be a significant and stable determinant of initial classroom learning.

Hypothesis Two

Null Hypothesis Two states that:

> The classroom average of the perceived psycho-social classroom environment is not a significant predictor of initial classroom learning when initial classroom learning has been adjusted for general ability and a set of covariates. $I_{CE} = 0$.

An analysis of partial variance was performed to test this null hypothesis. The CE set (factors 1, 4, and 5) was added hierarchically to model 1, i.e. the regression model tested under hypothesis one. The new model (model 2) states that L = COV + A + CE.

When the CE set was added to model 1 for the experimental group, it accounted for an increment of 6.9% of the total initial learning variance (see Table XLI). Under model 2, the variance due to the covariate set and due to the ability set was removed from the initial learning variance, so that the classroom environment (CE) factor accounted for 11.3% of the adjusted initial learning variance.

The F value for this increment was 5.425 with 3 and 128 degrees of freedom. The observed significance level of this test was .002, and the power of the test was .935. Thus, the present author concluded that the average student perception of the classroom environment accounted for a significant proportion of the adjusted initial learning variance, and H_2 was rejected.

Replication of Hypothesis Two

Null hypothesis two was also tested using the replication group sample. This hypothesis was again tested with analysis of partial variance based on model 2 stated above. When the classroom environment factor was added to model 1, it accounted for an increment of 2.4% of the total initial learning variance, or equivalently, 5.6% of the adjusted initial learning variance. With 3 and 140 degrees of freedom the F value for this increment was 2.755. The observed significance level of this test was .046, and the power of the test was .667. Thus, the present author concluded that the class average of students' perception of the classroom environment accounted for a significant proportion of the adjusted initial learning variance, and H_2 was rejected.

The class average of students' perception of the classroom environment was confirmed by both analyses as a significant predictor of adjusted initial learning. However, the magnitude of this relationship varies for the two samples. In the experimental group the CE factor accounted for twice the proportion of adjusted initial learning variance as in the replication group.

This discrepancy may be an artifact of the restricted range of teachers and classes in the replication group. The replication group contained nine classes taught by three different teachers, and the experimental group contained 11 classes taught by five different teachers. Or this result may be an accurate picture of the stability of the CE factor. If so, then the CE factor is less stable than the ability factor. There is not enough evidence in the present study to select either alternative. The present author concluded that the CE factor is educationally significant, but that the magnitude of this relationship with initial learning is potentially variable.

Hypothesis Three

Null hypothesis three states that:

> The interaction of general ability and perceived classroom environment is not a significant predictor of initial classroom learning when initial classroom learning has been adjusted for the classroom average of the perceived psycho-social classroom environment, general ability, and a set of covariates. $I_{(A \times CE)} = 0$.

An analysis of partial variance was performed to test this null hypothesis. The (A X CE) set was added hierarchically to model 2. This interaction set contained six variables: (factor 2 X Z1); (Z1 is the classroom average of factor 1; the Z notation was used to symbolize the classroom average); (factor 2 X Z4); (factor 2 X Z5); (factor 3 X Z1); (factor 3 X Z4); (factor 3 X Z5). Model 3 states that: L = COV + A + CE + (A X CE).

When the (A X CE) set was added to model 2 for the experimental group, it accounted for an increment of 4.6% of the total initial learning variance, or 8.5% of the adjusted initial learning variance (see Table XLI). Under model 3 initial learning was adjusted to remove covariate, ability and CE differences. The F value for this increment was 1.885 with 6 and 122 degrees of freedom. The observed significance level of this test was .090 and the power of the test was .71. The observed significance level was higher than the .05 significance level adopted by the present study. So the present author concluded that there was not enough evidence to reject null hypothesis three, i.e. the interaction between student ability and the classroom average of the students' perception of the classroom environment does not account for a significant proportion of the adjusted initial learning variance.

The reader should be cautious in failing to reject null hypothesis 3 for the following reasons: (a) The observed significance level was fairly improbable; these results would occur only nine times out of 100 (one out of ten) by chance. (b) The power of the test was acceptable, but not overwhelming. There was a 71% chance of finding a significant result when it existed. (c) The interaction term accounted for 8.5% of the adjusted initial learning variance. This is an educationally significant amount.

Replication of Hypothesis Three

Null hypothesis three was tested on the replication group sample using analysis of partial variance and model three. When the (A X CE) set was added to model 2, it accounted for an increment of 2.1% of the total initial learning variance, or 5.3% of the adjusted initial learning variance. Under model 3 initial learning was adjusted for covariate, student ability and CE differences. The F value for this test was 1.251 with 6 and 134 degrees of freedom.

The observed significance level of this test was .28, and the power of the test was .50. The above test does not meet the .05 criterion of significance; so the present author concluded that there was not enough evidence to reject null hypothesis 3. However, the reader should be cautioned again that the power of the test was low and there was only a 50% chance of finding a significant result when it existed.

Both tests of null hypothesis 3 failed to reject this hypothesis. The power of both tests was low, and there was some evidence of an interaction in the experimental sample. For these reasons the present author suggested that more powerful research be directed at this null hypothesis.

Hypothesis Four

Null hypothesis four states that:

> The interaction of grade level and the classroom average of the perceived psycho-social classroom environment is not a significant predictor of initial classroom learning when initial classroom learning has been adjusted for the interaction of general ability and the classroom average of the perceived psycho-social classroom environment, the classroom average of the perceived psycho-social classroom environment, general ability, and a set of covariates. $I_{(G \times CE)} = 0$.

An analysis of partial variance was performed to test this null hypothesis. The (G X CE) set was added hierarchically to model 3. This interaction set contained three variables: (G X Z1); (G X Z4); (G X Z5). Model 4 states that: L = COV + A + CE + (A X CE) + (G X CE).

When the (G X CE) set was added to model 4 for the experimental group, it accounted for an increment of 0.05% of the total initial learning variance, or 0.1% of the adjusted initial learning variance see Table XLI.). The F value for this increment was 0.040 with 2 and 119 detrees of freedom. The observed significance level was 1.0, and the power of the test was .015. The observed significance level was larger than the .05 significance level; so the present author concluded that there was not enough evidence to reject null hypothesis four. However, there was only a 1.5% chance of finding a significant result with an effect this small.

Replication of Hypothesis Four

Null hypothesis four was tested for the replication group using analysis of partial variance. When the (G X CE) set was added to model 3, it accounted for 1.7% of the total initial learning variance, or 4.5% of the adjusted initial learning variance (see Table XLI). The F value for this increment was 2.08 with 3 and 133 degrees of freedom. The observed significance level was .10 and the power of the test was .536.

Since this test did not meet the .05 significance level, the present author concluded that there was not enough evidence to reject null hypothesis four. However, the reader should be cautious in failing to reject null hypothesis four for the following reasons:

(a) The F test is testing the average effect of each variable in the set; if one of the variables in the set is ineffective, then this will reduce the average effect tested by the F test. This appears to be the situation for the control gorup. The (G X Z4) variable is redundant with the set of independent variables analyzed by this model. If this variable had not been included, the observed significance level of the F test would have been raised to .03.

(b) Null hypothesis four could have been tested by a different model of learning. For example, L = COV + A + CE + (G X CE). This model might have yielded more positive results. This model was not tested because it would have competed with model 3 used in the present study. Model 3 was used because it was central to the purpose of the present study.

(c) Finally, the eighth grade classes in the experimental group were of questionable value, since all of these students were learning disabled. These students may not have been representative of all eighth grade students.

Regression Homogeneity Check for the Model of Initial Classroom Learning

As mentioned earlier, in order for the results of the analysis of partial variance to be valid, it was necessary to check for interactions between the covariate set and the research factor set. The interaction of these two sets produced 15 variables, i.e. the interaction of the three covariates with the five variables in the research factor set: factor 2, factor 3, Z1, Z4, and Z5. Only first order interactions were tested; so, the (A X CE) set was not included in the research factor set.

When a significant interaction is found between the covariate set and the research factor set, then the analysis of partial variance cannot be applied. For example, a non-significant interaction between grade level and ability suggests that any covariate adjustments made to the initial learning scores of high ability eighth grade students should also be made to the initial learning scores of high ability high school students. That is, the covariate adjustments are uniform for all groups in the sample. However, a significant covariate by research factor interaction demands that the initial learning scores of some groups receive a greater adjustment than other groups.

Regression Homogeneity Check for the Experimental Group

When the (COV X R) set was added to model 3, this set accounted for an increment of 6.3% of the total initial learning variance, (see Table XLI) or 12.6% of the covariate adjusted learning variance. The F value for this test was 1.356 with 12 and 112 degrees of freedom. The observed significance level was .21, and the power of the test was .77. The present author concluded that there was no evidence to reject the null hypothesis of regression homogeneity for the experimental group analysis. That is, the APV for the experimental group is a valid analysis.

Regression Homogeneity Check for the Control Group

The F value when the (COV x R) set was added to model 3 for the replication group was 1.452, with 8 and 128 degrees of freedom. The observed significance level was .20 and the power of the test was .664. Based on this test there was not enough evidence to reject the regression homogeneity hypothesis for the replication group analysis.

Since the regression homogeneity hypothesis was confirmed by both the experimental group data, and the replication group data, the present author concluded that the results of the analysis of partial variance were valid for both sets of data.

Hypothesis Five

Table XLII shows that the covariate set accounted for 16.4% of the retention variance. The F value for this test was 5.61 with 3 and 86 degrees of freedom. The observed significance level was .002, and the power of the test was .98.

TABLE XLII

REGRESSION MODEL OF RETENTION FOR THE EXPERIMENTAL GROUP

	Experimental Group (N = 90)							
Set	R^2	sr_i^2	pr_i^2	K_A	K_B	F	Alpha	Power at a = .05
Covariate Set	.164				3	(86)* 5.61	.000	.98
Ability Set	.262	.098	.118	3	2	(84) 5.60	.004	.87
CE Set	.362	.100	.136	5	3	(81) 4.25	.008	.86
(A X CE) Set	.416	.053	.083	8	6	(75) 1.14	L.T.** .25	.46
(G X CE) Set	.416	.001	.001	14	1	(74) .08	L.T.** .25	.01
(COV X R) Set	.486	.070	.121	11	11	(67) .83	L.T.** .25	.48

*The number in parentheses is the degrees of freedom for the denominator of the F test.
**L.T. is an abbreviation for less than.

The present author concluded that the covariate set accounted for a significant proportion of the retention variance. This was a much lower proportion than the adjustment made to either of the initial learning samples.

Null hypothesis five states that:

> H_5: General ability is not a significant predictor of classroom retention when retention has been adjusted for a set of covariates. $I_A = 0$. Model 5: R = COV + A.

When the ability set was added to the covariate set it accounted for an increment of 9.8% of the total retention variance, or 11.8% of the covariate adjusted retention variance. The F value for this test was 5.595 with 2 and 84 degrees of freedom. The observed significance level was .004, and the power of the test was .87. The present author concluded that the student ability set and model 1 accounted for a significant proportion of the covariate adjusted retention variance, and H_5 was rejected. The reader should note that the ability set accounted for a slightly smaller proportion of the covariate adjusted retention variance than initial learning variance.

Hypothesis Six

Null hypothesis six states that:

> H_6: The clasroom average of the perceived psycho-social classroom envionment is not a significant predictor of classroom retention, when retention has been adjusted for general ability and a set of covariates. $I_{CE} = 0$. Model 6: R = COV + A + CE.

An analysis of partial variance was performed to test this hypothesis. When the CE set was added to Model 5 it accounted for an increment of 10.0% of the retention variance, or 13.6% of the adjusted retention variance. The F value for this test was 4.249 with 3 and 81 degrees of freedom. The observed significance level was .008, and the power of the test was .86. The present author concluded that the CE set accounted for a significant proportion of the adjusted retention variance, and H_6 was rejected.

Hypothesis Seven

Null hypothesis seven states that:

> H_7: The interaction of general ability and the classroom average of the perceived classroom environment is not a significant predictor of classroom retention, when retention has been adjusted for the classroom average of the perceived psycho-social environment, general ability and a set of covariates. $I_{(A \times CE)} = 0$. Model 7: R = COV + A + CE + (A X CE).

This hypothesis was tested using analysis of partial variance. When the (A X CE) set was added to model 6, it accounted for 5.3% of the retention variance, or 8.3% of the adjusted retention variance. The F value for this test was 1.137 with 6 and 75 degrees of freedom. The observed significance level of this test was greater than .25, and the power of the test was .46; so the present author concluded that there was not enough evidence to reject null hypothesis seven. Because there was only a 46% chance of finding a significant result when it existed, the present author suggested that an experiment with more power be conducted.

In failing to reject null hypothesis seven the reader is cautioned that the (A X CE) set accounted for 8.3% of the adjusted retention variance. This was a promising result. Six interaction terms were tested under this hypothesis; fewer interaction terms would produce a more powerful test. Since this F test was testing the average interaction effect, limiting the set of interaction terms to the most probable interactions could raise the significance of the interaction set by eliminating unproductive interaction terms. This would only happen if, for example, two of the six interaction terms were truly significant. If all of the interaction terms accounted for approximately the same proportion of variance, then the results of this significance test would not change by eliminating interaction terms.

One of the best ways to eliminate interaction terms would be by combining factor 2 and factor 3 to form one measure of general ability. This procedure would eliminate three interaction terms with the loss of little information.

Hypothesis Eight

Null hypothesis eight states that:

> H_8: The interaction of grade level and the classroom average of the perceived psycho-social classroom environment is not a significant predictor of clasroom retention, when retention has been adjusted for the interaction of general ability and the classroom average of the perceived psycho-social classroom environment, the classroom average of the perceived psycho-social classroom environment, general ability, and set of covariates. $I_{(G \times CE)} = 0$.

This hypothesis was tested using analysis of partial variance. When the (G X CE) set was added to model 7, it accounted for an increment of 0.06% of the total retention variance, or 0.1% of the adjusted retention variance. The F value for this test was .076 with 1 and 74 degrees of freedom. The observed significance level was greater than .25, and the power of the test was .01. The present author concluded that there was not enough evidence to reject the null hypothesis. However, there was little chance of finding a significant result when it existed.

Regression Homogeneity Check for the Retention Sample

When the (COV X R) set was added to model 7, it accounted for 7.0% of the total retention variance, or 12.1% of the adjusted retention variance. The F value for this test was .834 with 11 and 67 degrees of freedom. (Three variables were dropped from this set because they were redundant with the other variables in this set, i.e. their multiple correlation with the other independent variables was greater than .9999). The observed significance level of this test was greater than .25, and the power of the test was .48. The present author concluded that there was not enough evidence to reject the regression homogeneity hypothesis, and concluded that the analysis of partial variance was valid. However, the reader should note that there was only a 48% chance of rejecting this hypothesis when it was false.

Significant Independent Variables

There are two different methods for examining significant independent variables: The best method is to look at the proportion of variance accounted for when the variable of interest is added to the model, i.e. variance components. For any of the three groups examined in the present study, this requires testing 17 variance components or 51 significance tests for the complete study. With this many comparisons there is an 88.4% chance of spuriously finding significance at alpha equals .05. This approach was rejected because of the uncertainty it would introduce into the study.

However, the reader should note that this was the only way to uniquely partition the total variance. These results are presented in Table XLIII; no significance levels were reported because they would be misleading.

An alternative method to the variance components method described above, is to examine the significance level of each independent variable in each of the proposed models of learning. It is only appropriate to look for significant independent variables when the set of variables was determined to be significant. Since the ability set, and the CE set were the only sets of variables which were significant in the present study, it is appropriate to look only at the independent variables in these two sets.

To determine if an independent variable is significant, it is necessary to look at the t value for the variable in the model being considered. It is important to note that the observed significance level of each independent variable depends on the model you are examining. For example, Factor 2 might be significant under model one, but not under model three. This unusual situation occurs because the regression coefficients produced by each model are partial regression coefficients. That is, the values of all other variables in the model are held constant, when a regression coefficient is calculated. This means that as you add variables to a model, new variables may steal variance from previously significant variables. Thus, when an independent variable is declared significant, it is necessary to specify which model was examined for significance.

In addition to the regression coefficient of the independent variables, the squared semi-partial and partial correlations for each

TABLE XLIII

VARIANCE COMPONENTS FOR A REGRESSION MODEL OF LEARNING AND RETENTION

	Cumulative R^2			Proportion of Variance		
Variable	Initial Learning	Learning Replication	Retention	Initial Learning	Learning Replication	Retention
Grade Level	.2500	.4096	.1520	.2500	.4096	.1520
Instructional Time	.2710	.4845	.1579	.0210	.0749	.0059
Class size	.2907	.4861	.1637	.0197	.0016	.0058
F2 (Non-verbal Ability)	.3289	.5621	.1983	.0382	.0760	.0346
F3 (Verbal Ability)	.3892	.5768	.2621	.0603	.0147	.0638
Z1 (Student-centered)	.4468	.5972	.3514	.0576	.0204	.0893
Z4 (High Structure)	.4533	.5980	.3535	.0065	.0008	.0021
Z5 (High Discipline)	.4581	.6004	.3624	.0048	.0024	.0089
(F2 x Z1)	.4582	.6038	.3628	.0001	.0034	.0004
(F2 x Z4)	.4731	.6063	.3796	.0149	.0025	.0168
(F2 x Z5)	.4763	.6089	.3806	.0032	.0026	.0010
(F3 x Z1)	.4803	.6164	.3806	.0040	.0075	.0000
(F3 x Z4)	.4872	.6174	.3809	.0069	.0030	.0003
(F3 x Z5)	.5037	.6217	.4156	.0165	.0047	.0347
N	137	149	90			

independent variable can also be calculated. However, all three of these coefficients are based on the same significance test. So that, if one coefficient is significant, all three coefficients will be significant.

Significant Aptitude Variables

Since the ability set was significance under the 5th order models and the 8th order models for all three sets of data, then at least one of the independent variables in the ability set should be significant.

Factor 2-Initial Learning Model. Factor 2 had an observed significance level less than .05 for model 1 and model 2 (see Table XLIV, Appendix L). So, the present author concluded that Factor 2 was a significant predictor of classroom learning. However, the magnitude of this relationship varies from sample to sample, and model to model. In general, the higher the order of the model, the lower proportion of variance factor 2 accounted for. The squared semi-partial correlations for factor 2 ranged from .029 to .058. Thus, factor 2 accounted for approximately 4% of the initial learning variance.

Factor 2-Retention Model. Factor 2 met the .05 significance level for model 5 but nor for model 6. This raises some doubt about the stability of factor 2 as a predictor of retention when other variables were included in the model. In spite of this, the present author concluded that factor 2 was a significant predictor of retention. This decision was based primarily upon the variance component for factor 2; it showed that factor 2 accounted for 3.5% of the retention variance. The squared semi-partial correlation ranged from .017 to .043.

The present author concluded that factor 2 was a significant predictor of both initial learning and retention, and the magnitude of this relationship was approximately 4% of the variance.

Factor 3-Initial Learning Model. Factor 3 was tested four times for significance as a predictor of initial learning: twice under model 1 and twice under model 2. The observed significance level of all four tests was less than .05. Thus, the present author concluded that factor 3 was a significant predictor of initial learning.

The squared semi-partial correlations ranged from .012 to .060. The variance component for the two samples ranged from .015 to .060. The average variance component was .0375. Thus the present author concluded that factor 3 accounted for roughly 4% of the initial learning variance.

Factor 3-Retention Model. Factor 3 had an observed significance level less than .05 for model 5, but was not significant under model 6. This finding casts some doubt on the stability of factor 3 as a predictor of retention when CE variables are also considered. Despite this doubt the present author concluded that factor 3 was a significant predictor of retention.

The squared semi-partial correlations ranged from .02 to .064. The variance component estimated that factor 3 accounted for 6.4% of the retention variance. Thus, the present author concluded that factor 3 accounted for approximately 6% of the retention variance (see Table XLIV, Appendix L).

Significant Classroom Environment Variables

Since the CE set was significant for all three samples, it was appropriate to look for significant independent variables. There were three independent variables in the CE set. None of these variables was significant at the .05 level for any of the three samples. When this situation occurs, Cohen and Cohen (1975) suggest selecting the most significant independent variable.

Classroom Environment Variables in the Initial Learning Model. In the experimental group the most substantial classroom environment variable was factor 4; the observed significance level was .17. In the control group the most substantial classroom environment variable was factor 1; the observed significance level was .12.

The inconsistent results and the general lack of significance could be due to the existence of suppressor variables. For the experimental group, factor 1 was a net suppressor, and factor 5 is a cooperative suppressor. For the replication group factors 1, 4, and 5 were all net suppressor variables. The present author suggested that the existence of this suppression has lowered the significance levels in the 8th order partials for the CE set, so that none of them meet the required significance level, even though a significant relationship was shown to exist. Thus, it seems appropriate to look at the variance components in Table XLIII for a significant classroom environment variable.

As discussed earlier, it would be inappropriate to discuss the observed significance level of these variance components. However, Factor 1 was clearly the most significant of the three factors. It accounted for 5.7% of the total learning variance in the experimental group, or 9.4% of the adjusted initial learning variance. That is, it was approximately of the same magnitude as either ability measure!

Factor 1 accounted for 2% of the initial learning variance of the replication group, or 4.8% of the adjusted initial learning variance. Factor 1 accounted for twice as much of the adjusted initial learning variance in the experimental group as in the control group. Thus factor 1 seemed to be an important variable for classroom learning, but the magnitude of its relationship to learning is variable.

Factor 1 seemed to be the only substantial CE variable; however, factor 1 presented a serious problem of interpretation. The magnitude of its relationship to initial learning is approximately the same order for both samples, but the direction of the relationship is reversed! For the experimental group, classes high on factor 1 learn more, and for the replication group, classes low on factor 1 learn more. The present author had no explanation for this phenomenon, and can only suggest that it was the result of the large number of suppressor variables in both samples.

Classroom Environment Variables in the Retention Model. None of the three classroom environment variables met the .05 significance level for the retention model. However, factor 1 had an observed significance level of .075; neither of the other variables were close to the required .05 significance level. Since the sample for the retention model is drawn from the same group as the experimental group, it was surprising to find that factor 1 was substantial in the retention sample, but not significant for the experimental group sample.

Since factor 1 had the highest significance level, it was chosen as the only substantial variable in the CE set. The variance components support this decision; factor 1 accounted for 8.9% of the retention variance. Its semi-partial and partial correlations were .026 and .038 respectively.

Suppressor variables affected the results of the retention model also. Factor 4 was a net suppressor, and factor 1 was a classical suppressor.

The present author concluded that factor 1 was the only substantial independent variable in the classroom environment set, and it accounted for most of the retention variance attributed to the CE set.

CHAPTER V

DISCUSSION

Major Findings

Initial Learning Model

Evaluation of the Proposed Model of Classroom Learning. The general model of classroom learning proposed in the introduction to the present study was not confirmed by the data. Model 2 was the best model of classroom learning supported by the data. That is, the present study found that classroom learning was a function of general ability and the classroom average of the student's perception of the classroom environment. The present study did not support the hypothesis of an ability by classroom environment interaction.

The present study found that model 2 (L = COV + A + CE) accounted for 23.6% of the covariate adjusted initial learning variance for the experimental group, and 22.2% of the covariate adjusted initial learning variance for the replication group. These estimates were remarkably consistent with each other, and supported the stability of this finding.

Model 2 accounted for an average of 22.9% of the covariate adjusted learning variance. The present author concluded that this model was moderately successful. This was an educationally significant result but at the same time, it demonstrated the limits of our understanding of classroom learning. Approximately, 75% of the adjusted learning variance remained unexplained by the proposed model.

In evaluating the proposed model of classroom learning, the reader should consider the reliability of the initial learning tests. The average reliability was .78; thus approximately 39% of the learning test scores were unreliable. When this fact was considered, the explanatory power of the above model improved. The above model explained 37.7% of the reliable initial learning variance, i.e. 23%/61%. This still leaves approximately 62% of thee adjusted learning variance unexplained. Perhaps, this result helps to explain why it is so difficult to specify what effective teaching is.

Evaluation of the Classroom Environment Variables. The classroom average of the student's perception of the classroom environment accounted for between 5.6% (replication group) and 11.3% (experimental group) of the adjusted initial learning variance. Thus, the present study demonstrated that the student's perceptions were effective predictors of classroom learning. That is, students learned better in some types of perceived environments than others.

Three factor scores were used to describe the student's perception of the classroom environment. However, no effort was made to verbally describe these factors. Verbal descriptions or labels of factor scores can be misleading, and so were avoided until now.

However, at this time verbal labels for the factor scores are needed to enhance the discussion. The reader should be cautious in interpreting the verbal labels that are presented in the sequel. These labels go beyond the data, and may be either too broad or too narrow. There is very little empirical evidence to validate these labels against. Future research is needed to determine the exact verbal meaning of these factors.

Table XLV contains the factor loadings for each of the CES factors produced by three different factor analyses. Column 1 presents the factor loadings for the total sample. Column 2 presents the factor loadings for the experimental sample, and column 3 presents the factor loadings for the replication sample.

Only the results of the overall factor analysis (column 1) were used in the present study. But the results from column two and three were used in naming the factors. These two analyses were performed to determine how stable the factor loadings in column 1 were. Only factor loadings which were replicable were used to name factors. That is, the results of column two should be in agreement with column three; both factor loadings should be greater than .25, and of the same sign. Variables marked with an asterisk did not meet these criteria. These variables were not considered in formulating the verbal label for each factor because the factor loadings did not occur under replication, and thus were specific to the present analysis.

Appendix M contains a list of the verbal statements used to describe each of the three CES factors. These statements were selected from each of the CES scales which had a high loading on each factor. For example, the student involvement scale has a high factor loading on factor 1. One of the dominant themes in this scale was "students show an interest in class activities." Therefore, this statement was included in the descrip tion of factor 1. Finally, the statements listed in Appendix M were synthesized by the present author into a verbal label which was descriptive of a classroom environment. Joyce and Weil (1972) was very valuable for formulating these labels.

Factor 1 was described as "a student centered environment"

TABLE XLV

FACTOR LOADINGS FOR THE THREE CLASSROOM ENVIRONMENT FACTORS PRODUCED BY THREE DIFFERENT FACTOR ANALYSES

CES Scales that had Significant Factor Loadings on each Factor	Factor Loadings Total Sample	Experimental Group	Replication Group
Factor 1			
Student Involvement	.688	.766	.490
Teacher Support	.679	.743	.542
Teacher Innovation	.636	.726	.544
Student Affiliation	.634	.653	.710
**V-1	-.134	-.257	-.031*
**Rule Clarity	.176*	.072*	.265
Proportion of Total Variance Accounted for by Factor 1	12.6%	14.9%	10.2%
Factor 4			
Order and Organization	.749	.468	.780
Task Orientation	.623	.742	.566
Rule Clarity	.433	.380	.383
**Student Involvement	.377	.112*	.580*
Teacher Support	.225	-.053*	.374
Proportion of Total Variance Accounted for by Factor 4	9.3%	7.2%	10.8%
Factor 5			
Teacher Control	.964	.963	.857
Rule Clarity	.374	.415	.384
Student Competition	.274	.194*	.415
**Teacher Support	-.148*	.019*	-.323
Proportion of Total Variance Accounted for by Factor 5	8.3%	8.2%	8.4%
Total N	375	172	204
Proportion of Variance Accounted for by all Three CE Factors	30.2%	30.3%	39.4%

*Variables with loadings of less than .25 were considered non-significant.

**These variables were not included in the descriptions used to generate a verbal label for the factor.

Rogers 1969). Factor 4 was described as a "high structure environment," and factor 5 was described as a "high structure/teacher control environment." Factor 5 was distinguished from factor 4 by factor 5's large emphasis upon discipline. A high factor score indicated that the classroom environment was perceived as high on the specified characteristics. Since these three dimensions were independent, a classroom could be high on all three dimensions. Empirical evidence is needed to demonstrate the actual range of classroom average factor scores.

As mentioned previously the class average of the student's perception of the classroom environment was an effective predictor of classroom learning. For the experimental group, it accounted for approximately the same amount of adjusted initial learning variance as the ability set! However, the existence of suppressor variables made the interpretation of these factors difficult. The evidence suggested that the perceived student centered environment (Factor 1) was the most promising CE variable for future research. It accounted for almost all of the adjusted learning variance attributed to the CE set.

Evaluation of the Ability Variables. Verbal labels were determined for factor 2 and factor 3 using the procedures described above (see Table XLVI). Factor 2 had high factor loadings on all four Culture Fair subscales, and a low loading (.33) on V-2. The V-2 loading accounted for 7% of the factor 2 variance. Since V-1 did not have a significant factor loading on factor 2, this suggested that the V-2 loading was related to the format of the V-2 scale, rather than

TABLE XLVI

SIGNIFICANT FACTOR LOADINGS FOR THE TWO ABILITY FACTORS PRODUCED BY THREE DIFFERENT FACTOR ANALYSES

	Factor Loadings		
Ability Tests that had Significant Factor Loading on Each Factor	Total Sample	Experimental Group	Replication Group
Factor 2			
G1	.624	.826	.577
G3	.566	.750	.504
G4	.545	.474	.639
G2	.521	.486	.503
** V-2	.330	.230*	.279
** V-1	.200*	.129*	.418*
Total Proportion of Total Variance Accounted for by Factor 2	10.0%	12.5%	10.4%
Factor 3			
V-1	.962	.862	.516
V-2	.601	.754	.958
Proportion of Total Variance Accounted for By Factor 3	9.3%	10.1%	8.7%
	375	172	204
Total N			
Proportion of Total Variance Accounted for By the Ability Factors	19.3%	23.6%	19.1%
Proportion of Total Variance Accounted for By all Five Factors	49.5%	53.1%	48.5%

* Variables with loadings of less than .25 were considered non-significant.

** These variables were not included in the descriptions used to generate a verbal label for each factor.

the verbal content of V-2. For both of these reasons V-2 was not considered in naming factor 2. Because of the high loadings on the Culture Fair tests, factor 2 was referred to as non-verbal intelligence.

Factor 3 had high factor loadings on both verbal scales: V1 and V2. Therefor, it seemed appropriate to label it verbal ability. Factor 3's high correlation with grades and posttest supported the proposition that this factor was measuring verbal ability.

The ability set accounted for 13.8% of the covariate adjusted initial learning variance in the experimental group, and 17.6% of the covariate adjusted initial learning variance in the replication group. This was considerably lower than would be expected, based on the simple correlations of factors 2 and 3 with initial learning, i.e. around 25%. This suggested that some of the ability variance was attributed to the covariate set. Factor 3 had a significant correlation with Grade level, (-.689) and classize (-.396) in the experimental group. Both factor 2 and factor 3 had a significant relationship with all three covariates (r = approximately .4) in the replication group.

A difference in verbal ability for eighth grade and high school students was expected. However, since non-verbal ability, i.e. fluid intelligence, reaches a ceiling around age 14, no relationship was expected between grade level and non-verbal ability. Surprisingly, high school students in the control group, had greater non-verbal ability than eighth grade students, ($r = -.410$). This relationship was not observed in the experimental group.

Whenever there was a significant relationship between a covariate and an ability variable, this relationship reduced the size of the proportion of adjusted variance attributed to the ability set. Despite this variance stealing, student ability still accounted for a sizeable proportion of the adjusted initial learning variance, i.e. approximately 15%.

Evaluation of the Ability by Classroom Environment Interaction. As discussed earlier the ability by CE interaction set was not significant; so, under the assumptions of the protected t test, it was not possible to examine the simple interaction terms. However, it was appropriate to discuss these simple interactions since they were the focus of much of the study.

The reader should be extremely cautious in his acceptance of the following discussion. The purpose of this discussion was to stimulate future research, and to explore why the interaction set was not significant. Occassionally, significance levels will be referred to; these significance levels were reported for descriptive purposes only, not to prove the existence of significant interactions. The present author still concluded that there was not enough evidence to reject the hypotheses about interactions.

When a set of variables is tested for significance, the proportion of variance accounted for by the set, is averaged over all variables in the set. If there are many variables in a set, this averaging process may obscure the significance of a single independent variable. The present author suggested that this may be happening in the interaction set of the experimental group. This set accounted for 4.6% of the total initial learning variance, and 8.5% of the adjusted initial learning variance (see Table XLI). The observed significance level of the F test was .09, and the power of the F test was .71.

In a simpler experiment, i.e. one with fewer comparisons, the present author would have used the .10 significance level for this test, because of the exploratory nature of this hypothesis. Under these conditions this null hypothesis would have been rejected. An F value this large would occur only 1 out of ten times by chance alone. This seemed to be adequate protection for an exploratory hypothesis. The above F value was unlikely enough (i.e. not the result of chance) to make the present author suspicious. Also, the interaction set accounted for 8.5% of the adjusted initial learning variance. This was certainly an educationally significant proportion of variance.

If the above result were replicated, the present author would be much more confident of having discovered a significant interaction. However, the replication group did not yield an interaction set of the same magnitude as in the experimental group. For the replication group, the interaction set accounted for 2.1% of the total initial learning variance, and 5.3% of the adjusted initial learning variance. The observed significance level of this F test was .28 and the power of the test was .50.

A look at the simple interaction terms revealed conflicting results. Three of the six interaction terms in the experimental group each accounted for more than 1% of the total initial learning variance, which was approximately 3% of the adjusted initial learning variance (see Appendix L). These three sizable interactions were: (Factor 2 X Z4), (Factor 3 X Z4), and (Factor 3 X Z5). However, none of these interactions were sizable in the replication group (see Appendix L). In fact, none of the interaction terms for the replication group were very large; the largest proportion of variance acounted for by any of these terms was .7%.

If the sizable interactions in the experimental group were also found in the replication group, the present author would have concluded that a substantial interaction was very probable. With the present set of findings, the reader should be cautious about failing to reject the null hypothesis of no interaction.

Three alternative explanations of the above findings were possible:

1. Ability by perceived classroom environment interactions truly do not exist. The sizable interactions found in the experimental group were the result of chance variations.

2. The interactions observed in the experimental group were true. An unknown factor in the replication group caused the interactions in this sample to be suppressed.

3. The interactions observed in the experimental group were true, but unstable. That is, these interations appear under some conditions, but not others. Thus, some unknown factor in the experimental group caused these interactions to appear.

It was difficult to find evidence to support any of the above alternatives. The best evidence in favor of alternative 1 was that few replicable ability by environment interactions have been found.

Two lines of evidence supported alternative 2. There were only three teachers in the replication group, and the range of two of three CE variables was approximately 50% greater in the experimental group than in the replication group, i.e. Z1 and Z4. It seems possible that the restriction of range on these variables attenuated any interactions which were present.

Conventional wisdom supports two of the interactions which were found. The two ability by Factor 4 interactions, i.e. (factor 2 X Z4), and (factor 3 X Z4), suggested that low ability students would learn most from a highly structured environment. The third sizable interaction term, (factor 3 X Z5) offered a surprising interpretation. It suggested that high verbal ability students would learn best in a highly disciplined environment, and that the learning of low verbal ability students was impeded by high discipline.

Thus alternative 2 found some support for the sizable interactions in conventional wisdom, and some support from the restriction of range observed in the replication group.

The support for alternative 3 was based on the notable differences between the experimental and replication group. The most notable difference between these groups was the presence of a large number of learning disabled students in the experimental group. This difference alone was enough to question the generalizability of any interactions.

Finally, the present author could not find any compelling evidence in favor of the three alternatives listed above. However, the present author believed that alternative 2 was the most promising explanation for the inability to replicate the sizable interactions found by the present study. Faith in this point of view played a role in this evaluation.

<u>Evaluation of the Grade by Classroom Environment Interaction.</u> These interactions were not significant for either sample, but the interactions present in the replication group approached signficance,

i.e. the observed significance level was .10. Because of conflicting results from the experimental and replication groups, the reader should be cautious in failing to reject the null hypothesis.

The large differences between the eighth grade classes in the experimental group and the eighth grade classes in the replication group made the present author suspicious of the experimental group's eighth grade classes. The replication group's eighth grade classes were much more representative of eighth grade classes. Since all three interaction terms tested under the replication group were significant, i.e. observed significance level less than .05. The present author concluded that there was enough evidence in favor of these interactions to warrant further research in this area.

The Retention Model

Evaluation of the Proposed Model of Classroom Retention.

In general all of the statements made about the initial learning model apply to the retention model. That is, the ability set and the perceived classroom environment set were both significant. The interaction set, the developmental set, and regression homogeneity check were not significant. Model 6 was the best model for predicting retention. Model 6 is comparable to model 2 for initial learning.

The present study found that model 6 accounted for 36.2% of the total retention variance, and 23.7% of the covariate adjusted retention variance. The proportion of covariate adjusted retention variance accounted for by model 6 is remarkably similar to the average proportion of covariate adjusted variance accounted for by model 2, i.e. 22.9%. The major difference between the two models was in the total proportion of variance accounted for. Model 2 accounted for 45.8% and 60.0% of the initial learning variance; model 6 accounted for 36.2% of the retention variance. This difference is almost completely accounted for by the fact that grade level was a much better predictor of initial learning (25.0% and 40.1%) than of retention (13.2%).

In terms of the other covariates, instructional time was unrelated to retention (r = .41) and did not account for a significant proportion of the retention variance (0.6%). In contrast instructional time was a significant predictor of initial learning (2.1% and 7.5%). This suggested that once something was learned, retention was not influence by how long it took to learn it. Class size was not a significant predictor of either initial learning or retention under any of the models tested.

Evaluation of the Ability Variables. Both ability variables were significant under model 5 but not under model 6; this was a very surprising result. The present author has no explanation except to note the power of the test under model 6 was low, approximately .35. Increasing the sample size would increase the power of the test, and possible the significance level of the variables.

In spite of this difficulty the variance component of factor 2 accounted for 3.5% of the retention variance, and the variance component of factor 3 accounted for 6.4% of the retention variance. It is interesting to note that verbal ability accounted for approximately twice as much of the retention variance as non-verbal ability did. The reader should also note that the ability set accounted for less of the covariate adjusted retention variance (11.8%) than it accounted for under model 2, i.e. 13.8% and 17.6% for the experimental and replication groups respectively.

Evaluation of the Classroom Environment Variables. The CE set was a significant predictor of retention, just as it was for initial learning. The CE set accounted for 13.6% of the covariate adjusted retention variance as opposed to 13.8% (experimental group) and 5.6% (replication group) of the covariate adjusted initial learning variance. Thus the CE set was approximately twice as good a predictor of retention as of initial learning. However, none of the three CE predictors were significant at the .05 level. Suppressor variables may be responsible for this lack of significance.

The perceived client centered environment (Z1) was the most substantial of the three CE variables. This variable was also the most substantial CE variable in the initial learning model. Its variance component accounted for 8.9% of the retention variance as opposed to 5.8% (experimental group) and 2.0% (replication group) of the variance of initial larning. Thus, the present author concluded that perceived client centered environment was more important in predicting retention than in the prediction of learning.

Evaluation of the Ability by Environment Interaction. The (A X CE) interaction set was not a significant predictor of retention, despite the fact that it accounted for 8.3% of the adjusted retention variance. However, the power of this test was low, and the sample size was relatively small (N = 90). If an effect this large were found with a sample size of 200 it would be significant.

Only one of the six interaction terms in the (A X CE) set was sizable, i.e. (factor 3 X Z5). The verbal ability by high discipline interaction accounted for approximately 5.6% of the adjusted retention variance (see Table XLIII). This interaction term was also sizable for initial learning in the experimental group, but was not significant for the replication group. Thus, the reader is faced with the dilemma of which sample to believe.

Since the students in the retention sample were also in the experimental group for initial learning, it was not surprising to find this interaction sizable in both samples. This interaction suggested that high verbal ability students would learn best from perceived environments high in discipline, and that low verbal ability students would learn best in perceived environments low in discipline.

Evaluation of the Grade Level by Classroom Environment Interaction. No evidence for a developmental interaction was found in the retention sample. The power of this test was low, and the sample size was small, so the reader should be cautious about failing to reject this hypothesis; larger sample sizes were recommended for future research.

Implications for Future Research

This section discussed three areas: implications for educational/psychological theory, implications for the practice of education, and implications for educational research.

Implications for Educational/Psychological Theory. An examination of Table XXIII in Appendix I shows that classes retained 96.6% of what they learned on the initial learning test. For each of the nine classes which had both initial learning and retention scores the average percentage retained ranged from 81.5% to 109.2%. Three classes had retention scores greater than their posttest class average; the present author suggested that these classes learned about acid-base theory during the retention interval. The reader should be wary of this type of change/gain score; it is notoriously unreliable. However, the present author believed this was a significant finding, because it was consistent in direction and magnitude over all nine classes.

The present author suggested that the observed high degree of retention implies that meaningful learning and retention processes were utilized by the average student in these classes. If rote learning and retention was the dominant learning process, then interference theory suggested that a much lower rate of retention was expected, i.e. 10% to 30%. This should not imply that all students adopted a meaningful learning set, but only that the average student did.

The presence of meaningful learning and retention in the schools is a sign that schools are succeeding in their goals, but more important, it argues for more educational research on meaningful learning and retention. For example, are rules and verbal information retained in the same way? Or does student ability play the same role in the meaningful learning and retention of verbal information and rules as it does in classroom learning?

The present study confirmed the existence of two ability factors as Cattell suggested. These ability factors had factor loadings which Cattell associated with fluid and crystalized intelligence. Both of these factors were significant predictors of classroom learning. Since the unit of instruction was very heavily weighted toward verbal abilities, e.g. reading and listening to lectures, it was surprising that the fluid intelligence factor was significant. The present author suggested that future research pay more attention to the fluid intelligence factor in education.

However, the present study cannot confirm that it is educationally worthwhile to make this distinction. To test this proposition, it was necessary to add the fluid and crystalized intelligence factors together, and then reanalyze the data. If this new model accounts for roughly the same proportion of variance of the dependent variable, then the present author would conclude that the fluid/crystalized intelligence distinction was not educationally significant. This debate is really a question of which model best fits the data. The present study assumed that the fluid/crystalized distinction was necessary.

The present study found that the classroom average of the students' perception of the classroom environment was a significant predictor of classroom learning. The data from the present study gave conflicting results on the types of perceived environments which were most conducive to learning. These conflicting results may have been the result of small sample sizes. In spite of these problems the present author believed that the students' perception of the classroom environment was a significant determinant of classroom learning which should be explored in greater detail.

Future research should also explore the relationship between the perceived classroom environment and the objectively measured classroom environment. At present it is difficult and time consuming to objectively measure the classroom environment with techniques like Flander's interaction analysis. It is possible that the perceived environment is a more important variable than the actual environment in determining classroom learning. If this were true, it would make educational research in the classroom somewhat easier.

It is also possible that the perceived classroom environment and measures of the acatual classroom environment are redundant measures of the same phenomenon. If this were true, paper and pencil tests such as the CES, could become the method of choice, because they are much less reactive than objective measures of the classroom environment.

The tests for interactions in the present study were disappointing because they were so inconclusive. It is possible that a larger sample size would yield conclusive results. The present author still believes that it is important to look for ATI's in education, and it is recommended that future research continue the search for educationally significant ATI's. The present author believes that the search will produce a sounder understanding of educational phenomenon, even if ATI's prove to be theoretical illusions.

The models developed in the present study are both gratifying and disappointing. In general the models accounted for approximately 50% of the variance of the dependent variable. This suggested that our basic understanding of classroom learning and retention is essentially correct. This is a gratifying thought for an educational theorist.

However, the models also leave approximately 50% of the variance of classroom learning and retention unexplained, i.e. error variance. This is very disappointing for an educational practitioner. The harshness of this reality can be softened somewhat by observing that the dependent variables only contained 61% reliable variance; more reliable dependent variables may improve the explanatory power of educational models. In the final analysis the present author believes that the models developed in the present study are encouraging for the researcher, but discouraging for the practitioner searching for educational prescriptions.

Finally, the present author suggests that future research look for interactions which involve the mode of instruction utilized by the teacher. The present study collected data on the amount of class time the teacher spent using different instructional modes. There was enough variability between teachers to make this a plausible environmental variable. For example, high ability students might do better in educational environments which demanded high verbal skills, e.g. lecture and outside reading.

Implications for Educational Practice. Cronbach and Snow (1977) suggested that any treatment which produced an improvement of .4 s.d. in the dependent variable was an educationally significant treatment. One way to evaluate the effectiveness of the unit of instruction in the present experiment is to apply this standard to each class. The mean and standard deviation of the pretest were 12.1 and 4.88 respectively. All of the classes had posttest averages greater than 14.05, i.e. .4 s.d. greater than the pretest mean. In fact all but two classes had posttest class averages greater than 1 s.d.; both of these classes were eighth grade classes. Twelve classes had posttest class averages greater than 2 s.d. above the pretest mean. By Cronbach and Snow's standard the unit of instruction was highly effective.

In attempting to evaluate the effectiveness of the unit of instruction, the reader should also note the degree of variability in the amount learned by different classes from different teachers. All classes learned form the instruction, but some classes learned much more than others. This result was probably due to the different ability levels of the classes at the start of instruction.

Finally, the present author suggests that school systems and teacher education programs devote more attention to teaching teachers how to construct classroom achievement tests. It is commonly suggested that the reliability of teacher made tests is approximately .60, i.e. 36% of the test variance is reliable variance. The present author used a table of specifications, and an operational definition of learning to produce the achievement tests used in the present study. The reliability of these tests was approximately .80, i.e. 64% of the test variance was reliable variance. This is an improvement of 28%. Since classroom grades play such an important part in the student's future, it seems very worthwhile to strive for a more reliable measure of classroom learning. The test construction process may also make the goals of instruction clearer to the teacher.

Implications for Educational Research. The present study has two major implications for educational research. First, regression analysis is the data analytic strategy of choice because it permits the investigator to look at the interdependence of independent variables found in educational environments, i.e. multicolinearity of the independent variables is an acceptable research condition. Regression analysis also permits the researcher to analyze continuous independent variables, and does not force him to truncate continuous variables to fit the cross-classification of a factorial design.

The present study illustrates the power of the above approach by demonstrating that: (a) field studies in normal classrooms are possible, and that the results are analyzable. (b) The teaching environment can be described by a continuous quantitative variable, and does not need to be described in qualitative terms such as student centered or lecture. (c) Teaching environments can be described in terms of several variables rather than one global term, i.e. a multivariate description. For example, a teaching environment could be described as being both highly structured, and student centered.

The second major implication of the present study was: the reseacher, with a limited number of subjects, should be very selective in terms of the regression model used to analyze the data. That is, the present author believes that a less ambitious model would have produced more stable results for the present study. For example, a model which did not distinguish between fluid and crystaized intelligence, but which added these variables together to form a general ability measure, would have yielded a more powerful test of the research hypotheses by eliminating four degrees of freedom from the model.

Table XLVII illustrates the benefits of increasing the sample size using the full model of classroom learning described earlier. This sample was obtained by pooling the cases from the experimental and control groups. The problem with this approach is that the two samples used similar but different dependent variables. Since the two tests were approximately parallel, and since they appear to be measuring the same thing, it seemed reasonable to pool these samples as an exploratory effort.

The increased sample size has made two very important changes in the results: (a) The significance level of the previously significant independent variables has increased dramatically; this implies that the associated partial correlations also increased. (b) The tolerance level of most variables has also increased. Tolerance is the complement of multiple correlation (1 - tolerance = R^2) and thus is a measure of the redundancy or multicolinearity of the independent variables. Increasing the tolerance means that the independent variables are less redundant, and estimates of their regression coefficients are more stable. The increase in tolerance was probably a result of the increased variability caused by the larger sample size.

BIBLIOGRAPHY

Adkins, D.C., "L.L. Thurstone." In The International Encyclopedia of the Social Sciences, 16, 1968, 22-25.

Anderson, G.J. "Effects of Classroom Social Climate on Individual Learning." American Educational Research Journal, 1970, 7, 1325-1352.

Anderson Gary and H.J. Walberg. "Curriculum Effects on the Social Climate of Learning: A New Representation of Discriminant Functions." American Educational Research Journal, 1968, 315-327.

Anderson, G.J., Walberg, H.J. and Welch, W.F. "Curriculum Effects on the Social Climate of Learning: A New Representation of Discriminant Functions." American Educational Research Journal, 6 (3), 1969, 315-328.

Anderson, R.C., Spiro, R.J. and W.E. Montague. Schooling and the Acquisition of Knowledge. Hillsdale, New Jersey: Lawrence Erlbaum Associates, 1977.

Astin, A.W. The College Environment. Washington, D.C.: American Council on Education, 1968.

Atkinson, R.C. and J.A. Paulson, "An Approach to the Psychology of Instruction." Psychological Bulletin, 1972, 78, 49-61.

Ausubel, David. Educational Psychology, A Cognitive View. New York: Holt, Rinehard and Winston, 1968.

Ausubel, D.P., J.D. Novak and H. Hanesian. Educational Psychology: A Cognitive View (2nd ed.). New York: Holt, Rinehard and Winston, 1978.

Barker, R.J. "Explorations in Ecological Psychology." American Psychologist, 1965, 20, 1-14.

Barker, R.J. Ecological Psychology. Stanford: Stanford University Press, 1968.

Barker, R.G., Dembo, T. and Lewin K. "Frustration and Regression: A Study of Young Children." University of Iowa Studies in Child Welfare, 1941, 18, No. 1.

Berliner, D.C. and L.S. Cahen. "Trait-Treatment Interaction and Learning." Review of Research in Education, F.N. Kerlinger, Ed. Illinois: Peacock Publishers, 1973, 58-95.

Berliner, D.C. and N.L. Gage. "The Psychology of Teaching Methods." Psychology of Teaching Methods, N.L. Gage, Ed. Chicago: National Society for the Study of Education, 1976.

Bloom, B.S. Englehart, M.D., Furst, E.J., Hill, W.H., and Krathwohl, D.R. A Taxonomy of Educational Objectives: Handbook I: the Cognitive Domain. New York: Longmans Green, 1956.

Brody, E.B. and N. Brody. Intelligence: Nature, Determinants, and Consequences. New York: Academic Press, 1976.

Bourne, L.E., B. Ekstrand, and R. Dominowski. The Psychology of Thinking. Englewood Cliffs, New Jersey: Prentice-Hall Inc., 1971.

Bracht, G.H. "Experimental Factors Related to Aptitude Treatment Interactions." Review of Educational Research. 1970, 40, 627-645.

Bracht, G.H. and Gene V. Glass. "The External Validity of Experiment." American Educational Research Journal, 1968, 5, 437-473.

Brunswick, E. Perception and the Representative Design of Psyhchological Experiments. Berkeley, Calif: University of Calif.Press, 1956.

Campbell, D.T. "Factors Relevant to the Validity of Experiments in Social Settings." Psychological Bulletin, 1957, 54, 297-312.

Campbell, D.T. "Reforms as Experiment." American Psychologist, 1969, 234, 409-429.

Campbell, D.T. and J.C. Stanley. "Experimental and Quasi-Experimental Designs for Research on Teaching." Handbook of Research on Teaching, N.L. Gage, Ed. Chicago: Rand McNally Company, 1963, 171-247.

Campbell, D.T. and E.J. Webb, R.D. Schwartz, and L. Sechrest. Unobtrusive Measures Nonreactive Research in the Social Sciences, Chicago: Rand McNally Company, 1966.

Carroll, J.B. "A Model of School Learning." Teachers College Record, 1963, 64, 723-733.

Cattell, R.B. "Theory of Fluid and Crystallized Intelligence: A Critical Experiment." Journal of Educational Psychology, 1963, 54, 1-22.

Cattell, R.B. The Scientific Analysis of Personality, Chicago: Aldine Publishing Company, 1965.

Cattell, R.B. "Multivariate Behavioral Research." Multivariate Behavioral Research, 1966, 4-23.

Cattell, R.B., "C.E. Spearman." In International Encylclopedia of the Social Sciences. Vol. 15, 1968, 108-111.

Cohen, Jacob. "Multiple Regression as a General Data-Analytic System." Psychological Bulletin, 1968, 70, 426-443.

Cohen, Jacob. Statistical Power Analysis for the Behavioral Sciences, New York: Academic Press, 1969.

Cohen, J. and Patricia Cohen. Applied Multiple Regression/Correlation. New York: John Wiley and Sons, 1974.

Consulting Psychologist Press Catalogue. Palo Alto, Calif.: Consulting Psychologist Press, 1976.

Cornfield, J. and J.W. Tukey. "Average Values of Mean Squares in Factorials." Annal of Mathematical Statistics, 1956, 27, 907-953.

Craik, K.H. "Environmental Psychology." In New Directions in Psychology.Vol.4.. New York: Holt, Rinehart and Winston, 1970.

Cronbach, L.J. "The Logic of Experiments on Discovery." In Lee Shulman, and Evan Keislar (Eds.), Learning by Discovery. Chicago: Rand McNally, 1966.

Cronbach, L.J. "Intelligence? Creativity? A Parsimonious Reinterpretation of the Wallach-Kogan Data." American Educational Research Journal, 1968, 5, 491-512.

Cronbach, L.J. " The Two Disciplines of Scientific Psychology" American Psychologist, 1957, 12, 67-684.

Cronbach, L.J. "Beyond the Two Disciplines of Scientific Psychology." American Psychologist, 1975, 1116-127.

Cronbach, L.J. and R.E. Snow. Individual Differences in Learning Ability as a Function of Instructional Variables. Stanford University: School of Education, Stanford, California, 1969.

Cronbach, L.J. and R.E. Snow. Aptitudes and Instructional Methods. New York: Irvington Publishers, 1977.

Darlington, R.B. "Multiple Regression in Psychological Research and Practice." Psychological Bulletin, 1968, 69, 161-182.

Domino, George. "Differential Prediction of Academic Achievement in Conforming and Independent Settings." Journal of Educational Psychology, 1968, 59, 256-260.

Douglas, J.W.B. The Home and the School. London: MacGibbon and Kee, 1964.

Educational Psychology. Del Mar, California: CRM Books, 1973.

Ekstrom, R., J.W. French, and H. Harmon. Manual for Kit of Factor Referenced Cognitive Tests 1976. Princeton, New Jersey: Educational Testing Service, 1976.

Fairweather, G., Sanders, D., Cressler, D. and Maynord, H. Community Life for the Mentally Ill. Chicago: Aldine, 1969.

Fawl, C.I. "Disturbances Experienced by Children in their Natural Habitats." In R.G. Barker (Ed.) The Stream of Behavior. New York: Appleton-Century-Crofts, 1963. 23-41.

Flanders, N. Teacher Influence, Pupil Attitudes and Achievement. Cooperative research monograph #12. Washington, D.C.: U.S. Office of Education, 1965.

Fleishman E.A. and Bartlett, C.J. "Human Abilities." Annual Psychological Review, 1969, 349-380.

Fleishman, E.A. "On the Relation Between Abilities, Learning and Human Performance." American Psychologist, 1956, 11, 1017-1032.

Frederiksen, N. "Toward a Taxonomy of Situations." American Psychologist, 1972, 114-123.

Gage, N.L. "Paradigms for Research on Teaching." Handbook of Research on Teaching, N.L. Gage, Ed. Chicago: Rand McNally Company, 1963, 94-141.

Gagne, R.M. (Ed.) Learning and Individual Differences. New York: Macmillan, 1967.

Gagne, Robert M. The Conditions of Learning. New York: Holt, Rinehart and Winston, 1970.

Gagne, R.M. Essentials of Learning for Instruction. Illinois: Dryden Press, 1974.

Gagne, R.M. and L.J. Briggs. Principles of Instructional Design. New York: Holt, Rinehart and Winston, Inc., 1974.

Glaser, R. "Individuals and Learning: the New Aptitudes." Educational Researcher, 1972, 1, 5-12.

Glaser, R. "Educational Psychology and Education." American Psychologist, 1973, 557-566.

Hall, C.S. and Gardner Lindzey. Theories of Personality. New York: John Wiley and Sons, 1970.

Halpin, A. and Croft, D. The Organizational Climate of Schools. Chicago: Midwest Administration Center, University of Chicago, 1963.

Hilgard, E.R. and Bower, G.H. Theories of Learning. (3rd Ed.) New York: Appleton-Century-Crofts, 1966.

Hilgard, E. and Marquis, D.G. Conditioning and Learning. (2nd Ed.) New York: Appleton-Century-Crofts, 1961.

Holland, J. The Psychology of Vocational Choice. Waltham, Mass.: Blaisdell, 1966.

Horn, J.L. "Integration of Structural and Developmental Concepts in Theory of Fluid and Crystallized Intelligence." Handbook of Multivariate Experimental Psychology, R.B. Cattell, Ed. Chicago: Rand McNally Company, 1966, 553-563.

Horn, J.L. "Organization of Abilities and the Development of Intelligence." Psychological Review, 1968, 75, 242-259.

Horn, John and R.B. Cattel.. "Refinement and Test of the Theory of Fluid and Crystalized General Intelligences." Journal of Educational Psychology, 1966, 57, 253-270.

Humphreys, L.G. "The Organization of Human Abilities." American Psychologist, 1962, 17, 475-483.

Hunt, D.E. Matching Models in Education: the Coordination of Teaching Methods with Student Characteristics. Toronto: Ontario Institute for Studies in Education, 1971.

Hunt, D.E. "Person-Environment Interaction: A Challenge Found Wanting Before It Was Tried." Review of Educational Research, 1975, 45, 209-231.

Hune, D.E. and B.R. Joyce. "Teacher Trainee Personality and Initial Teaching Style." American Educational Research Journal, 1967, 4, 253-259.

Hunt, D.E. and E.V. Sullivan. Between Psychology and Education. Illinois: Dryden Press, 1974.

Insel, Paul and Rudolf Moos. "Psychological Environments: Expanding the Scope of Human Ecology." American Psychologist, 1974, 179-188.

Johnson, P.E. Psychology of School Learning, New York: John Wiley and Sons, 1971.

Joyce, Bruce and Marsha Well. Models of Teaching. New Jersey: Prentice-Hall, 1972.

Kates, R. and Wohlwill, J. (Eds.) "Man's Response to the Physical Environment." Journal of Social Issues. 1966, 22, 1-140.

Kerlinger, F. and Elazar J. Pedhazur. Multiple Regression in Behavioral Research. New York: Holt, Rinehart and Winston, Inc., 1973.

Klausmeier, H.J., E.S. Ghatala, And D.A. Frayer. Conceptual Learning and Development. New York: Academic Press, 1974.

Hilgard, E.R. and Bower, G.H. Theories of Learning. (3rd Ed.) New York: Appleton-Century-Crofts, 1966.

Klausmeier, H.J., and W. Goodwin. Learning and Human Abilities: Educational Psychology. (4th ed.). New York: Harper & Row, 1975.

Koan, Scven and William J. McGuire. "The Yin and Yang of Progress in Social Psychology." Journal of Personality and Social Psychology, 1973, 26, 446-456.

Krause, M.S. "Use of Social Situations for Research Purposes." American Psychologist, 19709, 25, 748-753.

Lesser, G.S. "Matching Instruction to Student Characteristics." Psychology and Educational Practice, G.S Lesser, Ed. Illinois: Scott, Foresman Company, 1971, 530-550.

Lewin, K. A Dynamic Theory of Personality. New York: McGraw-Hill, 1935.

Linton, R. The Cultural Background of Personality. New York: Century, 1945.

Litwin, G.H. and Stringer, R.A. Motivation and Organizational Climate. Boston: Division of Research, Harvard Business School, 1968.

March, J. (Ed.) Handbook of Organizations. Chicago: Rand McNally, 1965.

McKeachie, W.J. "The Decline and Fall of the Laws of Learning." Educational Researcher, 1974, 3 (3), 7-11.

McLachlan, J.F. and D.E. Hunt. "Differential Effects of Discovery Learning as a Function of Student Conceptual Level." Canadian Journal of Behavioral Science, 1973, 5, 152-160.

Messick, S. "The Criterion Problem in the Evaluating of Instruction: Assessing Possible Not Just Intended Outcomes." In M.C. Witrock and D.C. Wiley (Eds.) The Evaluation of Instruction: Issues and Problems. New York: Holt, Rinehart, and Winston, 1970, 183-202.

Metfessel, N.S., W.B. Michael, and Kirsner, D.A. Instrumentation of Bloom's and Krathwohl's Taxonomies for the Writing of Educational Objectives. Psychology in the Schools, 1969, 6, (3)227-231.

Mischel, W. Personality and Assessment. New York: Wiley, 1968.

Mitchell, J.U. "Education's Challenge to Psychology: The Prediction of Behavior From Person-Environment Interactions," Review of Educational Research, 1969, 39, 695-721.

Moos, R.H. "Conceptualizations of Human Environments." American Psychologist, 1973, 653-665.

Moos, R.H. Evaluating Educational Environments. Palo Alto, Calif.: Consulting Psychologist Press, 1978.

Moos, R.H. Evaluating Educational Environments. San Francisco: Jossey-Bass, 1979.

Moos, R. and Tricketts, E. Classroom Environment Scale. Palo Alto, Calif.: Consulting Psychologists Press, 1974.

Murray, H. Explorations in Personality, New York: Oxford University Press, 1938.

Nunnally, J.C. Psychometric Theory. New York: McGraw-Hill Book Co., 1978.

Nuthall, G. and Ivan Snook. "Contemporary Models of Teaching." Second Handbook of Research in Teaching, R.M. Travers (Ed), Chicago: Rand McNally Company, 1973, 47-76.

Pace, R. College and University Environment Scale. (Tech. Manual, 2nd Ed.) Princeton, N.J.: Educational Testing Service, 1970.

Pereboom, A.C. " Some Fundamental Problems in Experimental Psychology: An Overview." Psychological Reports, 1971, 28, 439-455.

Pervin, L.A. "Performance and Satisfaction as a Function of the Individual-Environment Fit." Psychological Bulletin, 1968, 69. 56-68.

Peterson, R. Centra, J. Nartnet, R., and Linn, R. Institutional Functioning Inventory: Preliminary Technical Manual. Princeton, N.J.: Educational Testing Service, 1970.

Porter, L. and Lawler, R. "Properties of Organization Structure in Relation to Job Attitudes and Job Behavior." Psychological Bulletin, 1965, 64, 23-51.

Proshansky, H., Ittelson, W. and Rivlin, L. (Eds.) Environmental Psychology: Man and His Physical Setting. New York: Holt, Rinehart, and Winston, 1970.

Pugh, D. "Modern Organization Theory: A Psychological and Sociological Study." Psychological Bulletin, 1966, 66, 235-251.

Rhetts, John. "Attribute - Treatment Interactions and Individualized Instruction: A Conceptual Framework and an Example from Project PLAN." Learning Performance and Individual Differences, Len Sperry, Ed. London: Scott, Foresman and Company, 1972, 269-285.

Rimoldi, H.J. "Study of Some Factors Related to Intelligence." Psychometrika, 1948, 13, 27-46.

Rock, D.A. and L.L. Baird. "Interaction Between College Effects and Students' Aptitudes." American Educational Research Journal, 1972, 9, 149-161.

Rosenshine, Barak. "Evaluation of Classroom Instruction." Review of Educational Research, 1970, 40, 279-300.

Salomon, Gauriel. "Heuristic Models for the Generation of Aptitude Treatment Interaction Hypothesis." Review of Educational Research, 1971, 42, 327-343.

Salomon, G. Interaction of Media, Cognition, and Learning. San Francisco: Jossey-Bass, 1979.

Schneicer, B., and Bartlettt, C. "Individual Differences and Organizational Climate by the Multi-trait, Multi-rater Matrix." Personnel Psychology, 1970, 23, 493-512.

Schulman, L.S. "Reconstruction of Educational Research." Review of Educational Research, 1970, 40, 371-396.

Sells, S.B. "Ecology and the Science of Psychology" Multivariate Behavioral Research, 1966, 131-144.

Sells, S.B. "An Interactionist Looks at the Environment." American Psychologist, 1963, 18, 696-702.

Snow, Richard. "Brunswikian Approaches to Research on Teaching." American Educational Research Journal, 1968, 5, 475-489.

Snow, R.E. "Theory Construction for Research on Teaching." Second Handbook of Research on Teaching, R.M. Travers (Ed), Chicago: Rand McNally Company, 1973, 77-112.

Snow, R.E. "Representative and Quasi-Representative Designs for Research on Teaching." Review of Educational Research, 1974, 44, 265-291.

Sommer, R. Personal Space. New York: Prentice-Hall, 1969.

Sperry, L. Learning Performance and Individual Differences: Essays and Readings. Glenview, Ill.: Scott, Foresman and Co., 1972.

Stein, J. (Ed.) The Random House Dictionary of the English Language. New York: Random House, 1971.

Stephens, J.M. The Process of Schooling: A Psychological Examination. New York: Holt, Rinehart and Winston, 1967.

Stern, G. People in Context: Measuring Person-Environment Congruence in Education and Industry. New York: Wiley, 1970.

Sternberg, R.J. Intelligence, Information Processing, and Analogical Reasoning. New York: Lawrence Erlbaum Associates, 1977.

Suppes, P. "The Place of Theory in Educational Research." Educational Researcher, 1974, 3 (6), 3-10.

Tallmadge, G.K. and J.W. Shearer. "Relationships Among Learning Styles, Instructional Methods and the Nature of Learning Experience." Journal of Educational Psychology, 1969, 60, 222-230.

Thomburg, H. School Learning and Instruction, Belmont, Calif.: Wadsworth Publishing, 1973.

Thorndike, R.M. Correlational Procedures for Research. New York: Gardner Press, 1978.

Tobias, S. "Achievement Treatment Interaction." Review of Educational Research, 1976, 46, 61-75.

Tukey, John. "Analyzing Data: Sanctification or Detective Work?" American Psychologist, 1969, 24, 83-91.

Tyler, Leona. Individual Differences. New Jersey: Prentice-Hall, 1974.

Tyler, Leona. The Psychology of Human Differences. New Jersey: Prentice-Hall, 1965.

Vale, Jack R. and Carol A. Vale. "Individual Differences and General Laws in Psychology: A Reconciliation." American Psychologist, 1969, 24, 1093-1108.

Walberg, H.J. "Predicting Class Learning: An Approach to the Class as a Social System." American Educational Research Journal, 1969, 6, 529-542.

Walberg, H.J. and Andrew Ohlgren. "Predictors of the Social Environment of Learning." American Educational Research Journal, 1972, 9, 139-148.

Walberg, H.J. and Juanita Sorenson. "Ecological Correlates of Ambience in the Learning Environment." American Educational Research Journal, 1972, 9, 139-148.

Wallen, N.E. and Travers, R.M. "Analysis and Investigations of Teaching Methods." In N.L. Gage (Ed.), Handbook of Research on Teaching. Chicago: Rand McNally, 1963, 448-505.

Weiner, Bernard. Theories of Motivation: From Mechanism to Cognition. Chicago: Markham Publishing Company, 1972.

Witrock, M.C. Learning and Instruction. Berkeley, California: McCutchum Publishing, 1977.

Wolfe, R. "The Measurement of Environments." In A. Anastasi (Ed.), Testing Problems in Perspective. Washington, D.C.: American Council on Education, 1966.

Yee, Albert. "Source and Direction of Causal Influence in Teacher - Pupil Relationships." Journal of Educational Psychology, 1968, 59, 275-282.

APPENDIX A

TEST MATERIALS

Test of "g": CULTURE FAIR

Scale 2, Form A

Prepared by R. B. Cattell and A. K. S. Cattell

Name ______________________________ Sex ________
First Last (Write M or F)

Name of School (or Address) ______________________________

Today's Date ______________________ Grade (or Class) ____________

Date of Birth ______________________ Age ______________________
Month Day Year Years Months

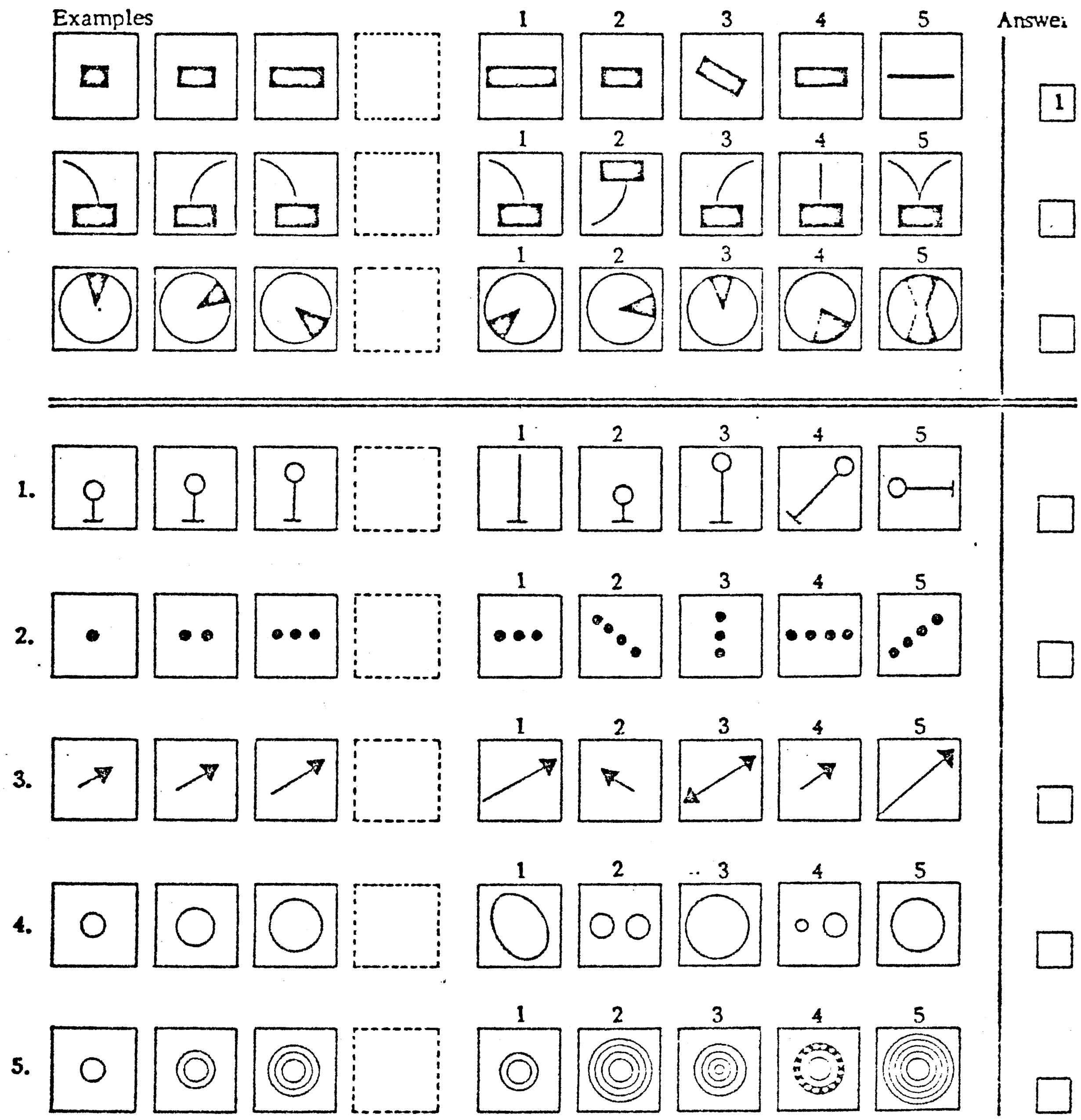
Test	Score	Remarks
1		
2		
3		
4		
		Total Score

M. ________

Q. ________

CF2-Atb-6AA

TEST 1



1.

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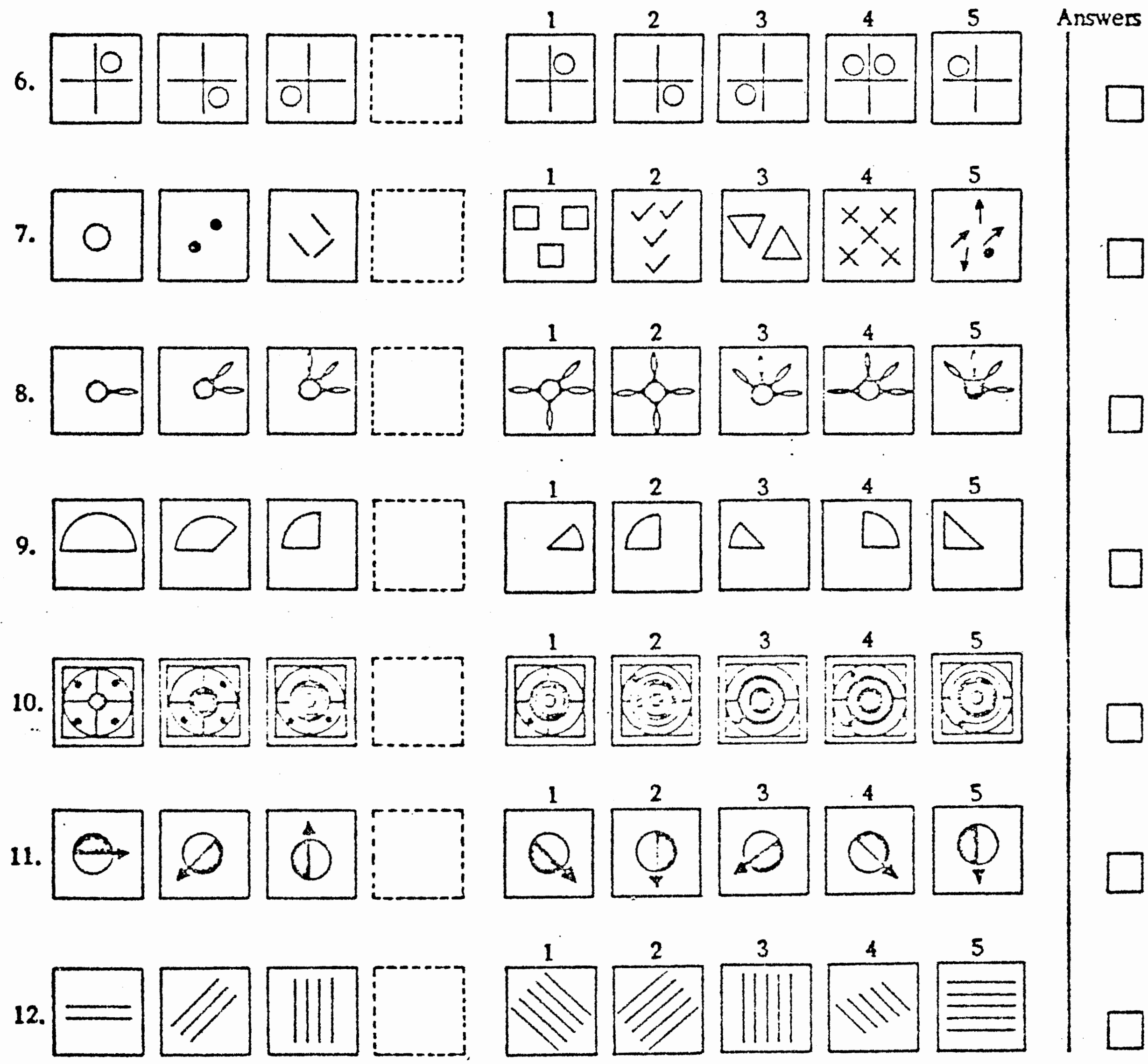

End of Test 1

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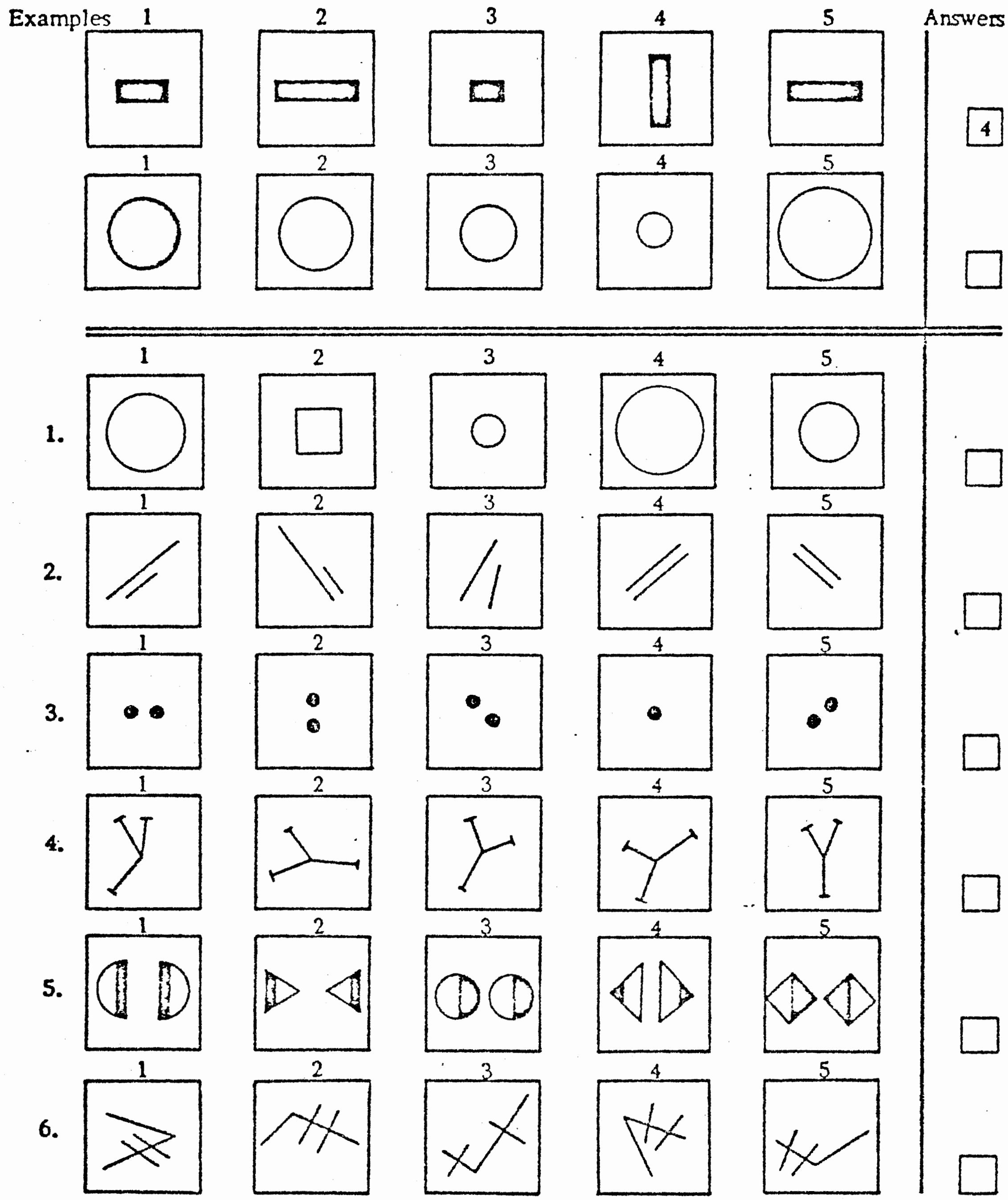

3.

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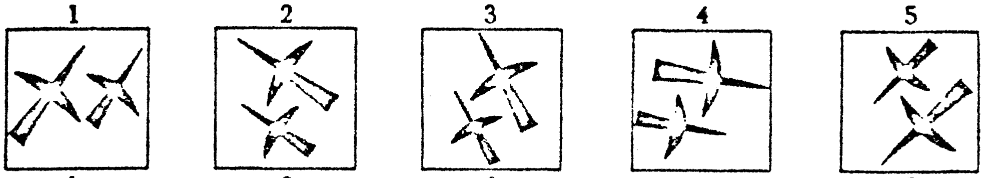
1 2 3 4 5 Answers

7. 

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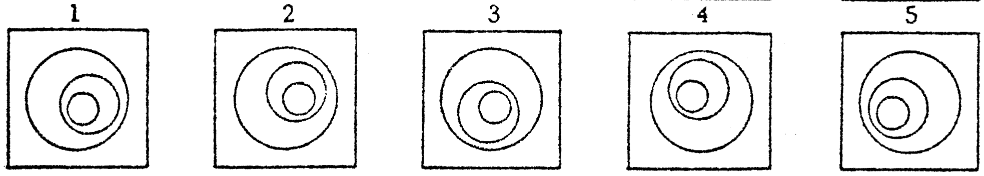
8. 

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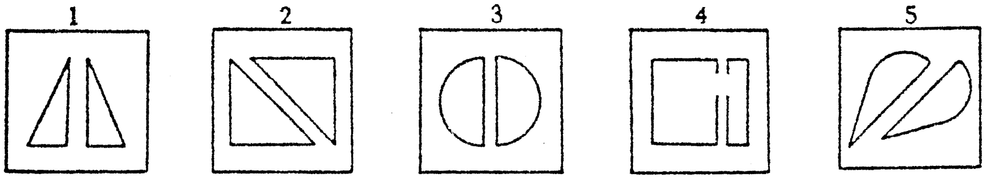
9. 

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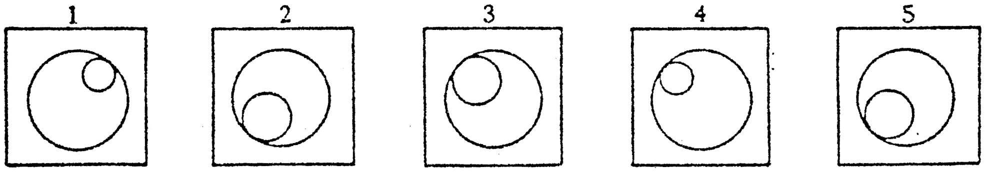
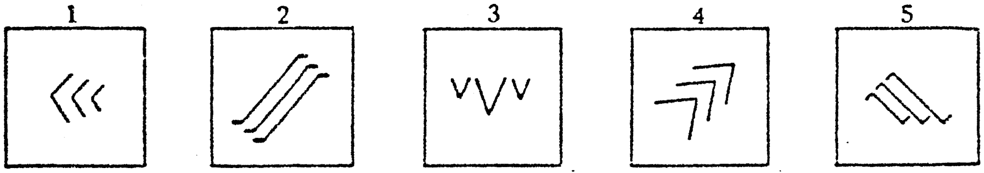
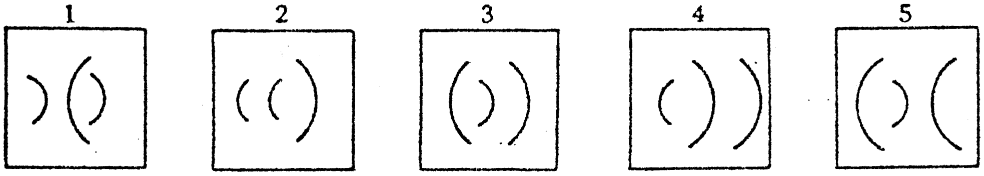
10. 

1 2 3 4 5

11. 

1 2 3 4 5

12. 

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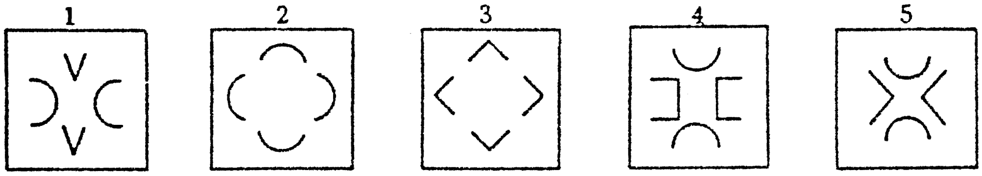
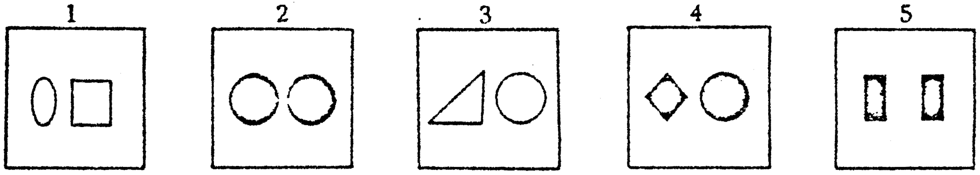
13. 

1 2 3 4 5

14. 

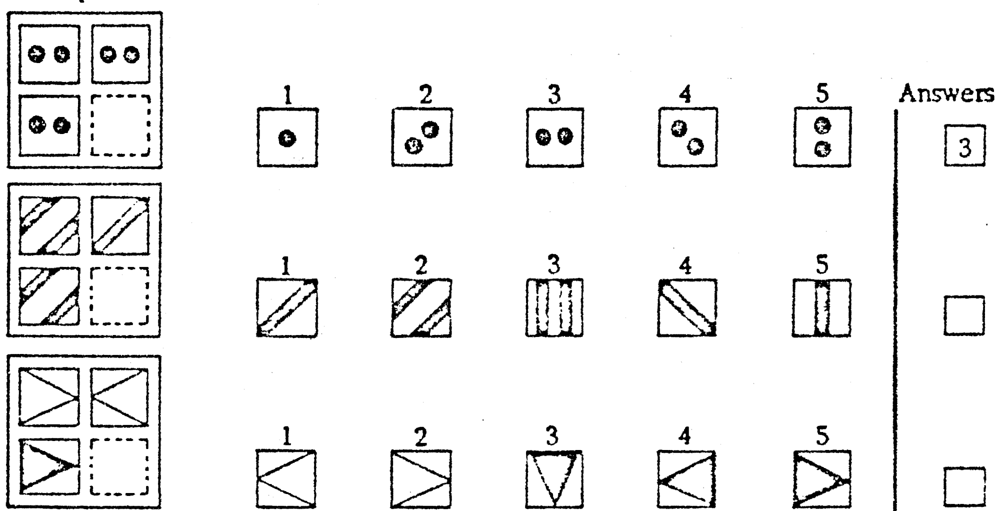
End of Test 2

4.

STOP! Do not turn the page until told to do so.

TEST 3

Examples



1.
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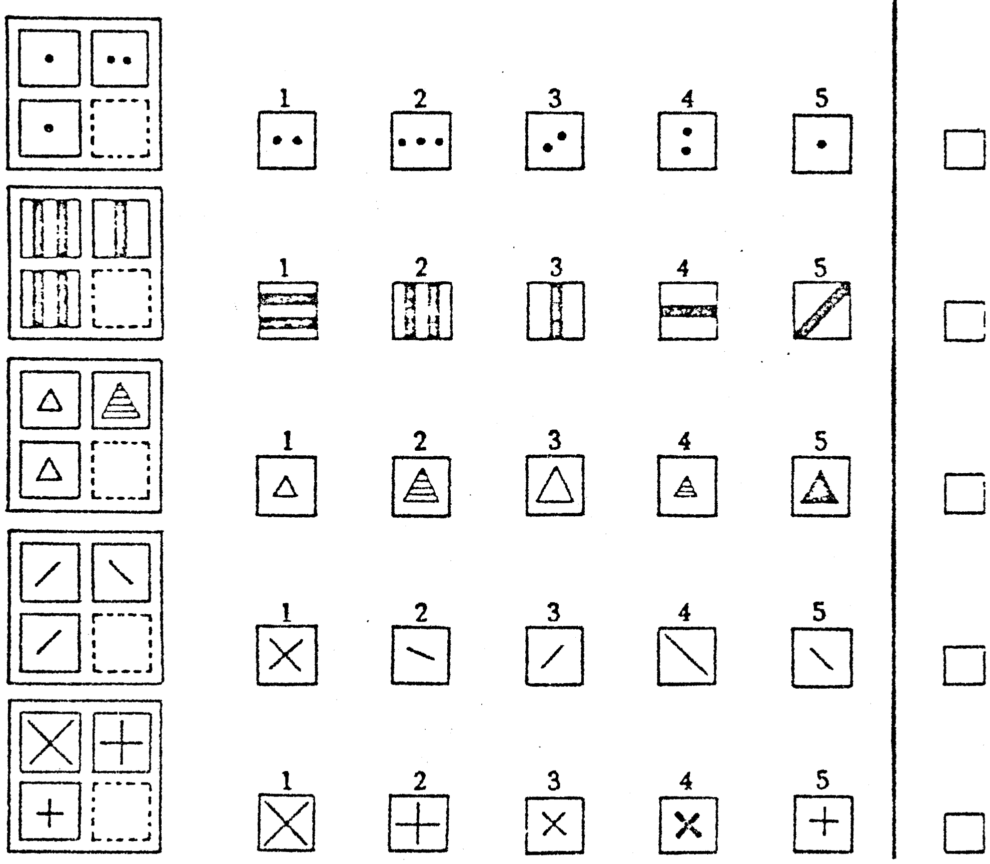

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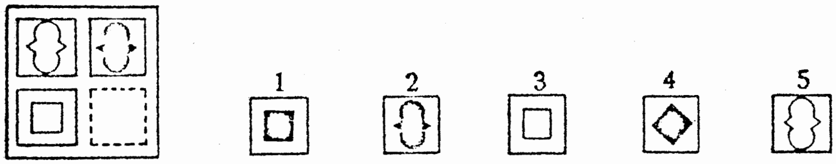
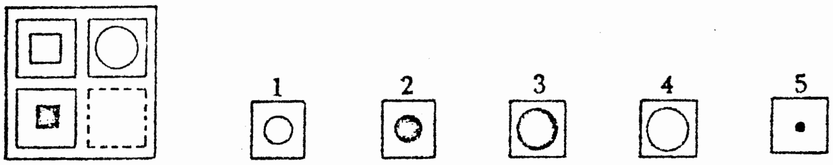
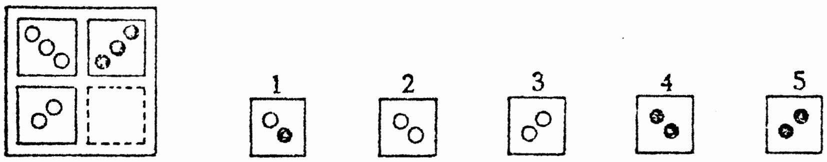
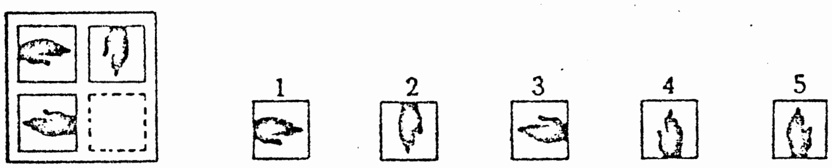
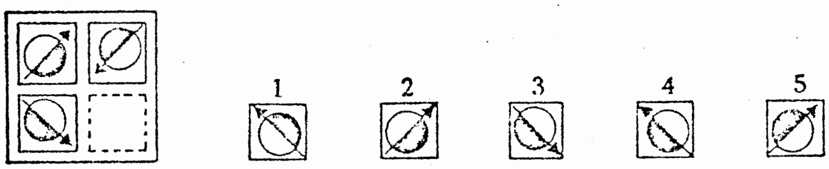
Answers

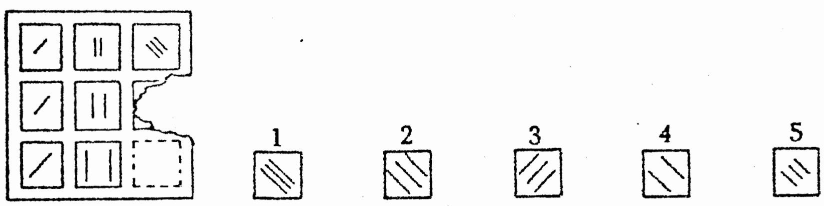
6. 

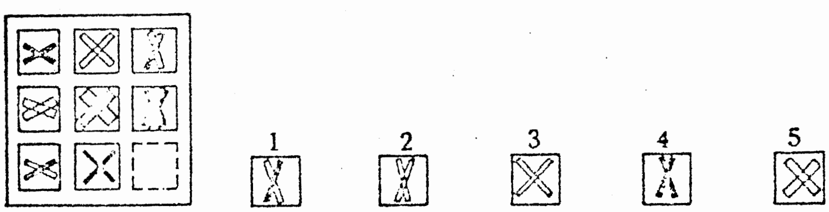
7. 

8. 

9. 

10. 

11. 

12. 

End of Test 3

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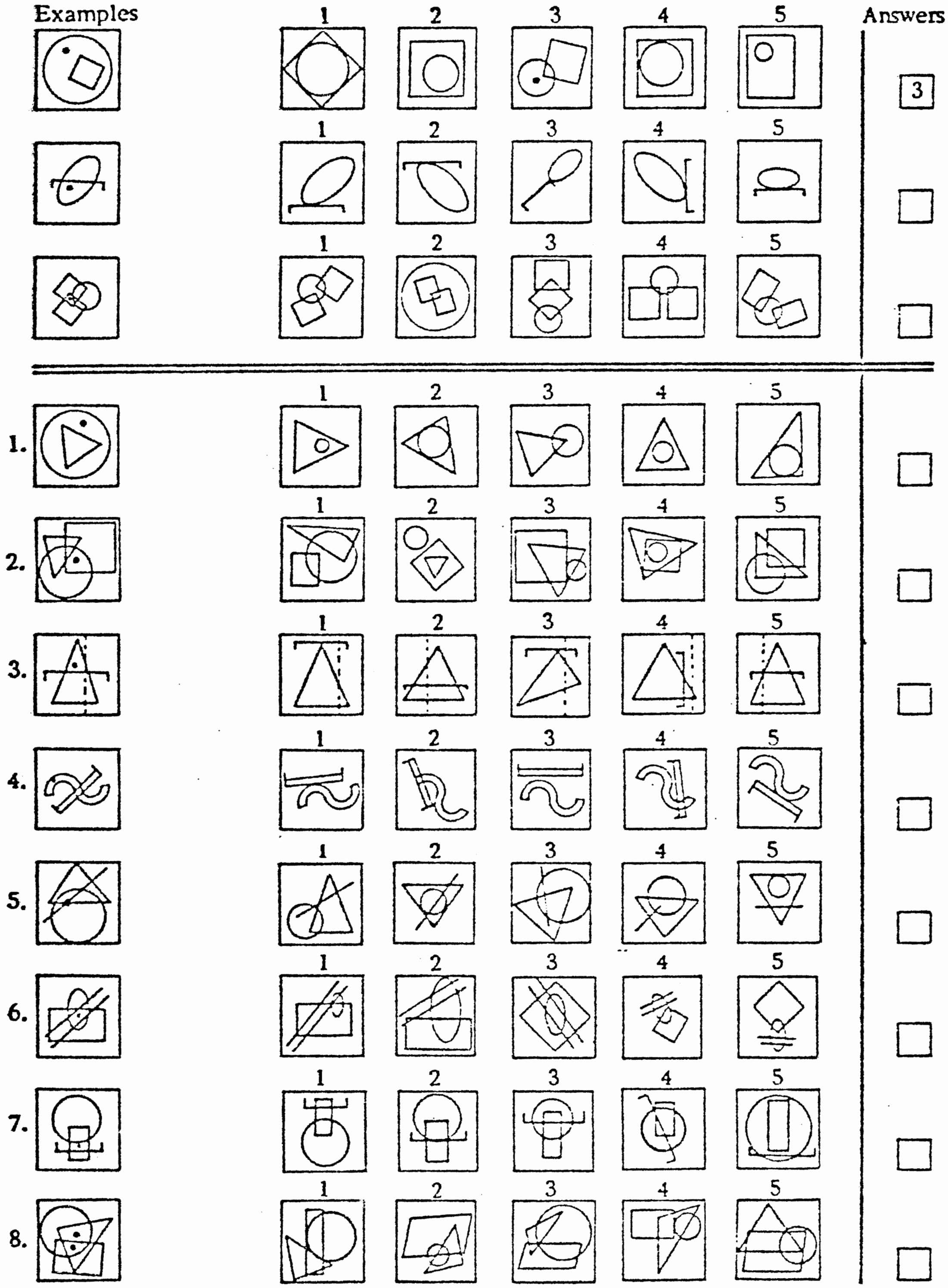
TEST 4



End of Test 4

ANSWER SHEET

Test of "g": Culture Fair, SCALE 2, Form ____ (A or B)

NAME ______________________________ DATE ____________
Last Name First Name Initial

SCHOOL (or Address, Occupation, as instructed) ______________________________

AGE ____ ____ DATE OF BIRTH ____ ____ ____ GRADE ____________ MALE ☐ FEMALE ☐
Years Months Month Day Year (Boy) (Girl)

CIRCLE HIGHEST GRADE COMPLETED IN SCHOOL 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

Instructions: Place this answer sheet next to the booklet. Inside the booklet there are rows of little puzzles. You are to pick the best one of the 5 choices that are given for each puzzle. If the answer you choose is the first one in the line, fill in the box under the "1." If the answer you choose is the second, fill in the box under the "2." If you choose the third, fill in the box under the "3," and so on. Be sure when you are working on Test 1 to fill in the boxes under Test 1; when you are working on Test 2, be sure you fill in the boxes under Test 2; and so on.

★

TEST 1	TEST 2	TEST 3	TEST 4
Examples:	Examples:	Examples:	Examples:
1 2 3 4 5 ■ ☐ ☐ ☐ ☐	1 2 3 4 5 ☐ ☐ ☐ ■ ☐	1 2 3 4 5 ☐ ☐ ■ ☐ ☐	1 2 3 4 5 ☐ ☐ ■ ☐ ☐
1 2 3 4 5 ☐ ☐ ☐ ☐ ☐	1 2 3 4 5 ☐ ☐ ☐ ☐ ☐	1 2 3 4 5 ☐ ☐ ☐ ☐ ☐	1 2 3 4 5 ☐ ☐ ☐ ☐ ☐
1 2 3 4 5 ☐ ☐ ☐ ☐ ☐		1 2 3 4 5 ☐ ☐ ☐ ☐ ☐	1 2 3 4 5 ☐ ☐ ☐ ☐ ☐
1 ☐ ☐ ☐ ☐ ☐	1 ☐ ☐ ☐ ☐ ☐	1 ☐ ☐ ☐ ☐ ☐	1 ☐ ☐ ☐ ☐ ☐
2 ☐ ☐ ☐ ☐ ☐	2 ☐ ☐ ☐ ☐ ☐	2 ☐ ☐ ☐ ☐ ☐	2 ☐ ☐ ☐ ☐ ☐
3 ☐ ☐ ☐ ☐ ☐	3 ☐ ☐ ☐ ☐ ☐	3 ☐ ☐ ☐ ☐ ☐	3 ☐ ☐ ☐ ☐ ☐
4 ☐ ☐ ☐ ☐ ☐	4 ☐ ☐ ☐ ☐ ☐	4 ☐ ☐ ☐ ☐ ☐	4 ☐ ☐ ☐ ☐ ☐
5 ☐ ☐ ☐ ☐ ☐ End Page 1	5 ☐ ☐ ☐ ☐ ☐	5 ☐ ☐ ☐ ☐ ☐ End Page 5	5 ☐ ☐ ☐ ☐ ☐
6 ☐ ☐ ☐ ☐ ☐	6 ☐ ☐ ☐ ☐ ☐ End Page 3	6 ☐ ☐ ☐ ☐ ☐	6 ☐ ☐ ☐ ☐ ☐
7 ☐ ☐ ☐ ☐ ☐	7 ☐ ☐ ☐ ☐ ☐	7 ☐ ☐ ☐ ☐ ☐	7 ☐ ☐ ☐ ☐ ☐
8 ☐ ☐ ☐ ☐ ☐	8 ☐ ☐ ☐ ☐ ☐	8 ☐ ☐ ☐ ☐ ☐	8 ☐ ☐ ☐ ☐ ☐ Stop Here
9 ☐ ☐ ☐ ☐ ☐	9 ☐ ☐ ☐ ☐ ☐	9 ☐ ☐ ☐ ☐ ☐	
10 ☐ ☐ ☐ ☐ ☐	10 ☐ ☐ ☐ ☐ ☐	10 ☐ ☐ ☐ ☐ ☐	
11 ☐ ☐ ☐ ☐ ☐	11 ☐ ☐ ☐ ☐ ☐	11 ☐ ☐ ☐ ☐ ☐	
12 ☐ ☐ ☐ ☐ ☐ Stop Here not go on to next page until told to do so	12 ☐ ☐ ☐ ☐ ☐	12 ☐ ☐ ☐ ☐ ☐ Stop Here	
	13 ☐ ☐ ☐ ☐ ☐		
	14 ☐ ☐ ☐ ☐ ☐ Stop Here		

(Each item row has the choice numbers 1 2 3 4 5 above its boxes.)

Do not write in this space.

Test	Score
1	______
2	______
3	______
4	______
Total Score	______
Q.	______
M.	______ Optional

NOTES:

A2-214-74

VOCABULARY TEST I

A.	___
1.	___
2.	___
3.	___
4.	___
5.	___
6.	___
7.	___
8.	___
9.	___
10.	___
11.	___
12.	___
13.	___
14.	___
15.	___
16.	___
17.	___
18.	___

VOCABULARY TEST II

A.	1	2	3	4	5
1.	1	2	3	4	5
2.	1	2	3	4	5
3.	1	2	3	4	5
4.	1	2	3	4	5
5.	1	2	3	4	5
6.	1	2	3	4	5
7.	1	2	3	4	5
8.	1	2	3	4	5
9.	1	2	3	4	5
10.	1	2	3	4	5
11.	1	2	3	4	5
12.	1	2	3	4	5
13.	1	2	3	4	5
14.	1	2	3	4	5
15.	1	2	3	4	5
16.	1	2	3	4	5
17.	1	2	3	4	5
18.	1	2	3	4	5

LETTER SETS TEST

A.	NOPQ	~~DEFL~~	ABCD	HIJK	UVWX
B.	NLIK	PLIK	QLIK	~~THIK~~	VLIK
1.	QPPQ	HGHH	TTTU	DDDE	MLMM
2.	BCDE	FGHI	JKLM	PRST	VWXY
3.	BVZC	FVZG	JVZK	PWXQ	SVZT
4.	BCEF	FGIJ	STWX	CDFG	PQST
5.	BCCB	GFFG	LMML	QRRQ	WXXW
6.	AAPP	CCRR	QQBB	EETT	DDSS
7.	ABDC	FGFH	IJLK	OPRQ	UVXW
8.	CFRT	KMTV	FHXZ	BODQ	HJPR
9.	PABQ	SEFT	VIJW	COPD	FUZG
10.	CFCR	JCVC	CGCS	CLXC	KCWC
11.	XDBK	TNLL	VEGV	PFCC	ZAGZ
12.	CAEZ	CEIZ	CIOZ	CGVZ	CAUZ
13.	VEBT	XGDV	ZIFX	KXVH	MZXJ
14.	AFBG	FJFK	GKHM	PSQT	RWSX
15.	KGDB	DFIM	KIFB	HJMQ	LHEC

VOCABULARY TEST I

This is a test of your knowledge of word meanings. Look at the sample below. One of the four numbered words has the same meaning or nearly the same meaning as the word at the left. Indicate your answer by writing the number of the word you select on the answer sheet.

attempt 1-run 2-hate 3-try 4-stop

The answer to the item is number 3; you should have a "3" written on your answer sheet.

Your score will be the number marked correctly minus a fraction of the number marked incorrectly. Therefore, it will not be to your advantage to guess unless you are able to eliminate one or more of the answer choices as wrong.

You will have 4 minutes to complete this test. Remember, do not write in the test booklet.

DO NOT TURN THIS PAGE UNTIL ASKED TO DO SO.

Page 2

DO NOT WRITE ON TEST BOOKLET

1.	airtight	1-firm 2-light 3-hermetically sealed 4-plane sick
2.	peddle	1-tattle 2-cheat 3-misrepresent 4-sell
3.	raider	1-frontiersman 2-plunderer 3-murderer 4-cynic
4.	energetically	1-inspiringly 2-skillfully 3-delightfully 4-vigorously
5.	implicate	1-involve 2-remove 3-retaliate 4-exaggerate
6.	gloaming	1-autumn 2-midnight 3-twilight 4-daybreak
7.	legibleness	1-crookedness 2-amity 3-plainness 4-carelessness
8.	laceration	1-cut 2-oration 3-tumor 4-flogging
9.	jollification	1-capitulation 2-merrymaking 3-emancipation 4-teasing
10.	willowy	1-lithe 2-windy 3-quiet 4-fickle
11.	feline	1-guileless 2-fabulous 3-equine 4-catlike
12.	dispiritedly	1-neglectfully 2-conspicuously 3-dishonorably 4-dejectedly
13.	intricacy	1-delicacy 2-complexity 3-invisibility 4-hostility
14.	excerpt	1-accept 2-extract 3-curtail 4-deprive
15.	arrogance	1-contrariness 2-insubordination 3-haughtiness 4-vivacity
16.	gallivant	1-serenade 2-gad about 3-plunder 4-espouse
17.	sheik	1-priest 2-casque 3-shepherd 4-chief
18	exorbitance	1-excessiveness 2-dissidence 3-unanimity 4-gaiety

DO NOT TURN THIS PAGE UNTIL ASKED TO DO SO

STOP

VOCABULARY TEST II

This is a test of your knowledge of word meanings. Look at the sample below. One of the five numbered words has the same meaning or nearly the same meaning as the word above the numbered words. Mark your answer by putting an X on <u>your answer sheet</u> through the number you select.

jovial

1-refreshing
2-scare
3-thickset
4-wise
5-jolly

The answer to the sample item is number 5; you should have put an X through number 5 on your answer sheet.

Your score will be the number marked correctly minus a fraction of the number marked incorrectly. Therefore, it will <u>not</u> be to your advantage to guess unless you are able to eliminate one or more of the answer choices as wrong.

You will have <u>4 minutes</u> to complete this test. Remember, do <u>not</u> write in the Test Booklet.

DO NOT TURN THIS PAGE UNTIL ASKED TO DO SO.

Page 4

1. handicraft

   1-cunning
   2-fast boat
   3-utility
   4-manual skill
   5-guild

2. resistant

   1-confusing
   2-conjunctive
   3-systematic
   4-assisting
   5-opposing

3. ejection

   1-restoration
   2-expulsion
   3-reformation
   4-bisection
   5-exposition

4. yawl

   1-tropical storm
   2-foghorn
   3-carouse
   4-sailboat
   5-turn

5. listless

   1-aggressive
   2-adaptable
   3-indifferent
   4-sorrowful
   5-ugly

6. acceptable

   1-affected
   2-suitable
   3-attractive
   4-genial
   5-noteworthy

7. unobservant

   1-analytic
   2-conclusive
   3-heedless
   4-uninformed
   5-timid

8. perambulator

   1-coffeepot
   2-drunkard
   3-baby carriage
   4-liar
   5-camel

9. masticate

   1-chew
   2-massage
   3-manufacture
   4-create
   5-pollute

10. poignancy

   1-peignoir
   2-gloominess
   3-keenness
   4-gluttony
   5-barony

11. salaam

   1-salivation
   2-salmon
   3-salutation
   4-ransom
   5-brigand

12. compatible

   1-abridged
   2-congenial
   3-compelling
   4-related
   5-combined

13. inclement

   1-balmy
   2-happy
   3-righteous
   4-severe
   5-apprehensive

14. access

   1-abundance
   2-evaluation
   3-approach
   4-extremes
   5-foes

15. bland

   1-disagreeable
   2-pale
   3-soothing
   4-empty
   5-musical

16. collusion

   1-nerve
   2-rest
   3-prayer
   4-conspiracy
   5-disguise

17. degrade

   1-lower in rank
   2-bend downward
   3-disagree
   4-sort
   5-uplift

18. evolve

   1-develop gradually
   2-spin
   3-end suddenly
   4-implicate
   5-include

DO NOT TURN THIS PAGE UNTIL ASKED TO DO SO.

STOP.

Page 5

LETTER SETS TEST

Each problem in this test has five sets of letters with four letters in each set. Four of the sets of letters are alike in some way. You are to find the rule that makes these four sets alike. The fifth letter set is different from them and will not fit this rule. Draw an X on your answer sheet through the set of letters that is different.

NOTE: The rules will not be based on the sounds of sets of letters, the shapes of letters, or whether letter combinations form words or parts of words.

Examples:

A.	NOPQ	DEFL	ABCD	HIJK	UVWX
B.	NLIK	PLIK	QLIK	THIK	VLIK

In Example A, four of the sets have letters in alphabetical order. An X has therefore been drawn through DEFL. In Example B, four of the sets contain the letter L. Therefore, an X has been drawn through THIK.

Your score on this test will be the number of problems marked correctly minus a fraction of the number marked incorrectly. Therefore, it will not be to your advantage to guess unless you are able to eliminate one or more of the letter sets.

You will be allowed 7 minutes to complete this test. Remember, do not write in the test booklet.

DO NOT TURN THIS PAGE UNTIL ASKED TO DO SO

70. In the first few weeks the teacher explained the rules about what students could and could not do in this class.

71. The teacher will put up with a good deal.

72. Students can choose where they sit.

73. Students sometimes do extra work on their own in the class.

74. There are groups of students who don't get along in class.

75. This teacher does not trust students.

76. This class is more a social hour than a place to learn something.

77. Sometimes the class breaks up into groups to compete with each other.

78. Activities in this class are clearly and carefully planned.

79. Students aren't always sure if something is against the rules or not.

80. The teacher will kick a student out of class if he acts up.

81. Students do the same kind of homework almost every day.

82. Students really enjoy this class.

83. Some students in this class don't like each other.

84. Students have to watch what they say in this class.

85. The teacher sticks to classwork and doesn't get sidetracked.

86. Students usually pass even if they don't do much.

87. Students don't interrupt the teacher when he's talking.

88. The teacher is consistent in dealing with students who break the rules.

89. When the teacher makes a rule, he means it.

90. In this class, students are allowed to make up their own projects.

CLASSROOM ENVIRONMENT SCALE

FORM R

INSTRUCTIONS

There are 90 statements in this booklet. They are statements about high school and junior high school classrooms. You are to decide which of these statements are true of your classroom and which are false.

Make all your marks on the separate answer sheet. If you think a statement is true or mostly true of your class, make an X in the box labeled T (true). If you think the statement is false, or mostly false, make an X in the box labeled F (false).

Do not make any marks on this booklet.

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1. Students put a lot of energy into what they do here.
2. Students in this class get to know each other really well.
3. This teacher spends very little time just talking with students.
4. Almost all class time is spent on the lesson for the day.
5. Students don't feel pressured to compete here.
6. This is a well organized class.
7. There is a clear set of rules for students to follow.
8. There are very few rules to follow.
9. New ideas are always being tried out here.
10. Students daydream a lot in this class.
11. Students in this class aren't very interested in getting to know other students.
12. The teacher takes a personal interest in students.
13. Students are expected to stick to classwork in this class.
14. Students try hard to get the best grade.
15. Students are almost always quiet in this class.
16. Rules in this class seem to change a lot.
17. If a student breaks a rule in this class, he's sure to get in trouble.
18. What students do in class is very different on different days.
19. Students are often "clock-watching" in this class.
20. A lot of friendships have been made in this class.
21. The teacher is more like a friend than an authority.
22. We often spend more time discussing outside student activities than class-related material.
23. Some students always try to see who can answer questions first.
24. Students fool around a lot in this class.
25. The teacher explains what will happen if a student breaks a rule.
26. The teacher is not very strict.
27. New and different ways of teaching are not tried very often in this class.
28. Most students in this class really pay attention to what the teacher is saying.
29. It's easy to get a group together for a project.
30. The teacher goes out of his way to help students.
31. Getting a certain amount of classwork done is very important in this class.
32. Students don't compete with with each other here.
33. This class is often in an uproar.
34. The teacher explains what the rules are.
35. Students can get in trouble with the teacher for talking when they're not supposed to.
36. The teacher likes students to try unusual projects.
37. Very few students take part in class discussions or activities.
38. Students enjoy working together on projects in this class.
39. Sometimes the teacher embarrasses students for not knowing the right answer.
40. Students don't do much work in this class.
41. A student's grade is lowered if he gets homework in late.
42. The teacher hardly ever has to tell students to get back in their seats.
43. The teacher makes a point of sticking to the rules he's made.
44. Students don't always have to stick to the rules in this class.
45. Students have very little to say about how class time is spent.
46. A lot of students "doodle" or pass notes.
47. Students enjoy helping each other with homework.
48. This teacher "talks down" to students.
49. We usually do as much as we set out to do.
50. Grades are not very important in this class.
51. The teacher often has to tell students to calm down.
52. Whether or not students can get away with something depends on how the teacher is feeling that day.
53. Students get in trouble if they're not in their seats when the class is supposed to start.
54. The teacher thinks up unusual projects for students to do.
55. Students sometimes present something they've worked on to the class.
56. Students don't have much of a chance to get to know each other in this class.
57. If students want to talk about something this teacher will find time to do it.
58. If a student misses class for a couple of days, it takes some effort to catch up.
59. Students here don't care about what grades the other students are getting.
60. Assignments are usually clear so everyone knows what to do
61. There are set ways of working on things.
62. It's easier to get in trouble here than in a lot of other classes.
63. Students are expected to follow set rules in doing their work.
64. A lot of students seem to be only half awake during this class.
65. It takes a long time to get to know everybody by his first name in this class.
66. This teacher wants to know what students themselves want to learn about.
67. This teacher often takes time out from the lesson plan to talk about other things.
68. Students have to work for a good grade in this class.
69. This class hardly ever starts on time.

CLASSROOM ENVIRONMENT SCALE

DIRECTIONS

Look at your test booklet and check the Form printed on it here:

Form R___ E___ I_____

Please provide the information requested below.

Your Name ______________________________ Age __________

School ______________________________ Sex: M F (circle)

Grade ____________ Classroom ______________________

How long have you been in this school? __________ years __________ months

How long have you been in this classroom? __________ years __________ months

Today's Date ______________ Other ______________

Now, please read each statement in your booklet and then, in the boxes on the other side of this sheet, mark T (true) if you think the statement is true of your classroom, and F (false) if the statement is not true of your classroom.

Use a heavy X, as in the example: Please use a pencil with an eraser, not a pen. Be sure to match each number in the booklet with each one on this sheet.

EXAMPLE ONLY

T/F	1	2
T	X	
F		X

START HERE

T/F										T/F
T / F	1	2	3	4	5	6	7	8	9	T / F
T / F	10	11	12	13	14	15	16	17	18	T / F
T / F	19	20	21	22	23	24	25	26	27	T / F
T / F	28	29	30	31	32	33	34	35	36	T / F
T / F	37	38	39	40	41	42	43	44	45	T / F
T / F	46	47	48	49	50	51	52	53	54	T / F
T / F	55	56	57	58	59	60	61	62	63	T / F
T / F	64	65	66	67	68	69	70	71	72	T / F
T / F	73	74	75	76	77	78	79	80	81	T / F
T / F	82	83	84	85	86	87	88	89	90	T / F

do not mark below this line

	I	A	TS	TO	C	OO	RC	TC	Inn
R/S									
S/S									

Designed by Rudol[f] Moos

INVOLVEMENT

1. Students put a lot of energy into what they do here. TRUE
10. Students daydream a lot in this class. FALSE
19. Students are often "clock-watching" in this class. FALSE
28. Most students in this class really pay attention to what the teacher is saying. TRUE
37. Very few students take part in class discussions or activities. FALSE
46. A lot of students "doodle" or pass notes. FALSE
55. Students sometimes present something they've worked on to the class. TRUE
64. A lot of students seem to be only half awake during this class. FALSE
73. Students sometimes do extra work on their own in the class. TRUE
82. Students really enjoy this class. TRUE

AFFILIATION

2. Students in this class get to know each other really well. TRUE
11. Students in this class aren't very interested in getting to know other students. FALSE
20. A lot of friendships have been made in this class. TRUE
29. Its easy to get a group together for a project. TRUE
38. Students enjoy working together on projects in this class. TRUE
47. Students enjoy helping each other with homework. TRUE
56. Students don't have much of a chance to get to know each other in this class. FALSE.
65. It takes a long time to get to know everybody by his first name in this class. FALSE.
74. There are groups of students who don't get along in this class. FALSE
83. Some students in this class don't like each other. FALSE

TEACHER SUPPORT

3. This teacher spends very little time just talking with students. FALSE
12. The teacher takes a personal interest in students. TRUE
21. The teacher is more like a friend than an authority. TRUE
30. The teacher goes out of his way to help students. TRUE
39. Sometimes the teacher embarasses students for not knowing the right answer. FALSE
48. This teacher talks down to students. FALSE
57. If students want to talk about something this teacher will find time to do it. TRUE
66. This teacher wants to know what students themselves want to learn about. TRUE
75. This teacher does not trust students. FALSE
84. Students have to watch what they say in this class. FALSE

TASK ORIENTATION

4. Almost all class time is spent on the lesson for the day. TRUE
13. Students are expected to stick to classwork in this class. TRUE
22. We often spend more time discussing outside student activities than class-related material. FALSE
31. Getting a certain amount of classwork done is very important in this class. TRUE
40. Students don't do much work in this class. FALSE
49. We usually do as much as we set out to do. TRUE
58. If a student misses class for a couple of days, it takes some effort to catch up. TRUE
67. This teacher often takes time out from the lesson plan to talk about other things. FALSE
76. This class is more a social hour than a place to learn something FALSE.
85. The teacher sticks to classwork and doesn't get sidetracked. TRUE

COMPETITION

5. Students feel pressured to compete here. FALSE
14. Students try hard to get the best grade. TRUE
23. Some students always try to see who can answer questions first. TRUE
32. Students don't compete with each other here. FALSE
41. A student's grade is lowered if he gets homework in late. TRUE
50. Grades are not very important in this class. FALSE
59. Students here don't care about what grades the other students are getting. FALSE
68. Students have to work for a good grade in this class. TRUE
77. Sometimes the class breaks up into groups to compete with each other. TR
86. Students usually pass even if they don't do much. FALSE

ORDER AND ORGANIZATION

6. This is a well organized class. TRUE
15. Students are almost always quiet in this class. TRUE
24. Students fool around a lot in this class. FALSE
33. This class is often in an uproar. FALSE
42. The teacher hardly ever has to tell students to get back in their seats. TRUE
51. The teacher often has to tell students to calm down. FALSE
60. Assignments are usually clear so everyone knows what to do. TRUE
69. This class hardly ever starts on time. FALSE
78. Activites in this class are clearly and carefully planned. TRUE
87. Students don't interrupt the teacher when he is talking. TRUE

RULE CLARITY

7. There is a clear set of rules for students to follow. TRUE
16. Rules in this class seem to change a lot. FALSE
25. The teacher explains what will happen if a student breaks a rule. TRUE
34. The teacher explains what the rules are. TRUE
43. The teacher makes a point of sticking to the rules he's made. TRUE
52. Whether or not students can get away with something depends on how the teacher is feeling that day. FALSE
61. There are set ways of working on things. TRUE
70. In the first few weeks the teacher explained the rules about what students could and could not do in this class. TRUE.
79. Students aren't always sure if something is against the rules or not. FALSE
88. The teacher is consistent in dealing with students who break the rules. TRUE

TEACHER CONTROL

8. There are very few rules to follow. FALSE
17. If a student breaks a rule in this class, he's sure to get in trouble. TRUE
26. The teacher is not very strict. FALSE
35. Students can get in trouble with the teacher for talking when they are not supposed to. TRUE
44. Students don't always have to stick to the rules in this class. FALSE
53. Students get in trouble if they're not in their seats when this class is supposed to start. TRUE
62. It's easier to get in trouble here than in a lot of other classes. TRUE
71. The teacher will put up with a good deal. FALSE
80. The teacher will kick a student out of class if he acts up. TRUE
89. When the teacher makes a rule, he means it. TRUE

INNOVATION

9. New ideas are always being tried out here. TRUE
18. What students do in class is very different on different days. TRUE
27. New and different ways of teaching are not tried very often in this class. FALSE
36. The teacher likes students to try unusual projects. TRUE
45. Students have very little to say about how class time is spent. FALSE
54. The teacher thinks up unusual projects for students to do. TRUE
63. Students are expected to follow set rules in doing their work. FALSE
72. Students can choose where they sit. TRUE
81. Students do the same kind of homework almost every day. FALSE
90. In this class, students are allowed to make up their own projects. TRUE

APPENDIX B

CONCEPT CHECKLIST

CONCEPT CHECKLIST

The following is a list of most of the concepts you might teach for a unit on acids and bases. Rate each concept in terms of the emphasis or importance it has to your presentation of the unit. Use the scale listed below for your ratings. These ratings will help me to construct a unit test. The unit test will contain only those concepts which teachers feel are important to the goals of their unit.

Rate each concept using the following scale. Circle the most appropriate rating. Please return your checklist to me as soon as possible.

(1) Very Important- This is an essential concept which all students should know.
(2) Important- Most students should understand this concept, but not all students will learn it.
(3) Useful- Probably only your better students will learn this concept. It is useful information, but your average student can pass the course without knowing this information.
(4) Marginally relevant- Students may learn this type of information but it will not be very helpful for achieving your unit goals or course goals.
(5) Irrelevant- This is trivial information which has very little to do with a person's understanding of chemical principals, e,g, the birthplace or age of a prominent scientist.

	Very Important 1	2	3	4	Irrelevant 5
1. Organic acids	1	2	3	4	5
2. Inorganic acids	1	2	3	4	5
3. Mineral acids	1	2	3	4	5
4. Industrial acids	1	2	3	4	5
5. An acid should be added to water slowly with stiring, but water should never be added to concentrated sulfuric acid.	1	2	3	4	5
6. Arrhenius	1	2	3	4	5
7. Bronsted	1	2	3	4	5
8. Lowery	1	2	3	4	5
9. Lewis	1	2	3	4	5
10. Theory of Ionization- Arrhenius	1	2	3	4	5
11. Bronsted-Lowery model of acids and bases	1	2	3	4	5
12. Lewis Model of acids and bases	1	2	3	4	5
13. Proton donor	1	2	3	4	5
14. Proton acceptor	1	2	3	4	5
15. Strong acids	1	2	3	4	5
16. Weak acids	1	2	3	4	5
17. Properties of acids	1	2	3	4	5
18. turn litmus solution red	1	2	3	4	5
19. has a sour taste	1	2	3	4	5
20. neutralizes bases	1	2	3	4	5
21. conducts an electric current	1	2	3	4	5
22. liberates hydrogen on reacting with certain metals such as Al, Mg, or Zn.	1	2	3	4	5

23. acids react with carbonates	1	2	3	4	5
24. acids react with oxides of metals	1	2	3	4	5
25. acids react with many metals	1	2	3	4	5
26. acids neutralize hydroxides	1	2	3	4	5
27. Acids furnish protons when they react with bases.	1	2	3	4	5
28. Monoprotic acids	1	2	3	4	5
29. Diprotic acids	1	2	3	4	5
30. triprotic acids	1	2	3	4	5
31. Naming the traditional acids	1	2	3	4	5
32. binary acids	1	2	3	4	5
33. ternary acids	1	2	3	4	5
34. Acid anhydrdides	1	2	3	4	5
35. oxyacids	1	2	3	4	5
36. The strength of an acid depends upon the degree of ionization in water solution.	1	2	3	4	5
37. The strength of acids can be compared by measuring their ability to donate protons to the same base, usually water.	1	2	3	4	5
38. K_A , the acid constant	1	2	3	4	5
39. Strong acids have high K_A values.	1	2	3	4	5
40. Hydronium ion	1	2	3	4	5
41. Hydrated proton	1	2	3	4	5
42. Lewis acid	1	2	3	4	5
43. Lewis base	1	2	3	4	5
44. Hydroxly group	1	2	3	4	5
45. Hydroxides	1	2	3	4	5
46. Definition of acids	1	2	3	4	5
47. Definition of bases	1	2	3	4	5
48. Properties of bases	1	2	3	4	5
49. bases turn litmus solution blue	1	2	3	4	5
50. a base has a bitter taste	1	2	3	4	5
51. a base neutralizes acids	1	2	3	4	5
52. a base conducts an electric current	1	2	3	4	5
53. a base feels slippery to the touch	1	2	3	4	5
54. Chemicals should never be tasted unless it is absolutely certain that they are not poisonous.	1	2	3	4	5
55. Chemicals should never be touched unless it is absolutely certain that they are not corrosive.	1	2	3	4	5
56. Characteristics of hydroxides	1	2	3	4	5
57. Hydroxides of the active metals furnish OH^- ions in solution.	1	2	3	4	5
58. soluable hydroxides have bitter taste	1	2	3	4	5
59. solutions of hydroxides feel slippery	1	2	3	4	5
60. soluable hydroxides affect indicators	1	2	3	4	5
61. hydroxides neutralize acids.	1	2	3	4	5
62. Hydroxides react with oxides of non-metals.	1	2	3	4	5
63. certain hydroxides are amphiprotic.	1	2	3	4	5
64. Amphiprotic	1	2	3	4	5
65. basic anhydride	1	2	3	4	5
66. protolysis	1	2	3	4	5

67. Experimental evidence must establish the acidic or basic character of a substance.	1	2	3	4	5
68. Conjugate acid	1	2	3	4	5
69. conjugate base	1	2	3	4	5
70. conjugate acid-base pair	1	2	3	4	5
71. The stronger an acid, the weaker its conjugate base is, and the stronger a base, the weaker its conjugate acid is.	1	2	3	4	5
72. Protolysis reactions favor the production of the weaker acid and the weaker base.	1	2	3	4	5
73. Molarity	1	2	3	4	5
74. Normality	1	2	3	4	5
75. Gram-equivalent	1	2	3	4	5
76. Advantages and disadvantages of having solutions expressed in molarity or normality.	1	2	3	4	5
77. Autoprotolysis	1	2	3	4	5
78. Acidity or alkalinity of a solution can be expressed in terms of its hydronium ion concentration.	1	2	3	4	5
79. pH	1	2	3	4	5
80. pOH	1	2	3	4	5
81. common logarithm	1	2	3	4	5
82. Testing pH with Hydrion paper (demonstrate)	1	2	3	4	5
83. Calculating pH	1	2	3	4	5
84. Titration	1	2	3	4	5
85. Demonstrate acid-base titration	1	2	3	4	5
86. equivalente point or end point of titration	1	2	3	4	5
87. Standard solution	1	2	3	4	5
88. using pH indicators	1	2	3	4	5
89. Measuring pH with meters	1	2	3	4	5
90. Definition of a salt	1	2	3	4	5
91. salt producing reactions	1	2	3	4	5
92. Properties of salts	1	2	3	4	5
93. Salts can be formed by the direct union of the elements	1	2	3	4	5
94. Salts are formed by the replacement of the hydrogen of an acid by a metal	1	2	3	4	5
95. The oxide of a metal may react with an acid to form a salt.	1	2	3	4	5
96. The oxide of a non-metal may react with a soluable hydroxide to form a salt.	1	2	3	4	5
97. Acids neutralize soluable hydroxides and form salts.	1	2	3	4	5
98. Two salts may be prepared at one time by ionic reactions.	1	2	3	4	5
99. Salts may be formed by the action of an acid on a carbonate.	1	2	3	4	5
100. Salts may be formed by the reaction between a metal oxide and a non-metal oxide.	1	2	3	4	5

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101. Naming salts.	1	2	3	4	5
102. Brackets indicate moles/liter	1	2	3	4	5

CALCULATIONS

103. Molarity of a solution	1	2	3	4	5
104. Normality of a solution	1	2	3	4	5
105. gram equivalent of a solution	1	2	3	4	5
106. Calculate the pH when the of a solution is known.	1	2	3	4	5
107. Calculate the when the pH of a solution is known.	1	2	3	4	5
108. Solve a titration problem using the mole method.	1	2	3	4	5
109. Solve a titration problem using the method of equivalents.	1	2	3	4	5

FORMULAS

110. $K_w = 1 \times 10^{-14} = [H^+][OH^-]$	1	2	3	4	5
111. $pH = \log \frac{1}{[H_3O^+]} = -\log [H_3O^+]$	1	2	3	4	5
112. $pH + pOH = 14$	1	2	3	4	5
113. $[H_3O^+] \times [OH^-] = $ A CONSTANT	1	2	3	4	5

Your name ______________________

Your grade: High school 8th grade

Please return to me as soon as possible.

Bob DeGuglielmo

25 Champa Rd.

Billerica, Mass. 01821

667-1463

If you are having any problems, please give me a call.

Scores on the Concept Checklist

	Teacher Number									Eighth Grades	
Term #	3	7	2	5	1	6	Mean	sd	Median	9	8
1	3	4	4	2	3	3	3.17	.75		-	-
2	2	4	1	1	2	1	1.88	1.17	1.5	-	-
3	2	4	4	3	4	5	3.67	1.03		-	-
4	2	4	1	3	4	5	3.17	1.47		-	-
5 *	1	2	1	1	1	1	1.17	.41	1.0	1	1
6	2	4	1	1	1	1	1.67	1.21	1.0	5	-
7	2	4	1	3	1	2	2.17	1.17		-	-
8	2	4	1	3	1	2	2.17	1.17		-	-
9	2	4	3	2	1	3	2.50	1.05		-	-
10 *	2	1	1	2	2	1	1.50	.55	1.5	4	-
11 *	2	1	2	3	1	2	1.83	.75		4	-
12 *	2	1	3	2	1	3	2.00	.89		4	-
13 *	2	1	2	1	1	2	1.50	.55		4	-
14 *	2	1	2	1	1	2	1.50	.55		4	-
15 *	2	3	1	1	2	1	1.67	.82		1	1
16 *	2	3	1	1	2	1	1.67	.82		1	1
17 *	2	1	1	1	1	1	1.20	.45	1.0	1	1
18 *	1	1	1	1	1	1	1.00	.00		1	1
19 **	1	1	1	1	3	4	1.83	1.33		1	1
20 *	1	1	1	1	1	1	1.00	.00		1	1
21 *	1	1	1	1	2	1	1.17	.41	1.0	1	1
22 *	1	3	1	1	2	1	1.50	.84		1	1
23	3	4	3	3	3	1	2.83	.98		1	1
24	2	4	3	3	3	4	3.17	.75		1	1
25 *	2	1	3	1	2	1	1.67	.82		1	1
26 *	1	1	1	1	1	1	1.00	..00		1	1
27 *	3	1	1	1	1	1	1.33	.82	1.0	2	1
28	3	4	3	4	3	1	3.00	1.10		4	-
29	3	4	3	4	3	1	3.00	1.10		4	-
30	3	4	3	4	3	1	3.00	1.10		4	-
31 *	2	3	2	2	2	1	2.00	.63		4	-
32 *	2	3	2	2	2	1	2.00	.63		4	-
33 *	2	3	2	2	2	1	2.00	.63		4	-
34	3	2	2	3	2	2	2.33	.52		4	-
35	4	4	3	4	3	1	3.17	1.17		5	-
36 *	3	1	1	2	3	2	2.00	.89		3	1
37	3	2	2	3	3	3	2.67	.89		3	-
38	3	2	3	5	3	5	3.50	1.22		5	-
39	3	3	3	5	3	5	3.67	1.03		5	-
40 *	3	1	1	1	1	1	1.33	.82	1.0	3	-

Term #		Teacher Number 3	7	2	5	1	6	Mean	sd	Median	Eighth Grades 9	8
41	*	3	1	1	1	1	1	1.33	.82	1.0	3	-
42		3	1	3	2	3	3	2.50	.84		5	-
43		3	1	3	2	3	3	2.50	.84		5	-
44		3	4	1	1	1	1	1.83	1.33		5	-
45	*	1	1	1	1	1	1	1.00	..00		3	-
46	*	1	1	1	1	1	-	1.00	.00		1	1
47	*	1	1	1	1	1	-	1.00	.00		1	1
48	*	1	1	1	1	1	-	1.00	.00		1	1
49	*	1	1	1	1	1	1	1.00	.000		1	1
50	**	1	1	1	1	3	4	1.83	1.33	1.0	1	1
51	*	1	1	1	1	1	1	1.00	.00		1	1
52	*	1	1	1	1	1	3	1.33	.82	1.0	1	1
53	*	1	1	1	1	3	2	1.50	.84	1.0	1	1
54	*	1	1	1	2	1	1	1.17	.41	1.0	1	1
55	*	1	1	1	2	1	1	1.17	..41	1.0	1	1
56	*	1	2	1	1	1	-	1.20	.45	1.0	3	-
57	*	1	2	1	1	1	-	1.20	.45	1.0	3	-
58	*	1	2	1	2	3	-	1.80	.84		3	-
59	*	1	2	1	1	3	-	1.60	.89		3	-
60	*	1	2	1	1	1	-	1.20	.45	1.0	3	-
61	*	1	2	1	1	1	-	1.20	.45	1.0	3	-
62		1	4	3	4	2	-	2.80	1.30		3	-
63		1	4	3	5	3	-	3.20	1.49		4	-
64		3	4	3	5	3	3	3.50	.84		4	-
65		3	2	2	3	2	2	2.17	.41	2.0	4	-
66		4	2	3	5	3	5	3.67	1.21		4	-
67		3	2	2	1	3	-	2.20	.84		1	-
68		3	3	3	4	4	2	3.17	.75		4	-
69		3	3	3	4	4	2	3.17	.75		4	-
70		3	3	3	4	4	2	3.17	.75		4	-
71		3	2	3	4	4	2	3.0	.89		4	-
72		4	3	3	4	4	5	3.83	.75		4	-
73	*	1	1	1	1	1	1	1.00	.00		4	-
74	*	1	2	1	1	1	2	1.33	.52		4	-
75	*	1	2	2	1	3	3	2.00	.89		4	-
76	*	2	2	1	3	1	2	1.83	.75		4	-
77		4	4	3	5	3	5	4.00	.89		4	-
78	*	2	1	2	1	1	3	1.67	.82		4	-
79	*	1	1	1	1	1	3	1.33	.82	1.0	1	1
80		3	1	3	1	3	3	2.33	1.03		4	-

Term #	Teacher Number 3	7	2	5	1	6	Mean	sd	Median	Eighth Grades 9	8
81	3	3	3	1	1	3	2.33	1.03		4	-
82 *	1	1	1	1	3	3	1.67	1.03		1	1
83 *	1	1	1	1	1	3	1.33	.82	1.0	4	-
84 *	1	1	1	1	1	2	1.17	.41	1.0	4	-
85 *	1	1	1	1	1	2	1.17	.41	1.0	4	-
86 *	1	1	1	1	1	2	1.17	.41	1.0	4	-
87	1	-	3	3	1	3	2.20	1.10		4	-
88	1	1	1	2	1	5	1.83	1.60	1.0	1	-
89	4	3	3	3	3	5	3.50	.84		4	-
90 *	1	1	1	1	2	1	1.17	.41	1.0	1	1
91	1	3	1	3	2	5	2.50	1.52		1	1
92	1	3	1	2	1	5	2.17	1.60		1	1
93	1	4	1	1	2	5	2.33	1.75		1	-
94	1	4	1	1	1	5	2.16	1.83		1	-
95	1	4	2	3	1	5	2.67	1.63		1	-
96	1	4	2	3	1	5	2.67	1.63		1	-
97	1	4	1	1	1	5	2.16	1.83		1	-
98	3	4	1	5	3	5	3.50	1.52		5	-
99	3	4	2	5	3	5	3.67	1.21		1	-
100	3	4	2	5	3	5	3.67	1.21		1	-
101	3	4	1	3	3	5	3.17	1.33		1	-
102	3	1	3	1	2	5	2.50	1.52		5	-
103 *	1	1	1	1	1	1	1.00	.00		5	-
104 *	1	2	1	1	1	2	1.33	.52		5	-
105	1	2	3	1	3	3	2.17	.98		5	-
106 *	3	1	-	1	1	3	1.80	1.10		5	-
107 *	-	1	-	2	-	3	2.00	1.00		5	-
108	1	1	1	4	3	2	2.00	1.26		5	-
109	3	2	3	4	1	3	2.67	1.03		5	-
110	4	1	1	1	4	4	2.50	1.64		5	-
111	4	3	3	1	2	3	2.67	1.03		5	-
112	4	1	1	1	2	3	2.00	1.26	1.5	5	-
113	2	1	3	1	2	4	2.17	1.17		5	-

* These terms were accepted into the subject matter domain.
**These terms were added to the subject matter domain to increase the number of eighth grade terms.

TERMS SELECTED FROM THE CONCEPT CHECKLIST FOR THE LEARNING TEST DOMAIN

Verbal Information Terms	Defined Concept Terms	Rule Terms
5	13 *	31 *
10 *	14 *	82
11 *	15	83**
12 *	16	85 *
17	32 *	103 *
18	33 *	104 *
19 **	40 *	106 *
20	41 *	107 *
21	45 *	
22	46	8 (total)
25	47	
26	73 *	
27 *	74 *	
36 *	75 *	
48	79 *	
49	84 *	
50**	86 *	
51	90	
52		
53	18 (total)	
54		
55		
56 *		
57 *		
58 *		
59 *		
60 *		
61 *		
76 *		
78 *		
30 (total)		

* These terms were only appropriate for high school students.
** These terms were added to the test domain to increase the number of eighth grade terms.

APPENDIX C

LEARNING TEST CONSTRUCTION

TABLE OF SPECIFICATIONS FOR TEST 2 *

Grade Level	Learning Outcomes: Verbal Information	Defined Concepts	Rules	Total
Eighth Grade	5,17,18,19,21, 22,25,26,48,49, 50,51,52,53,54	15,16,45, 46,90		
Subtotal	15	5	0	20
High School	10,11,27,36,58, 61	32,33,73, 74,75,79, 84,86	82,83, 85,103, 104,106	
Subtotal	6	8	6	20
Total	21	13	6	40

TABLE OF SPECIFICATIONS FOR TEST 1 *

Grade Level	Learning Outcomes: Verbal Information	Defined Concepts	Rules	Total
Eighth Grade	5,17,18,20, 21,22,25,26, 48,49,50,51, 53,54,55	15,16,46, 47,90		
Subtotal	15	5	0	20
High School	10, 11, 12,59, 60, 78	13,33,40, 41,73,74, 79,86	31,82, 85,103, 104,106	
Subtotal	6	8	6	20
Total	21	13	6	40

* The numbers listed in the table are the terms from the concept checklist.

APPENDIX D

LEARNING TESTS AND ITEM ANALYSIS

ITEM ANALYSIS FOR TEST # 1 *

Item #	Discrimination Index	Difficulty Index
1	.15	.21
2	.36	.16
3	.23	.12
4	.28	.48
5	.49	.40
6	.08	.12
7	.44	.39
8	.23	.15
9	.28	.63
10	.49	.28
11	.44	.34
12	.51	.37
13	.39	.23
14	.28	.18
15	.38	.16
16	.31	.36
17	.41	.34
18	.46	.20
19	.44	.21
20	.49	.40
21	.33	.26
22	.38	.24
23	.28	.46
24	.21	.44
25	.54	.40
26	.26	.55
27	.38	.58
28	.41	.50
29	.51	.37
30	.54	.38
31	.15	.40
32	.51	.45
33	.20	.51
34	.18	.64
35	.36	.69
36	.44	.36
37	.23	.45
38	.36	.52
39	.33	.29
40	.51	.38

* Based on the 130 high school students who completed this test.

ITEM ANALYSIS FOR TEST # 2 *

Item #	Discrimination Index	Difficulty Index
1	.37	.10
2	.07	.09
3	.55	.37
4	.30	.21
5	.63	.24
6	.59	.26
7	.82	.47
8	.59	.20
9	.26	.11
10	.33	.27
11	-.16	.43
12	.15	.01
13	.07	.64
14	.19	.03
15	.30	.20
16	.07	.12
17	.70	.43
18	.48	.17
19	.37	.17
20	.52	.21
21	.52	.30
22	.82	.51
23	.77	.30
24	.70	.42
25	.55	.17
26	.66	.37
27	.55	.32
28	.37	.67
29	.20	.69
30	.41	.44
31	.22	.62
32	.30	.67
33	.03	.68
34	.37	.68
35	.44	.18
36	.26	.33
37	.37	.34
38	.07	.69
39	.37	.53
40	.33	.47

* Based on the 90 high school students who completed this test.

TEST 1 -1-

NAME____________________ PERIOD____________________

DIRECTIONS: Write your answers on the answer sheet provided. You should do all of your calculations on this test, and not on the answer sheet.

1. Which of the following statements is true?
   A) An acid should be added to water quickly so that the acid will not drip as you pour it.
   B) An acid should be added to water slowly with stirring, but water should never be added to concentrated sulfuric acid.
   C) Water should be added to an acid slowly with stirring.
   D) Water should be added to an acid slowly with stirring, but concentrated sulfuric acid should never be added to water.

2. Which of the following is a property of an acid?
   A) Acids turn red when they are mixed with salt.
   B) Acids feel slippery.
   C) Acids have a sour taste.
   D) Both B and C are true.

3. Acids...
   A) neutralize salts to produce a base.
   B) neutralize salts.
   C) neutralize bases.
   D) don't neutralize; they burn if you touch them.

4. Acids react with...
   A) Many metals B) all metals C) many salts D) all salts

5. Acids neutralize...
   A) some hydroxides B) most hydroxides
   C) all hydroxides D) none of the above

6. Bases neutralize...
   A) litmus solution B) acids C) A and B D) none of the above

7. Which of the following is a property of a base?
   A) Turns litmus indicator solution red.
   B) Reacts with certain metals to produce hydrogen
   C) A and B D) none of the above

8. Chemicals should never be tasted...
   A) unless your friend tastes it first and says its safe.
   B) under any circumstances, because they might be poisonous.
   C) unless it is absolutely certain that they are not poisonous.
   D) because you might taste one that would taste terrible.

9. Chemicals should never be touched...
   A) because you could contaminate the chemicals and ruin your experiment.
   B) unless it is absolutely certain that it is safe to touch them.
   C) under any circumstances
   D) because your hands might be stained by them.

Four statements are listed below. Match each statement with the descriptions in column A. You may use any statement more than once. All of the descriptions in Column A should be matched with one of the following statements.
A) Property of both an Acid and a Base. B) property of an acid.
C) Property of a base. D) not a property of a base or an acid.

Column A

_____ 10. Turns litmus solution indicator red.
_____ 11. Conducts an electric current.
_____ 12. Reacts with certain metals, such as magnesium, to produce hydrogen gas.
_____ 13. Turns litmus indicator solution blue.
_____ 14. tastes bitter.
_____ 15. feels slippery when touched.

Classify each of the solutions listed in column A as
A) a strong acid B) a weak acid
C) a salt disolved in water D) a base
E) an acid of unknown strength

One of the tests described below uses an electric light bulb which is connected to a battery and a pair of electrodes. The electrodes are then placed in the test solutions.

Column A

_____ 16. The electric light glows brightly. The solution does not feel slippery, or taste sour, and the solution does not react with magnesium to produce hydrogen.

_____ 17. The electric light glows brightly. A few drops of Congo Red placed in the solution turn blue; the pH is less than 3.0.

_____ 18. The electric light glows brightly. The solution feels slippery when it is touched.

_____ 19. The electric light is very dim when it is placed in the solution. Litmus solution turns red.

_____ 20. When magnesium is added to the unknown solution, hydrogen gas is produced.

Match the theories listed in column A with the descriptions in column B.

Column A	Column B
_____ 21. Lewis model of acids	A) All acids ionize in water to form hydrogen ions.
_____ 22. Bronsted-Lowery model of acids	B) An acid is a substance that can accept pairs of electrons.
_____ 23. Arrhenius model of acids	C) An acid is simply a proton donor, i.e. it gives up protons to another substance.
	D) None of the above.

24. When hydroxides are disolved in water, the solution will be...
    A) slightly acidic B) a strong acid C) a weak base D) basic

25. When hydroxides are disolved in water, they...
    A) will cause litmus to turn from red to blue.
    B) will cause litmus to turn from blue to red.
    C) will not cause litmus to change color.
    D) should be mixed slowly as this could cause a violent reaction.

26. The hydronium ion concentration of a solution can be used to express the solution's...
    A) Acidity B) Alkalinity C) both A and B D) none of the above.

27. What do all three of the following solutions have in common?
    (I) a solution of HCl disolved in water
    (II) a solution of HNO_3 disolved in water
    (III) a solution of H_2SO_4 disolved in water.

A) All contain hydrogen gas
B) All contain hydroxyl ions.
C) All contain hydronium ions
D) none of the above.

28. Which of the solutions listed in #27 contain a hydrated proton?
    A)Solution I B) Solution II C) Solution III D) All three solutions

29. Which of the solutions listed in #27 will be a proton donor?
    A) Solution I B) Solution II C) Solutions I,II, and III D) None

30. Which of the following is a ternary acid?
    A) H_2SO_4 B) HCl C) HBr D) A and B

.The following list of answers should be used with #31 and #32.
A) Moles of solute/ kilogram of solvent
B) Moles of solute/ liter of solution
C) gram-equivalents of solute/liter of solution
D) grams of solute/liters of solution
E) Moles of solute/ liters of solvent

_____31. Which of the above expressions best describes molarity?

_____32. Which of the above expressions best describes normality?

33. Which of the following could be used to describe the pH of a solution?
    A) a logrithmic function of the hydronium ion concentration
    B) the hydronium ion concentration
    C) Log ($1/[H_3O^+]$)
    D) All of the above

34. The end point of titration occurrs when...
    A) equivalent quantities of $[H_3O^+]$ and OH^- are present in the same solution
    B) A suitable indicator changes color during titration
    C) the moles of the standard solution equal the moles of the unknown solution
    D) A and B

35. Select the steps in correct order for testing the pH of an unknown solution using pH paper (Hydrion paper)
    1. Place the pH paper in the test solution.
    2. Compare the color of the test paper to the Hydrion color chart.
    3. Place a drop of solution on the pH paper.
    4. Wait at least 5 minutes before you compare the color of the test paper with the color of the Hydrion color chart. You need to be sure that the neutralization reaction is complete.
    5. Compare the color of the test solution to the colors on the Hydrion color chart.

    A) 1, 5 B) 1,4,5 C) 3,4, 2 D) 3,2

36. Select the steps in the correct order for doing an acid-base titration.
    1. Always use the same indicator for titrations.
    2. pour a known quantity of the standard solution into a flask.
    3. Choose the best indicator for the chemical reaction.
    4. Put a few drops of indicator into the standard solution.
    5. Pour a measured quantity of the unknown solution into a flask.
    6. Put a few drops of indicator into the unknown solution.
    7. Titrate a few drops of the unknown solution into the standard solution.
    8. Titrate a few drops of the standard solution into the unknown solution.
    9. Continue the titration until the indicator no longer changes color.
    10. Continue the titration until the indicator changes color.

    A) 3, 2, 6, 7, 9 B) 1, 2, 6, 7, 10
    C) 3, 2, 4, 7, 10 D) 3, 2, 4, 7, 9

37. What is the molarity of a solution containing 98 g of H_2SO_4 in 500 ml of water?
    A) 2 M B) .002M C) 4 M D) .004 M

38. Calculate the normality of the solution in question #37.
    A) 2 N B) 4 N C) .004 N D) 1 N

39. Calculalate the pH of a solution which has a $[H_3O^+]$ of 1.0 X 10^{-5}.
    A) less than 2.0 B) between 4.0 and 6.0
    C) between 8.0 and 10.0 D) greater than 12.0

Given that:

Sulfuric acid is H_2SO_4
Bromic acid is $HBrO_3$
Cloric acid is $HClO_3$

40. Which of the following acids is named <u>incorrectly</u>?
    A) Percloric acid is $HClO_4$
    B) Bromous acid is $HBrO_2$
    C) Sulfurous acid is H_2SO
    D) Hypobromous acid is HBrO

ANSWER SHEET (1)

NAME ANSWERS PERIOD__________

DATE__________ TEACHER__________

DIRECTIONS: Place an X through the correct answer.

	1.	A	B	C	D		21.	A	B	C	D		
	2.	A	B	C	D		22.	A	B	C	D		
	3.	A	B	C	D		23.	A	B	C	D		
	4.	A	B	C	D		24.	A	B	C	D		
	5.	A	B	C	D		25.	A	B	C	D		
	6.	A	B	C	D		26.	A	B	C	D		VI 2
	7.	A	B	C	D		27.	A	B	C	D		
	8.	A	B	C	D		28.	A	B	C	D		
	9.	A	B	C	D		29.	A	B	C	D		
	10.	A	B	C	D		30.	A	B	C	D		
	11.	A	B	C	D		31.	A	B	C	D	E	
	12.	A	B	C	D		32.	A	B	C	D	E	
	13.	A	B	C	D		33.	A	B	C	D		
	14.	A	B	C	D		34.		B	C	D		C 2
VI	15.	A	B	C	D		35.	A	B	C	D		
	16.	A	B	C	D	F	36.	A	B	C	D		
	17.	A	B	C	D	E	37.	A	B	C	D		
	18.	A	B	C	D	E	38.	A	B	C	D		
	19.	A	B	C	D	E	39.	A	B	C	D		
C1	20.	A	B	C	D	E	40.	A	B	C	D		R 1

TEST 2 -1-

NAME____________________ PERIOD________________

DIRECTIONS: Write your answers in the spaces provided in this test booklet, and also on the answer sheet. You should do all of your calculations on this test, and not on the answer sheet.

Match each description in Column A with one of the following answers.

A) Property of an acid B) property of a base
C) Property of both acids and bases
D) Not a property of either an acid or a base

Column A

_____ 1. This solution turns litmus solution red.

_____ 2. This solution turns litmus solution green

_____ 3. This solution tastes bitter.

_____ 4. This solution tastes sour

_____ 5. This solution conducts an electric current.

_____ 6. This solution does not conduct an electric current.

_____ 7. This solution neutralizes a salt solution.

_____ 8. This solution neutralizes hydroxides.

_____ 9. This solution feels slippery to the touch.

_____ 10. This solution will liberate hydrogen when it reacts with certain metals such as magnesium.

_____ 11. This solution will react with many metals.

_____ 12. It is safe to taste a chemical,...
A) if it looks and smells like water.
B) if you are sure it is an acid.
C) if you are sure it is a base.
D) when your teacher tells you it is safe, but the safest thing to do is not to taste chemicals.

_____ 13. Which of the following is true?
A) Never add water to a concentrated acid, e.g. sulfuric acid.
B) Always add acids to water.
C) A and B
D) None of the above is true.

_____ 14. Which of the following is a property of an acid?
A) Acids are always red.
B) Acids always smell sweet.
C) Both A and B are correct.
D) None of the above are correct.

_____ 15. Which of the following is a property of a base?
A) Bases conduct an electric current.
B) Bases neutralize acids.
C) Both A and B are correct.
D) None of the above.

Column A below describes 5 different solutions. Classify each of the solutions listed in Column A as:
A) an acid of unknown strength
B) A strong acid C) A weak acid
D) A hydroxide solution E) A salt solution

**Note--some of the tests described below use an electric light bulb which is connected to a battery and a pair of electrodes. The electrodes are then placed in the test solution.

_____ 16. The electric light is very dim, when it is placed in the test solution. The solution tastes mildly sour.

_____ 17. The electric light glows brightly. the solution has a mildly sweet taste.

_____ 18. The electric light glows brightly, and the solution is very slippery.

_____ 19. The electric light glows brightly, and a few drops of Congo Red placed in the solution turn blue. The pH is less 3.0.

_____ 20. When a few drops of litmus solution are added, the test solution turns red.

_____ 21. Arrhenius developed the theory of ionization. This theory concludes that:
A) all substances form ions when they are mixed with water.
B) All acids ionize in water solutions to form hydrogen ions.
C) all acids ionize in water solutions to form hydroxide ions.
D) all bases ionize in water solutions to form hydrogen ions.

_____ 22. Soluable hydroxides ...
A) have a bitter taste B) have a sour taste
C) neutralize bases D) none of the above

_____ 23. Hydroxides..
A) react with certain metals to produce hydrogen.
B) are water molecules with an extra proton.
C) furnish protons when they react with bases.
D) neutralize acids.

_____ 24. Acids...
A) neutralize hydronium ions.
B) react with oxides of non-metals.
C) furnish protons when they react with bases.
D) B and C

_____ 25. The Bronsted-Lowery model of acids suggests that ...
A) acids are proton donors B) acids are proton acceptors
C) acids are proton acceptors and bases are proton donors
D) acids and bases are proton conors.

____26. The strength of an acid depends upon...
A) its ability to accept protons
B) its ability to donate protons
C) the degree of ionization in water solutions
D) B and C

____27. Six substances are listed below; which of the following are binary acids?

(I) H_2S	(II) HF	(III) H_2CO_3
(IV) HNO_3	(V) KOH	(VI) HClO

A) I,II,V
B) I,II,III,IV
C) III,IV,VI
D) I,II
E) II

____28. Which of the substances listed in #27 are ternary acids?
A) I,V,IV
B) I,III,IV,V,VI
C) III,IV,V,VI
D) III,IV,VI
E) III

The following list of answers should be used with questions # 29, #30, and #31.

A) Moles of solute/liter of solution
B) Moles of solute/liter of solvent
C) Moles of solute/ kilogram of solvent
D) grams of solute/liter of solution
E) gram-equivalents of solute/liter of solution
F) gram-equivalents of solvent/ liter of solution

____29. Which of the above expressions best describes normality?

____30. Which of the above expressions best describes molarity?

____31. Which of the above expressions best describes gram-equivalent?

____32. Which of the following descriptions best describes titration?
A) titration determines the volumes of acidic and basic solutions which are chemically equivalent.
B) Titration measures the quantity of an unknown solution that will combine with a quantity of a known solution.
C) A and B
D) None of the above.

____33. Which of the following measurements could help you determine the approximate pH of an unknown solution?
A) Normality of the solution.
B) Molarity of the solution.
C) Gram-equivalent of the solution.
D) None of the above.

____34. Which of the following measurements could help you determine when the end point of a titration was reached?
A) the moles of the standard solution are equal to the moles of the unknown solution.
B) Equivalent quantities of $[H_3O^+]$ and OH^- are present.
C) A and B
D) None of the above.

_____35. Calculate the pH of a solution which has a $[H_3O^+]$ of 1.0×10^{-13}

A) less than 2.0 B) between 4.0 and 6.0
C) between 8.0 and 10.0 D) greater than 12.0

_____36. Calculate the hydronium ion concentration of a solution with a pH of 9.0 .
A) between 10^{-1} and 10^{-3} B) between 10^{-4} and 10^{-7}
C) between 10^{-8} and 10^{-10} D) between 10^{-11} and 10^{-13}

_____37. Calculate the molarity of a solution containing 98g of H_2SO_4 in 250 ml of solution.
A) 1 B) 4
C) 25 D) 250

_____38. Calculate the normality of the solution in question #37.
A) 1 B) 4
C) 8 D) 16

_____39. Select the steps in the correct order for testing the pH of an unknown solution using pH paper (Hydrion paper).
1. place a drop of solution on the pH paper.
2. Place the pH paper in the test solution.
3. Compare the color of the test paper to Hydrion color chart.
4. Wait at least 5 minutes before you compare the color of the test paper with the color of the Hydrion color chart. You need to be sure that the neutralization reaction is complete.
5. Compare the color of the test solution to the colors on the Hydrion color chart.

A) 2,5 B) 2,4,5 C) 1,3 D) 1,4, 3

_____40. Select the steps in the correct order for doing an acid-base titration.
1. Always use the same indicator for titrations
2. Pour a known quantity of the standard solution into a flask.
3. Choose the best indicator for the chemical reaction.
4. put a few drops of indicator into the standard solution.
5. put a few drops of indicator in the unknown solution.
6. pour a measured quantity of the unknown solution into a flask.
7. Titrate a few drops of the unknown solution into the standard solution.
8. titrate a few drops of the standard solution into the unknown solution.
9. continue the titration until the indicator changes color.
10. continue the titration until the indicator no longer changes color.

A) 3,2,5,7,10 B) 1,2,5,7,9
C) 3,2,4,7,9 D) 3,2,4,7,10

ANSWER SHEET 2

NAME ANSWERS PERIOD________ DATE______________

DIRECTIONS: Place an X through the correct answer.

1. A B C D
2. A B C D
3. A B C D
4. A B C D
5. A B C D
6. A B C D
7. A B C D
8. A B C D
9. A B C D
10. A B C D
11. A B C D
12. A B C D
13. A B C D
14. A B C D
15. A B C D
16. A B C D E
17. A B C D E
18. A B C D E
19. A B C D E
20. A B C D E
21. A B C D
22. A B C D
23. A B C D
24. A B C D
25. A B C D
26. A B C D
27. A B C D E
28. A B C D E
29. A B C D E F
30. A B C D E F
31. A B C D E F
32. A B C D
33. A B C D
34. A B C D
35. A B C D
36. A B C D
37. A B C D
38. A B C D
39. A B C D
40. A B C D

APPENDIX E

FORMULAS

Multiple Correlation Formulas

1. $R^2_{Y.1,2} = (r^2_{Y1} - r^2_{Y2} - 2r_{Y1}\, r_{Y2}\, r_{12})^2$

$$= (B_{Y1.2}\, r_{Y1} - B_{Y2.1}\, r_{y2})^2$$

2. $R^2_{Y.1,2,3...k} = B_i\, r_{Yi}$ p.94 *

$$= B^2_i - 2\, B_i\, B_j\, r_{ij}$$

$$= sd^2_Y \;/\; sd^2_Y$$

Semi-partial Correlation

3. $sr^2_i = t^2 \dfrac{(1 - R^2)}{(n-k-1)} = \dfrac{pr^2_i}{(1-pr^2_i)} (1-R^2_{Y.1,2...k})$ p.96*

$$= B^2_i (1-R^2_{i.1,2,...(i)..k})^2$$ p.96*

$$= R^2_{Y.1,2,...k} - R^2_{Y.1,2,\ 3...(i)..k}$$ p.95*

4. $sR^2_B = R^2_{Y.(B.A)} - I_B = R^2_{Y.AB} - R^2_{Y.A}$

Partial Correlation

5. $pr^2_i = t^2_i \;/\; (t^2_i - n - k_A - k_B - 1)$ p.348*

$$= sr^2_i \;/\; (1-R^2)$$ p.96*

6. $pR^2_B = I_B \;/\; (1 - R^2_{Y.A})$

Standardized Regression Coefficient

7. $B_i = b_i (sd_i / sd_Y)$

8. $B_{Y1.2} = r_{y1} - r_{y2}\, r_{12} \;/\; (1 - r^2_{12})$

Raw Score Regression Coefficient

9. $b_{YX} = r_{YX} (sd_Y / sd_X)$

10. $b_i = b_{Yi.1,2,3...(i)..k} = B_i (sd_Y / sd_i)$

Significance Tests For:

11. R^2 $F = \dfrac{R^2 (n - k - 1)}{(1 - R^2) k}$

with df = k and (n-k-1) p104*

12. sr^2_i $F = \dfrac{sr^2_i (n-k-1)}{(1 - R^2_{Y.1,2,3...k})} = t^2_i$

with df = 1 and (n-k-1) p107*

13. sR^2_B $F = \dfrac{I_B}{(1 - R^2_{Y.A,B})} \times \dfrac{(n - K_A - K_B - 1)}{K_B}$

with df = K_B and $(n-K_A -K_B - 1)$ p. 136*

14. B_i $t = B_i / SE_{B_i}$ $SE_{B_i} = \dfrac{1 - R^2_Y}{n - k - 1} \times \dfrac{1}{1 - R^2_i}$

with df = n-k-1 p.112*

Investigationwise Error Rate

15. = approximately $1 - (1 - \text{alpha})^C$

where C is the number of significance tests performed. p.163

Power Analysis For:

16. R^2 $\quad L^* = f^2\ (n-k-1) \quad f^2 = \dfrac{R^2}{(1-R^2)}$ = Effect Size

enter power table at $K_B = K$ p.154

17. sr^2_i $\quad L^* = f^2\ (n-k-1) \quad f^2 = sr2_i\ /\ (1-R^2)$

enter power table at $K_B = 1$ p. 119

18. sR^2_B $\quad L^* = f^2\ (n- K_A - K_B - 1) \quad f^2 = \dfrac{I_B}{1- R^2_{Y.AB}}$

enter power table at $K_B = K_B$ p. 153

19. N $\quad N = \dfrac{L^*}{f^2} - K_A - K_B - 1$ p. 145

Item Analysis Formulas

20. Discrimination Index $= \dfrac{\text{Upper group N} - \text{Lower Group N}}{\text{Upper group N}}$

21. Difficulty Index $= \dfrac{\text{Total N} - \text{Correct N}}{\text{Total N}}$

* These page numbers refer to Cohen and Cohen (1975).

APPENDIX F

TREATMENT DESCRIPTION FORM

NAME______________

	PERIOD	PERIOD	PERIOD	PERIOD	PERIOD
CLASS #					
Type of ability grouping, e.g. honors, academic, business.					
Total days of instruction including films and labs.					
minutes of instruction per day, i.e. length of period					
What percent of the total instructional time listed above was spent on: Lab & Demonstration					
Films					
Field Trips					
Problem Solving					
Lecture					
Group Discussion					
Other Activity					
Did the class know an experiment was being conducted?					
Did the class behave differently during the experiment than they usually behave?					
Did anything unusual happen during the experiment which might make the results invalid?		IF	YES EXPLAIN	ON BACK.	
Unit test ratings (See bottom of page)					

TEACHER DATA

1. How many years of teaching experience do you have? ______YEARS
2. How long have you been teaching chemistry? ______YEARS
3. How old are you? ______YEARS
4. Approximately, how many college credits do you have beyond the bachelor's degree? ______CREDITS
5. What is the highest degree you have completed? ______ DEGREE
6. How well do you think the unit test measured the student's knowledge of acids and bases? (Place rating in class data box above.)
   1. VERY WELL: It tested all of the most important points.
   2. MODERATELY WELL: It tested most of the important points, but left out some points which I thought should have been included.
   3. FAIRLY WELL: It included many of the important ideas, but it also included some irrelevant ideas. It did not go into the detail which I thought was necessary.
   4. POORLY: Most of the important points were not included; the test was overly picky.
   5. VERY POORLY: The test was really worthless; all or most of the important ideas were left out. Almost all of the items were irrelevant.

APPENDIX G

DIRECTIONS FOR ABILITY TEST ADMINISTRATION

DIRECTIONS FOR ADMINISTRATION

GENERAL CONSIDERATIONS

This test battery contains a total of 7 subtests; these tests should take approximately 40 minutes to complete. However, I have not given these tests in a classroom so it is possible that they may require more than 40 minutes. If you are running out of class time, please treat the seventh subtest, letter sets (p.5), as optional. That is, do not administer the letter sets test unless you have approximately seven minutes left in your period.

Before you begin administering the test battery, tell your class that they will be taking some ability tests today. Explain that you are helping a friend do some research on chemistry classes, and he is studying the ability level of high school chemistry students. Please, do not mention that they are part of an experiment, or that an experimental unit will follow. You should also explain that these scores will go to the guidance counselors, and that they can talk to him about their scores in about two months. It should take about two months to get the tests scored and returned to you.

You should read the test directions to yourself several times beforehand, in order to familiarize yourself with the test sequences, the timing, and the instructions. Most people are curious to know their own I.Q.; so if you wanted to take this test beforehand, I would be glad to score it for you and talk to you about the results. I would also be willing to do this for your family.

It is desireable to begin the testing session with some appropriate introductory remarks to put your students at ease, and to motivate them to do as well as possible. The test

2

instructions should be read exactly as they are given, in an unhurried, friendly conversational manner, so that the students are prepared to enjoy the test and to do their best. Be especially careful at the beginning of the test to see that the examples have been marked in the right places.

PLEASE KEEP IN MIND THAT:

(1) TIME LIMITS MUST BE STRICTLY ADHERED TO AND UNDER NO CIRCUMSTANCES ALTERED TO ALLOW FEWER OR MORE PERSONS TO COMPLETE A GIVEN SUBTEST.

(2) INSTRUCTIONS ARE TO BE PRESENTED EXACTLY. Major departures from the instructions may seriously affect the results.

Before distributing the test booklets and answer sheets, caution the class that the booklets are not to be opened until they are told to do so. Place the booklet on the desk with the front cover facing up. Have them fill in the information at the top of the answer sheet. On the line labled SCHOOL, have the class enter your name, and the class period they belong to. For example, SCHOOL DEGUGLIELMO 2 period

PRELIMINARY INSTRUCTIONS (Pen or pencil can be used on the answer sheet)

When everyone has filled in his name, etc. on the answer sheet say:

" Put down your pencils and I'll tell you a little bit about what you're going to do. In this booklet there are four tests which are like four different games or puzzles. There are no words in them- only drawings. Each of the tests has some examples for you to practice on so that you can see how to do it. First, we'll look at the examples together and then you'll be asked to go ahead

-3-

on your own. Some of the questions at the end of each test may be quite hard to do but try as many as you can. Even when you're not sure mark the answer you think might be right, rather than none It's perfectly all right to guess if you do not know the answer. You don't lose points for wrong guesses, and you might guess right.

Please don't turn any page until I tell you. You are to mark all your answers on the answer sheet you've been given, and not in the test booklet. Now, quickly check your test booklet for stray marks or answers. If your booklet has been marked in, ask for a new test booklet. Now read the instructions on the answer sheet and see if you understand them. Then we'll go over the examples together and you'll have a chance to mark some answers for practice. If you have any questions raise your hand. (Pause) "

SEE VERBATUM INSTRUCTIONS ON THE NEXT PAGE

Verbatim Instructions for Scale 2

FORM A

Now open the booklet to the first page, Test 1. At the top of the page are three examples. Look at the first example. (Point) Notice that the first three boxes have black lines that keep getting longer. Then there is a dotted empty box (Point), followed by five more boxes. (Point) Of the five, choose the one that would be right to put into the empty box. (Pause) For this example, the correct answer has been given to you. It is 1. Look at your answer sheet. Notice that under Test 1, in the first example, the box under the 1 has been filled in. That shows 1 is the correct answer of the five you have to choose from.

Look at the second example. See how the little curved line bends to the left, then to the right, then to the left. What will it do at the next step? (Wait for an answer) Yes, it will bend to the right. Number 3 is correct. Pick up your pencil and in the second example on the answer sheet, fill in the box under the 3.

Now, the third example. See how the black part moves. It begins at the top and moves around the circle. Look at the five choices for the right answer. (Pause) Which one is it? (Wait for an answer) Yes, it's number 1. Mark it on your answer sheet by filling in the box under 1.

You can see that none of the other choices in all three examples would have been quite right. When I tell you to start, go on and do the rest yourself. Begin with the first row just below the line and work through this page to the bottom of the next. (Point to both pages) In each row choose just *one* of the five boxes on the right that fits correctly in the empty box. Then mark it on your answer sheet. You might not have time to finish them all, but work as quickly and carefully as you can. You are allowed to change your answer if you change your mind, but be sure to erase carefully. Ready? Go!

After exactly *3 minutes* say
Stop! Pencils down.

Now turn to Test 2. (Check that all booklets are turned to the right page.) Look at the first example. (Pause) There are five figures in a row. Four are the same and one is different. In this row, which one is *different* in some way from all the others? (Pause) The *fourth* one is different, so the box under 4 has been filled in on the answer sheet. Why is that one different? (Permit an answer)

Let's do the second example now. Which one is the different one here? (Permit an answer) Yes, it's the first one. It's black and all the others are white. Of course, the others are different sizes but they are all white so you can't pick out one of those. On your answer sheet fill in the box under 1 in the second example.

When I tell you to start, I want you to choose one picture in each row which does not belong with the others. Remember, only *one* picture in each row is different in some way from all the others. Work quickly and carefully to try to finish as many as you can on the two pages before I tell you to stop. Ready? Go!

After exactly *4 minutes* say
Stop! Pencils down.

TEST 3 Turn to Test 3. Look at the first example. (Pause and check) There are four small boxes in the large square (Point) at the left. One of them is dotted and empty. Which one of these five boxes over here (Point) is the correct one to fill in the dotted empty box? (Pause for answer) Yes, it's the *third*. If we put that one in the empty box, it would look right. Do you see on your answer sheet that the box under the 3 has been filled in?

Now look at the second example. (Pause and check) Which one shall we put into the empty box to make it look right? (Permit an answer) Yes, it's 1, isn't it? Mark this on your answer sheet.

Let's take the third example. You choose the right answer. Which is it? (Pause for answer) Yes, it's 4. Mark it on your answer sheet.

When I say 'Go,' start with number 1, here, just below the line. (Point) Look first at the large square with the four boxes. (Point) Then look at the row of five boxes and pick out the *one* box that would look right in the dotted empty box. See what number it is and on your answer sheet, fill in the little box under that number. Do both pages. Work as carefully and as fast as you can. Ready? Go!

After exactly *3 minutes* say
Stop! Pencils down.

TEST 4 Turn to Test 4. Look at the first example. (Point) In the box at the top that's by itself (Point, check) you see that there is a circle, and in the circle there are a dot and a square. (Pause, check) The dot is *inside* the circle, but *outside* the square. Now look over here at the five boxes on the right. (Point) We must find one where we can do *just the same thing:* put a dot *inside* the circle but *outside* the square. What about the first one? No, because any dot in the circle would be in the square too. Would the second do? (Permit answer) No—because a dot in the circle would also be in the square. The third? Yes, you see the dot is *inside* the circle but *outside* the square. The dot was put in for you to show you that answer 3 would be right. (Pause) It is the only one where we can do the same as in the separate box on the left, here. (Point) So the box under the 3 has been filled in for the first example on your answer sheet.

Look at the second example. In the separate box at the left (Point), the dot is *inside* the egg-shaped figure, but *under* the line. Now we have to find another box where we can do just the same. Which one is it? (Pause) Yes, the *second*. That's the only right one. Fill in box 2 for the second example on your answer sheet.

Now look at the third example. (Pause) This time one dot must be in *both* squares at once, but *outside* the circle. In the first box over here (Point), you could not put a dot in both squares at once, could you? (Pause) In the second box, the dot *could* go in both squares, but it would be *inside* the circle, so it won't do. What about the third? (Pause) Yes, the *third* is the only one where we can put the dot in *both* squares, but *outside* the circle. Mark the answer on your answer sheet.

When I say, 'Go!' start at the first one under the line. (Point) Look carefully at the separate box to see just where the dot is. Then find the box where you could do just the same, and mark that number on your answer sheet. *Please do not make any dots or marks on the test booklet.*

You will have almost as much time for this one page as you had for the two pages in the last test. See how many you can do. Ready? Go!

After exactly *2½ minutes* say
Stop! Pencils down.

Collect booklets and answer sheets quickly to avoid changes in answers. If machine scorable answer sheets are being used and Form B is to be administered immediately after Form A, the examinees should keep their answer sheets.

DIRECTIONS FOR SECOND TEST BOOKLET

Each student should receive two test booklets at the beginning of the test period: a CULTURE FAIR test booklet , and the booklet titled VOCABULARY TEST I. The CULTRUE FAIR test should be administered first. The answer sheets for both tests are on the front and back of the same sheet of paper.

When students have completed the CULTURE FAIR test, proceed immediately to the second test booklet, and VOCABULARY TEST I. Begin VOCABULARY TEST I by reading the directions on page 1 of the test booklet. When the time for VOCABULARY TEST I is up, read the directions for VOCABULARY TEST II on page 3 of the test booklet. When the four minutes for VOCABULARY TEST II is up, check to see if you have enough time to do the LETTER SETS TEST on page 5. This test takes 7 minutes. If you have enough time, then turn to page 5 and read the directions to the class.

TEST TIMES

CULTURE FAIR	
test 1	3 minutes
test 2	4 minutes
test 3	3 minutes
test 4	2½ minutes
VOCABULARY TEST I	4 minutes
VOCABULARY TEST II	4 minutes
LETTER SETS TEST	7 minutes (OPTIONAL, IF YOU HAVE TIME)

APPENDIX H

DATA AVERAGED ACROSS TEACHERS

TABLE XXIX

DEMOGRAPHIC DATA ON ALL CLASSES TAUGHT BY EACH TEACHER

	Experimental Group						Replication Group				
	Teacher Number					Group	Teacher Number				Group
Variables	1	3	4	7	8*	Total	2	5	6	9	Total
Total N	70	12	14	75	54	225	82	62	38	98	280
Sex											
Male	28	6	9	28	23	94	40	27	24	46	137
Female	41	6	5	47	30	129	37	34	14	52	137
Race											
White	54	9	12	71	53	199	0	60	38	0	98
Black	7	1	1	3	0	12	0	1	0	0	1
No Info.	0	2	0	0	0	3	82	0	0	98	180
Age											
13	0	0	0	0	31	31	0	0	0	61	61
14	0	0	0	0	23	23	0	0	0	34	34
15	4	0	2	1	0	7	2	0	25	3	30
16	40	5	6	33	0	84	38	39	12	0	89
17	15	7	1	36	0	60	27	18	0	0	45
18	6	0	1	3	0	10	7	1	0	0	8
19	0	0	0	0	0	0	2	0	0	0	2
20	1	0	0	0	0	1	1	0	0	0	1
No Info.	3	0	4	2	0	9	5	4	1	0	10
Grade Level											
8th	0	0	0	0	54	54	0	0	0	98	98
10th	5	0	3	1	0	9	3	0	38	0	41
11th	55	7	10	49	0	121	60	61	0	0	121
12th	10	5	1	25	0	41	19	1	0	0	20

* Class 682 (N = 14) was dropped from the analysis due to missing data.

TABLE XXX

MEAN AND STANDARD DEVIATION OF THE RAW DATA FOR STUDENTS AVERAGED ACCROSS EACH TEACHER

	Experimental Group					Replication Group			
	Teacher Number					Teacher Number			
Variables	1	3	4	7	8*	2	5	6	9
Culture Fair I.Q.	113	115	125	114	110	106	109	118	100
sd	15.1	16.1	18.9	15.4	15.8	17.3	16.0	14.8	12.3
N	63	11	10	73	63	69	43	37	90
V-1	11.7	9.8	13.9	11.9	3.1	8.7	11.1	13.1	7.6
sd	3.9	4.1	2.4	3.2	1.6	4.1	2.8	2.6	2.9
N	59	11	10	73	62	56	43	37	91
V-2	9.4	7.7	12.4	10.4	6.5	6.9	8.6	10.5	6.2
sd	3.3	2.6	3.2	2.9	2.5	2.7	2.9	2.5	2.2
N	59	11	10	72	66	56	43	37	90
I-1	11.8	-	12.9	-	10.1	-	11.2	-	-
sd	2.6	-	1.1	-	2.9	-	2.1	-	-
N	59	0	10	0	66	0	43	0	0
Fourth Term Grade	72.5	75.8	87.3	78.7	-	-	81.7	84.0	76.6
sd	17.3	11.5	8.3	10.1	-	-	12.7	6.4	13.7
N	65	12	9	74	0	0	60	37	98
Final Grade Grade	79.8	-	88.8	80.1	-	-	79.9	83.1	78.7
sd	13.4	-	6.5	8.9	-	-	13.4	6.1	9.9
N	64	0	9	74	0	0	61	37	98
Total N	70	12	14	75	54	82	62	38	98

* Class 682 (N= 14) was dropped from the analysis.

TABLE XXXI

MEAN, STANDARD DEVIATION, AND PERCENTILE OF STUDENT"S CES SCORES AVERAGED ACROSS EACH TEACHER

	Teacher Number									
Variables	1	3	4	7	8	2	5	6	9	Total
Sample N	70	12	14	75	68	82	62	38	98	519
Involvement	4.4	4.4	5.5	3.6	4.3	4.3	4.2	3.7	2.7	3.9
sd	3.0	3.0	4.0	2.7	4.3	2.9	2.9	2.6	2.2	3.0
s.s.*	46	46	52	41	46	46	38	41	34	44
Affiliation	5.0	5.6	6.1	5.1	4.3	5.5	5.7	6.5	5.7	5.4
sd	3.1	3.3	4.4	2.8	4.3	3.7	3.2	2.7	2.4	3.3
s.s.*	38	42	46	38	34	42	42	50	42	42
Teacher Support	6.5	6.3	6.1	5.4	4.2	6.0	6.5	5.0	4.3	5.4
sd	3.2	3.5	4.1	2.6	4.2	3.6	3.0	2.6	2.4	3.3
s.s.*	49	49	46	42	33	46	49	39	36	42
Task Orientation	6.8	6.1	4.9	7.8	4.2	5.7	7.0	6.9	6.3	6.3
sd	3.2	3.5	4.1	2.6	4.2	3.5	3.1	2.6	2.3	3.3
s.s.*	54	48	42	60	36	45	54	54	51	51
Competition	4.1	5.4	3.9	5.5	3.0	3.9	4.6	5.7	5.3	4.6
sd	2.4	2.9	3.1	2.4	3.1	2.6	2.5	2.4	2.0	2.7
s.s.*	40	52	40	52	32	40	44	52	52	44
Order & Organization	6.9	6.8	2.3	6.7	4.6	4.5	5.2	5.6	3.8	5.2
sd	3.3	3.5	2.0	3.0	4.5	3.1	2.9	2.8	2.2	3.4
s.s.*	56	56	32	53	43	43	45	48	40	45
Rule Clarity	6.4	5.1	4.2	6.8	3.5	5.0	5.1	4.4	6.3	5.5
sd	3.3	2.9	3.3	2.8	3.6	3.3	3.0	2.6	2.7	3.2
s.s.*	54	43	36	58	33	43	43	40	54	47
Teacher Control	3.4	2.4	1.8	3.6	2.0	2.4	2.8	2.9	5.8	3.4
sd	2.4	1.7	2.0	2.2	2.3	1.9	2.2	2.2	2.7	2.1
s.s.*	48	42	39	48	39	42	45	45	64	48
Innovation	4.1	4.8	4.7	2.4	3.1	3.9	3.7	4.1	4.5	3.8
sd	2.7	2.8	3.4	1.7	3.4	2.8	2.5	2.0	1.8	2.6
s.s.*	44	50	47	36	38	44	41	44	47	44

* The standard scores listed have a mean of 50 and a standard deviation of 10. The conversion table provided by Moos and Trickett (1974) lists raw scores to the nearest 0.5 raw score point. Raw scores were rounded to the nearest table entry before being converted to standard scores.

APPENDIX I

DATA AVERAGED ACROSS CLASSES

TABLE XXXII

MEAN AND STANDARD DEVIATION OF STUDENT SCORES ON THE INDEPENDENT AND DEPENDENT VARIABLES USED IN REGRESSION MODEL AVERAGED ACROSS CLASSES

	Experimental Group Teacher Number and Class Number											
	1				3	4	7			8 *		
Variables	111	112	113	114	131	141	271	272	273	681	682**	683
Classize	17	19	18	16	12	14	23	26	26	29	14	25
Posttest	22.9	27.5	20.1	22.8	21.9	29.8	24.5	26.3	29.8	18.2	18.5	17.4
sd	4.3	6.1	4.1	6.3	5.7	4.5	4.8	5.1	6.1	1.2	0.5	2.2
N	13	19	16	12	11	11	12	16	19	20	13	17
Retention	20.4	26.6	20.2	22.3	21.5	24.3	22.1	-	-	19.4	18.7	19.0
sd	4.1	4.7	4.9	6.5	5.0	6.9	5.6	-	-	0.9	0.6	0.9
N	10	17	16	12	6	9	13	0	0	26	13	20
Factor 1	-.31	.87	-.19	-.12	.28	1.17	-.53	-.63	-.56	1.09	.66	.97
sd	.26	.69	.60	.80	.81	.64	.82	.73	.65	.54	.59	.34
N***	8	18	12	14	9	10	19	23	25	16	3	14
Factor 2	.28	.37	.21	.01	.16	.60	.17	.04	.35	.70	-2.20	.14
sd	.30	.55	.94	.53	.81	.65	.56	.82	.62	.44	1.26	.49
Factor 3	.45	.84	-.01	.53	.04	1.03	.13	.31	.64	-1.62	-1.24	-1.56
sd	1.11	.88	.98	.84	.87	.60	.68	.75	.83	.40	.68	.60
Factor 4	.60	.12	.79	.62	.19	-.86	.87	.30	.48	.56	.56	.73
sd	.47	.41	.50	.53	.47	.61	.52	.84	.68	.42	.25	.45
Factor 5	0.00	.13	-.17	.25	-.49	-.21	-.07	-.18	-.10	-.13	.44	-.16
sd	1.14	.81	.95	.98	.58	.90	.95	1.06	.70	.78	.80	.68

* These three classes were eighth grade classes.
**This class was dropped from the analysis due to missing data.
***This N applies to all five factors.

TABLE XXXII CONTINUED

Replication Group
Teacher Number and Class Number

	2					5			6		9 *			
Variables	121	122	123	124	125	351	352	353	461	463	591	592	593	594
Classize	16	17	14	16	19	20	22	20	20	18	25	24	24	25
Pretest	10.2	10.8	9.7	10.0	10.5	15.7	14.1	15.1	16.7	15.9	10.0	8.9	9.0	10.7
sd	3.5	4.5	3.2	2.8	2.9	5.0	3.7	5.2	4.6	4.6	3.3	2.7	5.2	3.4
N	10	6	7	13	12	19	20	18	19	16	22	21	24	24
Posttest						25.1	24.2	21.6	28.9	29.4	20.2	17.8	14.5	15.9
sd						5.7	4.8	5.0	3.7	3.3	5.4	4.7	3.9	3.8
N	0	0	0	0	0	18	18	17	20	17	24	24	24	22
Factor 1	-.26	-	.75	.48	.39	-.41	.15	.48	-.18	-.22	-.71	-.19	-.37	-.41
sd	.99	-	.64	.79	.85	.64	.54	.89	.75	.72	.70	.54	.69	.54
N**	11	0	11	12	12	11	11	16	19	15	23	19	22	22
Factor 2	-.37	-	-.85	.04	-.27	.30	-.27	-.18	.42	.65	-.28	-.30	-.48	-.67
sd	.85	-	1.07	.96	.67	.72	.99	.52	.61	.42	.64	.62	.85	.78
Factor 3	.22	-	-.83	.23	-.32	.23	.66	.02	.64	.60	-.25	-.55	-.33	-.50
sd	.88	-	.85	.65	.94	.76	.69	.52	.79	.65	.72	.61	.66	.74
Factor 4	-.37	-	-.40	-.01	.07	-.04	.35	.00	.04	-.51	-.82	-.58	-.61	-.90
sd	.63	-	.43	.87	1.06	.83	.82	.55	.74	.68	.68	.65	.81	.67
Factor 5	-.66	-	-.09	-.49	-.41	-.74	.04	-.51	-.17	-.49	1.10	.64	.55	.44
sd	.72	-	.66	.68	.61	.97	.93	.88	.99	.85	1.09	1.21	1.08	.91

* These four classes were eighth grade classes.
** This N applies to all five factors.

TABLE XXXIII

MEAN AND STANDARD DEVIATION OF THE RAW DATA FOR EACH STUDENT AVERAGED ACROSS CLASSES

	Experimental Group: Teacher Number and Class Number											
	1				3	4	7			8*		
Variable	111		113	114	131	141	271	272	273	681	682**	683
Classize	17	19	18	16	12	14	23	26	26	29	14	25
Culture Fair												
I.Q.	114	117	111	109	115	125	112	113	116	120	89	109
sd	14	15	18	13	16	19	17	16	14	13	11	9
N												
V-1 + V-2	23.3	23.6	16.7	21.1	17.5	26.3	20.0	22.0	24.2	10.4	7.0	9.7
sd	6.6	6.7	5.5	6.1	6.2	5.2	4.3	5.8	6.2	2.9	2.8	3.4
N												
Fourth Term												
Grade	60.6	80.9	70.8	74.7	75.8	87.3	78.9	75.1	82.0	-	-	-
sd	22.1	11.0	11.6	18.8	11.5	8.3	6.9	12.1	9.4	-	-	-
N	14	19	17	15	12	9	23	25	26	0	0	0
Final Grade	68.5	87.2	79.1	82.3	-	88.8	81.1	77.3	83.8	-	-	-
sd	18.1	8.0	8.3	11.4	-	6.5	5.4	11.0	8.1	-	-	-
N	14	18	17	15	0	9	23	25	26	0	0	0

* These are eighth grade classes.

** This class was dropped due to missing data.

TABLE XXXIII CONTINUED

	Replication Group: Teacher Number and Class Number														
	2**					5			6			9***			
Variable	121	122	123	124	125	351	352	353	461	462*	463	591	592	593	594
Classize	16	17	14	16	19	20	22	20	20	22	18	25	24	24	25
Culture Fair															
I.Q.	102	109	99	113	103	114	109	106	117	105	119	101	98	98	98
sd	13	26	13	17	10	11	20	10	16	25	14	12	23	14	13
N	13	13	14	15	14	15	12	16	20	21	17	24	21	24	22
V-1 + V-2	18.2	-	10.2	19.7	13.9	21.2	20.6	17.6	23.1	19.5	24.0	14.8	13.3	13.5	13.5
sd	5.7	-	3.5	4.8	5.3	6.0	4.7	4.1	4.3	5.0	4.0	4.6	2.7	5.3	4.2
N	13	0	14	15	14	15	12	16	20	21	17	24	21	24	22
Fourth Term															
Grade	-	-	-	-	-	80.7	86.5	77.2	83.1	-	85.1	80.2	80.3	70.6	69.2
sd	-	-	-	-	-	13.6	8.3	14.5	6.8	-	5.9	13.2	13.2	13.0	13.1
N	0	0	0	0	0	18	22	20	20	0	17	25	24	24	25
Final Grade	-	-	-	-	-	79.5	84.3	75.2	81.9	-	84.4	81.0	81.8	78.0	74.0
sd	-	-	-	-	-	14.0	10.6	14.6	6.1	-	6.0	9.1	10.9	9.4	8.9
N	0	0	0	0	0	20	22	19	20	0	17	25	24	24	25

* This class was dropped due to missing both dependent variables.

** These classes were missing a posttest. They were used for the internal validity check, but not in the regression models.

*** All of these classes are eighth grade classes.

TABLE XXXIV

MEAN, STANDARD DEVIATION, AND PERCENTILE OF STUDENT CES SCORES AVERAGED ACROSS CLASSES

	Experimental Group: Teacher Number and Class Number											
	1				3	4	7			8 *		
Variable	111	112	113	114	131	141	271	272	273	681	682	683
Classize	17	19	18	16	12	14	23	26	26	29	14	25
N for CES	14	18	13	14	10	10	20	23	26	16	4	15
Involvement	4.9	6.3	4.8	4.8	5.3	7.7	5.0	3.4	3.5	8.6	7.5	8.3
sd	2.2	2.6	2.4	2.7	2.4	2.0	2.2	2.5	2.5	1.0	1.3	0.9
percentile	35	76	35	35	58	88	35	18	18	96	88	93
Affiliation	4.8	7.5	5.1	5.6	6.7	8.5	6.5	5.1	5.3	8.7	5.8	8.6
sd	2.4	2.0	2.1	2.3	2.3	2.1	2.5	2.3	2.5	1.3	0.5	1.2
percentile	12	79	12	22	66	91	50	12	22	98	34	94
Teach. Support	7.7	8.6	7.0	7.3	7.5	8.5	5.2	6.3	6.1	8.2	7.5	8.5
sd	1.5	1.3	1.7	2.0	2.1	1.1	1.9	2.1	2.1	1.4	1.3	1.0
percentile	69	86	58	69	69	86	14	49	40	70	69	86
Task Orient.	8.9	7.1	8.2	8.6	7.3	6.8	9.1	8.6	7.8	7.6	8.8	8.5
sd	1.3	1.1	1.3	1.4	1.5	1.8	1.0	1.5	1.3	1.9	1.3	1.4
percentile	96	65	92	92	76	65	96	94	92	76	96	94
Competition	4.4	5.9	4.8	4.1	6.5	5.4	6.0	6.0	6.2	5.6	7.2	5.8
sd	1.6	1.9	1.7	1.4	1.7	2.2	1.5	1.6	2.1	1.8	1.0	1.3
percentile	28	71	43	28	84	58	73	73	73	58	92	73
Order & Organ.	8.6	7.6	8.8	8.2	8.2	3.2	8.1	6.0	7.7	9.1	7.3	9.1
sd	1.5	1.4	1.4	1.7	1.7	11.6	1.7	2.5	2.1	0.7	1.0	0.6
percentile	91	72	96	86	86	7	86	54	72	96	73	96
Rule Clarity	7.2	7.8	7.8	7.4	6.1	5.9	7.9	7.0	7.4	7.1	7.2	6.3
sd	2.0	1.9	1.5	2.0	1.9	2.3	1.6	2.3	2.0	2.0	0.5	1.8
percentile	79	93	94	86	54	54	94	79	86	79	79	54
Teacher Cont.	4.3	3.6	3.8	4.6	2.9	2.5	4.1	3.8	3.8	3.7	5.8	3.8
sd	2.4	1.8	1.8	2.4	1.4	2.0	2.0	2.5	1.9	1.8	1.5	1.5
percentile	66	42	54	70	31	21	54	54	54	42	86	54
Innovation	4.1	6.7	3.5	4.4	5.8	6.6	2.5	2.5	2.9	6.2	6.0	6.1
sd	1.4	1.9	1.5	2.1	1.8	1.6	1.9	1.8	1.3	2.1	1.4	1.9
percentile	28	82	19	39	73	82	5	5	12	73	73	73

TABLE XXXIV CONTINUED

	Replication Group — Teacher Number and Class Number														
	2					5			6			9*			
Variable	121	122	123	124	125	351	352	353	461	462	463	591	592	593	594
Classize	16	17	14	16	19	20	22	20	20	22	18	25	24	24	25
N for CES	14	10	11	13	15	16	20	18	20	19	15	24	22	22	25
Involvement	4.7	5.7	6.5	5.3	5.9	2.6	5.6	6.0	4.1	3.0	4.0	2.4	3.8	3.1	2.0
sd	1.9	1.5	1.8	1.8	2.3	2.1	2.4	2.5	2.1	2.0	1.9	2.5	2.4	2.2	1.6
percentile	35	58	76	58	66	8	58	66	28	12	28	8	28	12	5
Affiliation	7.4	6.4	7.9	6.8	7.3	4.9	6.8	7.7	7.0	6.6	7.0	5.8	6.2	6.3	5.8
sd	2.5	2.2	1.6	3.0	2.4	2.1	2.2	2.0	2.5	2.4	2.3	2.1	2.4	2.2	1.6
percentile	79	50	88	72	79	12	66	79	66	50	66	34	34	50	34
Teacher Support	7.1	7.6	7.5	8.4	8.1	7.1	7.5	7.9	5.9	5.7	4.9	4.0	4.6	4.9	4.6
sd	2.5	1.4	1.6	1.6	1.5	1.9	1.9	1.4	2.1	2.1	2.1	1.9	2.3	2.0	2.3
percentile	58	69	69	83	79	58	69	79	40	25	14	5	8	14	8
Task Orient.	6.9	7.8	7.0	7.5	7.9	7.7	8.5	8.0	7.8	6.7	7.3	6.6	6.8	6.8	6.6
sd	1.7	1.7	1.9	1.9	1.7	2.0	1.5	1.4	1.5	1.7	1.7	2.0	1.8	2.0	1.7
percentile	66	84	66	76	84	76	92	84	84	54	76	54	66	66	54
Competition	4.6	5.5	5.8	5.5	4.3	4.4	5.7	5.6	6.4	5.1	6.0	5.3	6.0	5.3	5.0
sd	1.8	1.9	1.2	1.8	1.4	1.6	2.0	1.0	1.7	1.8	1.8	1.7	1.6	1.9	1.6
percentile	28	58	73	58	28	28	58	58	78	43	73	58	73	58	58
Order & Organ.	4.9	6.6	4.5	6.5	6.5	5.8	6.6	5.7	6.6	6.2	5.5	4.2	4.0	4.3	3.7
sd	1.8	2.4	1.2	2.5	2.5	2.1	2.5	1.9	2.3	2.3	2.3	2.2	1.6	2.4	2.0
percentile	38	62	24	62	62	54	62	42	62	54	42	16	16	24	10
Rule Clarity	6.5	6.3	6.7	6.1	6.9	4.9	6.1	6.8	5.8	6.8	3.7	6.2	7.0	6.8	6.5
sd	1.9	1.9	1.8	2.2	2.4	1.9	2.5	2.4	2.1	1.8	1.6	2.6	2.5	1.8	2.3
percentile	66	66	77	54	79	24	54	79	54	79	7	54	79	79	66
Teacher Cont.	2.3	3.3	4.1	2.8	3.1	2.8	3.7	2.9	3.5	4.1	2.6	7.0	6.2	5.7	5.7
sd	1.2	1.1	1.3	1.9	1.6	2.1	1.9	2.0	2.3	2.1	2.0	2.5	2.1	2.1	2.0
percentile	18	42	54	31	31	31	54	31	42	54	21	98	92	86	86
Innovation	4.6	5.3	5.7	5.3	4.5	3.2	4.5	4.8	4.2	4.7	4.8	4.5	4.8	4.6	5.2
sd	2.3	1.9	1.9	1.9	2.4	1.7	1.8	2.8	1.9	1.7	1.3	1.6	1.3	1.6	1.4
percentile	38	62	62	62	38	12	38	50	28	38	50	38	50	38	50

* These are eighth grade classes.

APPENDIX J

CORRELATION COEFFICIENTS FOR ALL VARIABLES

NOTATION USED IN THE COMPUTER PRINTOUT

Variable Number	Variable Name	Expanded Name	Source
4	Involve	Involvement	CES
5.	Affiliat	Affiliation	CES
6.	Support	Teacher Support	CES
7	Task	Task Orientation	CES
8	Compete	Competition	CES
9	Order	Order and Organ-ization	CES
10	Rule	Rule Clarity	CES
11	Control	Teacher Control	CES
12	Innovate	Innovation	CES
13	Race	Race	1 = White 2 = Black 3 = Other
14	LD	Learning Disa-bility	0 = absent 1 = present
15	ESL	English as a Second Language	0 = absent 1 = present
16	Fourth	Fourth Term Grade	Teacher Report
17	Final	Final Grade	Teacher Report
18	Age	Age	CES or Culture Fair Test
21	Years	Years in the present school	CES
22	Months	Months in the present Class	CES
19	Sex	Sex	0 = Female 1 = Male
20	Age	Age	Culture Fair test or CES
23	G1	Test 1:Series	Culture Fair Test
24	G2	Test 2: Classi-fications	Culture Fair Test
25	G3	Test 3: Matrices	Culture Fair Test
26	G4	Test 4:Conditions (Topology)	Culture Fair Test
27	IQ	I.Q.	Culture Fair Test
28	V1	V-1	Kit of Factor Referenced Tests
29	Guess1	The number of wrong answers to V-1	
30	V2	V-2	Kit of Factor Referenced Tests
31	Guess2	The number of wrong answers to V-2	

Variable Number	Variable Name	Expanded Name	Source Source
32	Induct	Induction I-1	Kit of Factor Referenced Tests
33	Guess3	The number of wrong	
34	Dscale	This scale was constructed by the author to measure ability to follow directions 0 = Followed Directions 1 = Did not Follow Directions	
35	Xscale	This scale was constructed by the author to measure motivation or personality. Some students made comments about the testing process. 0 = no comments; 1 = comments	
119	TOTAL1	This is the total score for unit Test 1. For the epxerimental group this was a posttest; this was a pretest for the control group.	
120	TOTAL2	This is the total score for unit test 2. This was a retention test for the experimental group, and a posttest for the control group.	
123	CITY1	This is a composite of factor 2 and factor 3.	
124	SCHOOL1	This is a composite of scroes from V-1 and V-2.	
152	FACTOR1	Factor 1	Factor Analysis
153	FACTOR2	Factor 2	Factor Analysis
154	FACTOR3	Factor 3	Factor Analysis
155	FACTOR4	Factor 4	Factor Analysis
156	FACTOR5	Factor 5	Factor Analysis

TABLE XXXV

CORRELATION MATRIX FOR THE TOTAL SAMPLE

		INVOLVL 4	AFFILIAT 5	SUPPORT 6	TASK 7	COMPETE 8	ORDER 9	RULE 10	CONTROL 11	INNOVATE 12	RACE 13	LD 14
INVOLVE	4	1.0000										
AFFILIAT	5	0.4702	1.0000									
SUPPORT	6	0.5479	0.4106	1.0000								
TASK	7	0.2542	0.0356	0.1146	1.0000							
COMPETE	8	0.1201	0.1065	-0.0469	0.2007	1.0000						
ORDER	9	0.4762	0.1357	0.3231	0.4728	0.0637	1.0000					
RULE	10	0.2148	0.1570	0.1960	0.3283	0.1523	0.3490	1.0000				
CONTROL	11	-0.0942	-0.1097	-0.3007	0.1119	0.2647	0.0054	0.3464	1.0000			
INNOVATE	12	0.3836	0.2858	0.3604	-0.1228	0.0530	0.0225	0.0648	0.0400	1.0000		
RACE	13	0.1072	0.0199	0.0628	-0.0323	-0.0175	0.0245	0.0422	-0.0321	0.0907	1.0000	
LD	14	0.3169	0.2121	0.1800	0.0556	0.0082	0.2605	0.0045	-0.0327	0.1538	-0.0486	1.0000
ESL	15	0.1535	0.0188	0.0781	0.0161	0.0159	0.0681	0.0952	0.0268	0.0838	0.4304	-0.0679
FOURTH	16	0.0250	0.1759	0.0967	-0.0578	0.0078	-0.0557	-0.0238	-0.1577	0.0623	-0.0520	0.0018
FINAL	17	0.0425	0.1813	0.1222	-0.1042	-0.0110	0.0082	0.0575	-0.1475	0.1283	0.0542	-0.0099
AGE	18	0.1647	-0.0592	0.2734	0.2113	-0.0447	0.2341	0.0200	-0.3334	-0.1550	0.1174	-0.4455
SEX	19	-0.1066	-0.0456	-0.0852	-0.1469	-0.0568	-0.0841	-0.1396	0.0275	0.0642	0.0222	-0.0382
GRADE	20	0.1047	-0.0570	0.2943	0.2653	-0.0377	0.2624	0.0569	-0.3601	-0.2005	0.0083	-0.4211
YEARS	21	-0.2566	-0.1564	-0.4035	-0.2036	-0.0133	-0.3920	0.0358	0.3723	-0.0179	0.0047	-0.2952
MONTHS	22	-0.4007	-0.1246	-0.4655	-0.2654	0.0386	-0.4520	-0.0204	0.4063	0.0130	-0.0312	-0.3228
G1	23	0.0032	0.0256	0.1096	0.0266	-0.0919	0.1013	-0.0779	-0.1032	0.0214	-0.0489	0.1176
G2	24	0.2455	-0.0689	0.0745	-0.0076	0.0063	0.0959	-0.0687	-0.1632	0.0307	0.0124	0.1011
G3	25	0.0715	0.0527	0.1187	0.0837	-0.0915	0.0922	0.0403	-0.1146	0.0128	0.0011	0.1050
G4	26	0.0907	0.0850	0.1323	0.0376	0.0570	0.0869	-0.0124	-0.1173	0.1099	0.0270	0.0691
IQ	27	0.1080	0.0256	0.1523	0.0361	-0.0324	0.1182	-0.0857	-0.2238	0.0800	0.0403	0.1205
V1	28	-0.1712	-0.1378	0.0613	0.0592	-0.0608	-0.0200	-0.0397	-0.2049	-0.1615	0.0215	-0.5024
GULSS1	29	-0.0461	0.0161	-0.1866	-0.1380	0.0327	-0.1275	-0.0391	0.2736	0.1173	-0.0350	0.3855
V2	30	-0.0219	-0.0434	0.1488	0.0153	-0.0575	0.0788	-0.0580	-0.2467	-0.0833	0.0171	-0.1546
GULSS2	31	-0.1600	0.0317	-0.2318	-0.1642	0.0503	-0.2574	-0.0459	0.2671	0.0527	-0.0296	0.0047
INDUCT	32	-0.0408	-0.1646	-0.0223	-0.0210	-0.0567	-0.0389	-0.0176	-0.0609	0.0565	0.0217	-0.1704
GULSS3	33	0.1711	0.0619	0.2148	0.1173	-0.0235	0.1381	-0.0032	-0.0480	0.0339	0.1400	0.2298
DSCALE	34	0.2648	0.1794	0.1953	0.0174	-0.0203	0.1832	-0.0525	-0.0994	0.1831	0.0417	0.4594
XSCALE	35	0.0047	0.0521	-0.0760	-0.0097	-0.0318	-0.0489	-0.0115	0.0429	0.0652	0.0244	-0.0736
TOTAL1	119	0.1536	-0.0449	0.2148	0.0938	-0.0421	0.3507	0.0874	-0.2055	-0.0509	0.1825	0.0341
TOTAL2	120	0.1005	0.1248	0.1932	0.0202	-0.0300	0.1351	-0.1433	-0.4111	0.0465	0.0651	-0.1658
CITY1	123	-0.0076	-0.0458	0.1649	0.0739	-0.0553	0.1104	-0.0466	-0.2045	-0.0049	0.0419	-0.2398
SCHOOL1	124	-0.1201	-0.1035	0.1081	0.0441	-0.0675	0.0236	-0.0519	-0.2455	-0.1423	0.0211	-0.4356
FACTOR1	152	0.7827	0.7247	0.7632	-0.0427	0.0762	0.2323	0.2008	-0.2059	0.7376	0.0980	0.2914
FACTOR2	153	0.1327	0.0094	0.1058	0.0432	-0.0480	0.2133	-0.1181	-0.1635	0.0992	0.0591	0.1486
FACTOR3	154	-0.1099	-0.0683	0.1337	0.0633	-0.0348	-0.0247	0.0330	-0.1399	-0.0860	0.0082	-0.4370
FACTOR4	155	0.4450	0.0606	0.2627	0.7330	0.1501	0.8848	0.5139	0.0281	-0.2323	-0.0076	0.2041
FACTOR5	156	0.0432	-0.0002	-0.1487	0.1194	0.2686	0.0324	0.3800	0.9862	0.1614	-0.0070	-0.0400

TABLE XXXV CONTINUED

		ESL 15	FOURTH 16	FINAL 17	AGE 18	SEX 19	GRADE 20	YEARS 21	MONTHS 22	G1 23	G2 24	G3 25
ESL	15	1.0000										
FOURTH	16	0.0065	1.0000									
FINAL	17	0.0749	0.0606	1.0000								
AGE	18	0.1195	0.0065	0.0371	1.0000							
SEX	19	0.0573	0.0588	0.0107	0.0340	1.0000						
GRADE	20	0.0445	0.0311	0.0614	0.4323	-0.0003	1.0000					
YEARS	21	[illegible]	-0.0770	-0.1054	-0.3364	-0.0358	-0.3638	1.0000				
MONTHS	22	-0.0201	-0.0426	-0.0645	-0.4523	-0.0199	-0.5142	0.8374	1.0000			
G1	23	-0.1407	0.2210	0.2548	-0.0347	0.0119	0.0214	-0.1963	-0.1447	1.0000		
G2	24	-0.0147	0.1791	0.1830	0.1184	-0.0208	0.1312	-0.1977	-0.2019	0.3300	1.0000	
G3	25	-0.1142	0.2712	0.2641	0.0408	-0.0834	0.0831	-0.1208	-0.1499	0.3964	0.2799	1.0000
GA	26	-0.0009	0.1924	0.2660	0.1240	0.0591	0.1295	-0.1402	-0.1709	0.3541	0.3867	0.3238
IQ	27	-0.0877	0.2499	0.2977	0.1074	-0.0041	0.1492	-0.2387	-0.2581	0.6372	0.7221	0.6079
V1	28	-0.2861	0.1967	0.2116	0.4172	0.0014	0.5237	-0.0231	-0.0384	0.2082	0.1324	0.1510
GUESS1	29	0.0166	-0.0865	-0.1195	-0.5248	-0.0176	-0.6008	0.2518	0.3078	-0.1509	-0.1418	-0.1709
V2	30	-0.0857	0.2534	0.3000	0.2865	0.0070	0.3484	-0.2058	-0.1955	0.2683	0.2590	0.2175
GUESS2	31	0.0548	-0.1142	-0.1566	-0.4311	-0.0478	-0.4750	0.4211	0.4099	-0.1832	-0.2259	-0.2403
INDUCT	32	-0.0158	0.2090	0.3799	0.0659	-0.0770	0.1023	0.0272	0.0220	0.3331	0.2259	0.2655
GUESS3	33	0.1666	-0.0800	-0.1078	0.0113	0.0550	-0.0065	-0.1564	-0.1936	-0.0717	-0.0022	-0.0349
DSCALE	34	-0.0083	-0.0524	-0.0693	-0.1449	-0.0121	-0.1710	-0.2486	-0.2702	0.0362	0.0772	0.0558
XSCALE	35	0.0125	-0.0054	0.0340	0.0761	0.0453	0.0459	0.0325	0.0467	-0.0653	0.0247	-0.1014
TOTAL1	119	0.1098	0.1950	0.2968	0.3581	-0.0159	0.4046	-0.3672	-0.4062	0.2335	0.2888	0.1998
TOTAL2	120	-0.0013	0.3853	0.2816	0.3933	0.0345	0.4337	-0.4155	-0.3411	0.3079	0.3268	0.2423
CITY1	123	-0.1095	0.2853	0.3424	0.3282	0.0277	0.4081	-0.2081	-0.2356	0.5113	0.4275	0.4231
SCHOOL1	124	-0.0958	0.2391	0.2741	0.3954	0.0005	0.4931	-0.1136	-0.1190	0.2562	0.2057	0.1979
FACTOR1	152	0.1286	0.0866	0.1144	0.0223	-0.0119	0.0094	-0.2836	-0.2983	0.0837	-0.0067	0.0425
FACTOR2	153	-0.1146	0.2776	0.3513	0.1031	0.0014	0.1213	-0.2504	-0.2561	0.7201	0.6466	0.6491
FACTOR3	154	-0.0532	0.1555	0.1721	0.3523	0.0356	0.4436	-0.0750	-0.1069	0.1001	0.0481	0.0401
FACTOR4	155	0.0707	-0.0607	-0.0459	0.2834	-0.1767	0.3355	-0.3739	-0.4617	0.0373	0.0354	0.0767
FACTOR5	156	0.0178	-0.0446	-0.0361	-0.2848	0.0524	-0.3034	0.2946	0.3366	-0.0826	-0.0863	-0.0290

TABLE XXXV CONTINUED

		G4 26	IQ 27	V1 28	GUESS1 29	V2 30	GUESS2 31	INDUCT 32	GUESS3 33	DSCALE 34	XSCALE 35	TOTAL1 119
G4	26	1.0000										
IQ	27	0.0459	1.0000									
V1	28	0.1915	0.2126	1.0000								
GUESS1	29	-0.2332	-0.2166	-0.0641	1.0000							
V2	30	0.2307	0.3309	0.6389	-0.4099	1.0000						
GUESS2	31	-0.2306	-0.2948	-0.2490	0.6671	-0.4636	1.0000					
INDUCT	32	0.2549	0.3796	0.2180	-0.1092	0.1983	-0.1707	1.0000				
GUESS3	33	-0.0546	-0.0516	-0.0687	0.0608	0.0645	0.0683	-0.8035	1.0000			
DSCALE	34	0.0427	0.0869	0.2534	0.1415	-0.0262	-0.0348	-0.2254	0.1609	1.0000		
XSCALE	35	0.0428	-0.0388	0.0638	0.0269	0.0515	-0.0065	-0.0743	0.0376	0.0762	.0000	
TOTAL1	119	0.2346	0.3388	0.3528	-0.2925	0.5075	-0.3642	0.2662	0.0246	0.0336	-0.0270	1.0000
TOTAL2	120	0.2685	0.3811	0.4907	-0.4185	0.4861	-0.3659	0.1658	-0.0333	-0.0361	-0.0293	0.4360
CITY1	123	0.5196	0.5917	0.6250	-0.6271	0.7005	-0.4008	0.3553	-0.0292	-0.1095	0.0409	0.4895
SCHOOL1	124	0.2315	0.2894	0.9312	-0.6150	0.8733	-0.3788	0.2281	-0.0403	-0.1678	0.0640	0.4617
FACTOR1	152	0.1354	0.0929	-0.1372	-0.0258	-0.0002	-0.1056	-0.0488	0.1674	0.2696	0.0546	0.0746
FACTOR2	153	0.6802	0.8702	0.2084	-0.2414	0.3919	-0.3465	0.4134	-0.0274	0.1521	-0.0271	0.3781
FACTOR3	154	0.1421	0.0864	0.9271	-0.6375	0.6141	-0.2639	0.1394	-0.0166	-0.2670	0.0760	0.3455
FACTOR4	155	0.0141	0.0441	0.0130	-0.1762	0.0559	-0.2801	-0.0679	0.1737	0.0897	-0.1009	0.2974
FACTOR5	156	-0.0018	-0.1013	-0.0752	0.2007	-0.1234	0.2272	-0.0069	-0.0374	-0.0987	0.0702	-0.1325

		TOTAL2 120	CITY1 123	SCHOOL1 124	FACTOR1 152	FACTOR2 153	FACTOR3 154	FACTOR4 155	FACTOR5 156
TOTAL2	120	1.0000							
CITY1	123	0.5996	1.0000						
SCHOOL1	124	0.5300	0.8524	1.0000					
FACTOR1	152	0.1104	0.0097	-0.0878	1.0000				
FACTOR2	153	0.4505	0.6585	0.3148	0.0703	1.0000			
FACTOR3	154	0.4334	0.7973	0.8772	-0.0435	0.0707	1.0000		
FACTOR4	155	0.0493	0.0499	0.0342	0.0988	0.0622	0.0163	1.0000	
FACTOR5	156	-0.2694	-0.0199	-0.1052	-0.0515	-0.0372	0.0035	0.0293	1.0000

FREQUENCY TABLE

		INVOLVE 4	AFFILIAT 5	SUPPORT 6	TASK 7	COMPETE 8	ORDER 9	RULE 10	CONTROL 11	INNOVATE 12	RACE 13	LD 14
INVOLVE	4	424										
AFFILIAT	5	424	424									
SUPPORT	6	424	424	424								
TASK	7	424	424	424	424							
COMPETE	8	424	424	424	424	424						
ORDER	9	424	424	424	424	424	424					
RULE	10	423	423	423	423	423	423	423				
CONTROL	11	424	424	424	424	424	424	423	424			
INNOVATE	12	424	424	424	424	424	424	423	424	424		
RACE	13	424	424	424	424	424	424	423	424	424	505	
LD	14	424	424	424	424	424	424	423	424	424	505	505
ESL	15	424	424	424	424	424	424	423	424	424	505	505
FOURTH	16	326	326	326	326	326	326	325	326	326	355	355
FINAL	17	317	317	317	317	317	317	316	317	317	343	343
AGE	18	422	422	422	422	422	422	421	422	422	486	486
SEX	19	424	424	424	424	424	424	423	424	424	497	497
GRADE	20	424	424	424	424	424	424	423	424	424	497	497
YEARS	21	424	424	424	424	424	424	423	424	424	505	505
MONTHS	22	424	424	424	424	424	424	423	424	424	505	505
G1	23	385	385	385	385	385	385	384	385	385	448	448
G2	24	385	385	385	385	385	385	384	385	385	448	448
G3	25	385	385	385	385	385	385	384	385	385	448	448
G4	26	385	385	385	385	385	385	384	385	385	448	448
IQ	27	385	385	385	385	385	385	384	385	385	448	448
V1	28	373	373	373	373	373	373	372	373	373	432	432
GUESS1	29	424	424	424	424	424	424	423	424	424	505	505
V2	30	374	374	374	374	374	374	373	374	374	433	433
GUESS2	31	424	424	424	424	424	424	423	424	424	505	505
INDUCT	32	131	131	131	131	131	131	131	131	131	165	165
GUESS3	33	424	424	424	424	424	424	423	424	424	505	505
DSCALE	34	424	424	424	424	424	424	423	424	424	505	505
XSCALE	35	424	424	424	424	424	424	423	424	424	505	505
TOTAL1	119	351	351	351	351	351	351	350	351	351	397	397
TOTAL2	120	267	267	267	267	267	267	266	267	267	313	313
CITY1	123	372	372	372	372	372	372	372	372	372	372	372
SCHOOL1	124	373	373	373	373	373	373	372	373	373	431	431
FACTOR1	152	372	372	372	372	372	372	372	372	372	372	372
FACTOR2	153	372	372	372	372	372	372	372	372	372	372	372
FACTOR3	154	372	372	372	372	372	372	372	372	372	372	372
FACTOR4	155	372	372	372	372	372	372	372	372	372	372	372
FACTOR5	156	372	372	372	372	372	372	372	372	372	372	372

		ESL 15	FOURTH 16	FINAL 17	AGE 18	SEX 19	GRADE 20	YEARS 21	MONTHS 22	G1 23	G2 24	G3 25
ESL	15	505										
FOURTH	16	355	355									
FINAL	17	343	341	343								
AGE	18	486	346	335	486							
SEX	19	497	352	341	486	497						
GRADE	20	497	352	341	486	497	497					
YEARS	21	505	355	343	486	497	497	505				
MONTHS	22	505	355	343	486	497	497	505	505			
G1	23	448	320	309	447	448	448	448	448	448		
G2	24	448	320	309	447	448	448	448	448	448	448	
G3	25	448	320	309	447	448	448	448	448	448	448	448
G4	26	448	320	309	447	448	448	448	448	448	448	448
IQ	27	448	320	309	447	448	448	448	448	448	448	448
V1	28	432	317	306	431	432	432	432	432	431	431	431
GUESS1	29	505	355	343	486	497	497	505	505	448	448	448
V2	30	433	317	306	432	433	433	433	433	430	430	430
GUESS2	31	505	355	343	486	497	497	505	505	448	448	448
INDUCT	32	165	106	106	165	165	165	165	165	162	162	162
GUESS3	33	505	355	343	486	497	497	505	505	448	448	448
DSCALE	34	505	355	343	486	497	497	505	505	448	448	448
XSCALE	35	505	355	343	486	497	497	505	505	448	448	448
TOTAL1	119	397	301	290	382	391	391	397	397	352	352	352
TOTAL2	120	313	258	252	303	311	311	313	313	278	278	278
CITY1	123	372	293	284	372	372	372	372	372	372	372	372
SCHOOL1	124	431	317	306	430	431	431	431	431	430	430	430
FACTOR1	152	372	293	284	372	372	372	372	372	372	372	372
FACTOR2	153	372	293	284	372	372	372	372	372	372	372	372
FACTOR3	154	372	293	284	372	372	372	372	372	372	372	372
FACTOR4	155	372	293	284	372	372	372	372	372	372	372	372
FACTOR5	156	372	293	284	372	372	372	372	372	372	372	372

		G4 26	10 27	V1 28	GUESS1 29	V2 30	GUESS2 31	INDUCT 32	GUESS3 33	DSCALE 34	XSCALE 35	TOTAL1 119
G4	26	448										
IQ	27	448	448									
V1	28	431	431	432								
GUESS1	29	449	448	432	505							
V2	30	420	420	431	433	433						
GUESS2	31	448	448	432	505	433	505					
INDUCT	32	162	162	163	165	165	165	165				
GUESS3	33	448	448	432	505	433	505	165	505			
DSCALE	34	448	448	432	505	433	505	165	505	505		
XSCALE	35	448	448	432	505	433	505	165	505	505	505	
TOTAL1	119	352	352	347	397	349	397	137	397	397	397	397
TOTAL2	120	278	270	278	313	270	313	137	313	313	313	285
CITY1	123	372	372	372	372	372	372	130	372	372	372	315
SCHOOL1	124	430	430	431	431	431	431	163	431	431	431	347
FACTOR1	152	372	372	372	372	372	372	130	372	372	372	315
FACTOR2	153	372	372	372	372	372	372	130	372	372	372	315
FACTOR3	154	372	372	372	372	372	372	130	372	372	372	315
FACTOR4	155	372	372	372	372	372	372	130	372	372	372	315
FACTOR5	156	372	372	372	372	372	372	130	372	372	372	315

		TOTAL2 120	CITY1 123	SCHOOL1 124	FACTOR1 152	FACTOR2 153	FACTOR3 154	FACTOR4 155	FACTOR5 156
TOTAL2	120	313							
CITY1	123	239	372						
SCHOOL1	124	278	372	431					
FACTOR1	152	239	372	372	372				
FACTOR2	153	239	372	372	372	372			
FACTOR3	154	239	372	372	372	372	372		
FACTOR4	155	239	372	372	372	372	372	372	
FACTOR5	156	230	372	372	372	372	372	372	372

TABLE XXXVI

CORRELATION MATRIX FOR THE EXPERIMENTAL GROUP

ESTIMATES OF CORRELATIONS - ALLVALUE

		ABILITY 1	INVOLVE 4	AFFILIAT 5	SUPPORT 6	TASK 7	COMPETE 8	ORDER 9	RULE 10	CONTROL 11	INNOVATE 12	RACE 13
ABILITY	1	1.0000										
INVOLVE	4	-0.2203	1.0000									
AFFILIAT	5	-0.1475	0.5451	1.0000								
SUPPORT	6	0.0456	0.5074	0.4489	1.0000							
TASK	7	-0.1235	0.0313	-0.0206	-0.1356	1.0000						
COMPETE	8	-0.1448	0.0902	0.1070	-0.0423	0.1674	1.0000					
ORDER	9	-0.2026	0.2569	0.1124	0.0381	0.3407	-0.0129	1.0000				
RULE	10	-0.0411	0.0199	0.1006	0.0790	0.3047	0.0525	0.2896	1.0000			
CONTROL	11	-0.1645	0.0197	-0.0574	-0.0329	0.2966	0.2401	0.2014	0.4468	1.0000		
INNOVATE	12	-0.0637	0.5713	0.4006	0.5634	-0.2222	0.0370	0.0749	-0.0399	0.0218	1.0000	
RACE	13	0.1043	0.1204	0.0916	0.0813	-0.1293	-0.0057	-0.0950	-0.0229	-0.0603	0.1005	1.0000
LD	14	-0.1350	0.4214	0.3122	0.2125	0.0007	0.0395	0.2133	-0.0048	0.0351	0.2876	-0.1723
ESL	15	-0.0470	0.1309	0.0753	0.0743	-0.1011	0.0249	0.0112	0.0133	-0.0043	0.1319	0.5506
FOURTH	16	0.2087	-0.0819	0.1911	-0.0051	-0.2489	-0.0112	-0.1238	0.0161	-0.1310	0.0256	-0.0287
FINAL	17	0.1792	-0.0457	0.2405	0.0677	-0.3171	-0.0016	-0.1079	0.0725	-0.1000	0.1210	0.0741
AGE	18	0.2981	-0.4089	-0.3130	-0.2114	0.0766	-0.0262	-0.1942	0.0809	-0.0161	-0.2790	0.2201
SEX	19	0.0110	0.0823	-0.0470	0.0195	-0.1940	-0.0996	-0.1053	-0.1093	-0.0727	0.0992	0.0804
GRADE	20	0.4820	-0.4707	-0.3260	-0.2890	0.0781	-0.0344	-0.2072	0.1065	-0.0354	-0.3596	0.1190
YEARS	21	0.2293	-0.4329	-0.2926	-0.3062	0.1880	0.0476	-0.1714	0.0902	-0.0053	-0.3459	0.0450
MONTHS	22	0.4842	-0.3797	-0.2665	-0.2148	-0.0094	-0.0467	-0.2138	0.0656	-0.0918	-0.2680	0.1153
G1	23	0.4150	0.1143	0.1309	0.1368	-0.0823	-0.1429	0.0863	-0.0400	-0.1406	0.1614	-0.1200
G2	24	0.3124	0.0001	-0.0964	0.0504	-0.1976	-0.1015	-0.0085	-0.1661	-0.2303	-0.0145	-0.0264
G3	25	0.4212	-0.0054	0.0502	0.0520	-0.0653	-0.1063	-0.0053	-0.0176	-0.0342	0.0365	0.0655
G4	26	0.3012	0.0239	0.0086	0.1326	-0.1577	-0.0422	-0.0043	-0.0693	-0.1670	0.1123	0.0585
IQ	27	0.4071	0.0613	0.0536	0.1463	-0.2086	-0.1000	-0.0700	-0.1468	-0.2012	0.1142	0.0075
V1	28	0.1254	-0.3803	-0.2588	-0.0993	-0.0450	-0.0987	-0.2855	-0.0103	-0.1762	-0.2049	0.0200
GUESS1	29	-0.1581	0.2447	0.1610	0.0342	-0.0137	0.0724	0.1657	-0.0333	0.0869	0.1340	-0.1227
V2	30	0.7216	-0.1970	-0.0664	0.0775	-0.1833	-0.1666	-0.2010	0.0105	-0.2398	-0.0702	-0.0487
GUESS2	31	-0.2119	0.0077	0.0621	-0.0554	0.0008	0.1310	0.0511	-0.1361	0.0291	-0.0192	-0.0652
INDUCT	32	0.4547	-0.0143	-0.0096	0.0060	-0.1190	-0.1159	-0.0940	-0.0199	-0.1378	0.1148	0.0971
GUESS3	33	-0.2273	0.1611	0.0018	0.1174	-0.0064	-0.0398	0.0392	-0.0217	0.0593	0.1370	0.0579
OSCALE	34	-0.4213	0.3620	0.2638	0.1871	-0.0378	0.0301	0.1714	-0.1205	0.0416	0.2780	-0.0794
XSCALE	35	0.0012	0.0017	0.0324	-0.0660	-0.2823	-0.0964	-0.2754	-0.1159	-0.0253	0.0090	0.0467
TOTAL1	119	0.5569	-0.3096	-0.1605	-0.1024	-0.2820	-0.1003	-0.3329	-0.0542	-0.2150	-0.1330	0.0577
TOTAL2	120	0.5274	-0.0229	0.0374	0.0679	-0.4212	-0.1991	-0.2524	0.0204	-0.2935	0.1404	0.1087
FACTOR1	152	-0.1122	0.0287	0.7330	0.7834	-0.2313	0.0170	0.0946	0.0228	-0.0791	0.8293	0.1595
FACTOR2	153	0.5275	0.0966	0.0621	0.1242	-0.2011	-0.1582	0.0965	-0.1371	-0.1602	0.1698	0.0244
FACTOR3	154	0.8332	-0.3221	-0.2140	-0.0272	-0.0250	-0.0674	-0.3017	0.0408	-0.1128	-0.1379	-0.0108
FACTOR4	155	-0.2513	0.1466	0.0055	-0.1080	0.7329	0.1117	0.8262	0.4917	0.3261	-0.3040	-0.1710
FACTOR5	156	0.0207	0.1486	0.0651	0.1301	0.2251	0.2146	0.2301	0.4555	0.9621	0.1801	-0.0121

TABLE XXXVI CONTINUED

		LD 14	ESL 15	FOURTH 16	FINAL 17	AGE 18	SEX 19	GRADE 20	YEARS 21	MONTHS 22	G1 23	G2 24
LD	14	1.0000										
ESL	15	-0.1520	1.0000									
FOURTH	16	0.0045	0.0800	1.0000								
FINAL	17	0.0016	0.1547	0.9281	1.0000							
AGE	18	-0.1786	0.2427	0.0122	-0.0058	1.0000						
SEX	19	0.0378	0.0082	0.0793	0.0804	0.0306	1.0000					
GRADE	20	-0.5562	0.1042	0.0022	-0.0262	0.9274	-0.0466	1.0000				
YEARS	21	-0.6415	0.0394	-0.0506	-0.0681	0.6802	-0.1227	0.7207	1.0000			
MONTHS	22	-0.7677	0.0721	0.0532	0.0445	0.7071	-0.1109	0.7525	0.7889	1.0000		
G1	23	-0.0132	-0.1867	0.2505	0.2701	-0.0731	-0.0474	0.0119	-0.0142	0.0680	1.0000	
G2	24	-0.1279	0.0186	0.1696	0.1311	0.0911	0.0330	0.1121	0.0397	0.1506	0.2584	1.0000
G3	25	-0.1061	-0.0679	0.2009	0.2221	0.0015	-0.0740	0.0963	0.0027	0.0512	0.5012	0.2672
G4	26	-0.0912	-0.0318	0.1036	0.1633	0.0562	0.0472	0.0667	-0.0147	0.0826	0.2755	0.3300
IQ	27	-0.0955	-0.0729	0.2713	0.2821	0.0244	-0.0221	0.0846	-0.0072	0.0999	0.6279	0.7200
V1	28	-0.1070	-0.0359	0.1018	0.1710	0.0466	-0.0492	0.7700	0.5594	0.6779	0.1196	0.1373
GUESS1	29	0.6515	-0.0566	0.0143	0.0142	-0.5958	0.0149	-0.6324	-0.3909	-0.4665	-0.0386	-0.0967
V2	30	-0.4742	-0.0653	0.3423	0.3251	0.3319	-0.0232	0.4452	0.3202	0.4163	0.3038	0.2399
GUESS2	31	0.2234	0.0717	-0.0847	-0.0919	-0.1088	-0.0604	-0.2129	-0.0737	-0.1339	-0.1908	-0.1642
INDUCT	32	-0.3646	0.0462	0.3279	0.3423	0.1962	-0.1627	0.3237	0.2436	0.3139	0.4373	0.4569
GUESS3	33	0.3397	0.1365	-0.0747	-0.0212	-0.2602	0.1593	-0.3618	-0.2403	-0.2002	-0.2588	-0.2694
DSCALE	34	0.6240	-0.0355	-0.0664	-0.1040	-0.5653	0.0127	-0.6217	-0.4941	-0.5440	-0.1058	-0.0918
XSCALE	35	-0.1106	0.0579	-0.0763	0.0373	0.1455	0.0721	0.1372	0.0489	0.1202	-0.0695	0.0366
TOTAL1	119	-0.5293	0.0463	0.5005	0.5534	0.3856	0.0346	0.4444	0.2539	0.5155	0.7052	0.1736
TOTAL2	120	-0.4225	0.1593	0.6089	0.6833	0.2837	0.0108	0.3389	0.2131	0.4759	0.1446	0.7183
FACTOR1	152	0.3828	0.1448	0.0743	0.1362	-0.3939	0.0653	-0.4699	-0.4518	-0.3522	0.1517	-0.0231
FACTOR2	153	-0.0026	-0.0443	0.2561	0.2884	-0.0689	-0.0061	-0.0381	-0.1105	0.0146	0.7345	0.5843
FACTOR3	154	-0.6325	-0.0264	0.1494	0.1409	0.5133	0.0252	0.5930	0.4594	0.5602	0.0101	-0.0117
FACTOR4	155	0.1321	-0.0595	-0.1502	-0.2109	-0.0110	-0.1953	-0.0098	0.0060	-0.1162	-0.0627	-0.1714
FACTOR5	156	-0.0026	-0.0074	-0.0510	-0.0068	-0.0224	-0.0224	-0.0317	-0.0438	-0.0644	-0.0033	-0.1596

		G3 25	G4 26	IQ 27	V1 28	GUESS1 29	V2 30	GUESS2 31	INDUCT 32	GUESS3 33	DSCALE 34	XSCALE 35
G3	25	1.0000										
G4	26	0.2427	1.0000									
IQ	27	0.2496	0.6215	1.0000								
V1	28	0.1907	0.1300	0.1775	1.0000							
GUESS1	29	-0.1279	-0.0850	-0.0870	-0.7072	1.0000						
V2	30	0.2714	0.1431	0.3078	0.6963	-0.3791	1.0000					
GUESS2	31	-0.2701	-0.1375	-0.2068	-0.2075	0.4026	-0.3437	1.0000				
INDUCT	32	0.4600	0.3869	0.5646	0.3556	-0.2341	0.4288	-0.2952	1.0000			
GUESS3	33	-0.3157	-0.2938	-0.3360	-0.3009	0.2685	-0.3220	0.3869	-0.7664	1.0000		
DSCALE	34	-0.0300	-0.0731	-0.0946	-0.5131	0.4158	-0.3423	0.1893	-0.3621	0.2995	1.0000	
XSCALE	35	-0.0101	0.0085	0.0104	0.0977	-0.0254	0.0045	-0.0334	-0.0059	0.0026	0.0288	1.0000
TOTAL1	119	0.1614	0.0953	0.1064	0.5900	-0.4228	0.5917	-0.3815	0.3144	-0.3360	-0.3675	-0.0056
TOTAL2	120	0.1720	0.0623	0.1976	0.4793	-0.3153	0.4460	-0.2094	0.2687	-0.1992	-0.2804	-0.0309
FACTOR1	152	0.0069	0.1191	0.1086	-0.2848	0.1888	-0.0674	0.0114	0.0691	-0.1655	0.3438	0.0260
FACTOR2	153	0.7166	0.6316	0.8953	0.0007	-0.0135	0.2972	-0.2243	0.5293	-0.2139	0.0344	-0.0098
FACTOR3	154	0.0374	0.0574	-0.0096	0.9186	-0.6478	0.6569	-0.2257	0.1904	-0.1282	-0.5180	0.0866
FACTOR4	155	-0.0944	-0.1725	-0.2291	-0.1903	0.1359	-0.2096	0.1211	-0.1774	0.0273	0.0502	-0.3233
FACTOR5	156	0.0647	-0.0575	-0.0623	-0.0358	0.0167	-0.0863	-0.0057	-0.0156	0.0547	0.0207	0.0000

TABLE XXXVI CONTINUED

		TOTAL1 119	TOTAL2 120	FACTOR1 152	FACTOR2 153	FACTOR3 154	FACTOR4 155	FACTOR5 156
TOTAL1	119	1.0000						
TOTAL2	120	0.6309	1.0000					
FACTOR1	152	-0.1828	0.1347	1.0000				
FACTOR2	153	0.1847	0.2196	0.1189	1.0000			
FACTOR3	154	0.5350	0.4775	-0.2094	-0.0303	1.0000		
FACTOR4	155	-0.3439	-0.3710	-0.1633	-0.1509	-0.1974	1.0000	
FACTOR5	156	-0.1288	-0.1342	0.0967	-0.0226	0.0391	0.2202	1.0000

FREQUENCY TABLE

	ABILITY 1	INVOLVE 4	AFFILIAT 5	SUPPORT 6	TASK 7	COMPETE 8	ORDER 9	RULE 10	CONTROL 11	INNOVATE 12	RACE 13
ABILITY 1	171										
INVOLVE 4	171	183									
AFFILIAT 5	171	183	183								
SUPPORT 6	171	183	183	183							
TASK 7	171	183	183	183	183						
COMPETE 8	171	183	183	183	183	183					
ORDER 9	171	183	183	183	183	183	183				
RULE 10	171	183	183	183	183	183	183	183			
CONTROL 11	171	183	183	183	183	183	183	183	183		
INNOVATE 12	171	183	183	183	183	183	183	183	183	183	
RACE 13	171	183	183	183	183	183	183	183	183	183	239
ED 14	171	183	183	183	183	183	183	183	183	183	239
ESL 15	171	183	183	183	183	183	183	183	183	183	239
FOURTH 16	126	146	146	146	146	146	146	146	146	146	100
FINAL 17	127	136	136	136	136	136	136	136	136	136	147
AGE 18	171	182	182	182	182	182	182	182	182	182	229
SEX 19	171	183	183	183	183	183	183	183	183	183	237
GRADE 20	171	183	183	183	183	183	183	183	183	183	237
YEARS 21	171	183	183	183	183	183	183	183	183	183	239
MONTHS 22	171	183	183	183	183	183	183	183	183	183	239
G1 23	171	174	174	174	174	174	174	174	174	174	220
G2 24	171	174	174	174	174	174	174	174	174	174	220
G3 25	171	174	174	174	174	174	174	174	174	174	220
G4 26	171	174	174	174	174	174	174	174	174	174	220
IQ 27	171	174	174	174	174	174	174	174	174	174	220
V1 28	171	172	172	172	172	172	172	172	172	172	218
GUESS1 29	171	183	183	183	183	183	183	183	183	183	239
V2 30	171	173	173	173	173	173	173	173	173	173	219
GUESS2 31	171	183	183	183	183	183	183	183	183	183	239
INDUCT 32	95	97	97	97	97	97	97	97	97	97	135
GUESS3 33	171	183	183	183	183	183	183	183	183	183	239
DSCALE 34	171	183	183	183	183	183	183	183	183	183	239
XSCALE 35	171	183	183	183	183	183	183	183	183	183	239
TOTAL1 119	140	148	148	148	148	148	148	148	148	148	179
TOTAL2 120	93	99	99	99	99	99	99	99	99	99	142
FACTOR1 152	171	171	171	171	171	171	171	171	171	171	171
FACTOR2 153	171	171	171	171	171	171	171	171	171	171	171
FACTOR3 154	171	171	171	171	171	171	171	171	171	171	171
FACTOR4 155	171	171	171	171	171	171	171	171	171	171	171
FACTOR5 156	171	171	171	171	171	171	171	171	171	171	171

		LD 14	ESL 15	FOURTH 16	FINAL 17	AGE 18	SEX 19	GRADE 20	YEARS 21	MONTHS 22	G1 23	G2 24
LD	14	239										
ESL	15	239	239									
FOURTH	16	160	160	160								
FINAL	17	147	147	147	147							
AGE	18	229	229	155	143	229						
SEX	19	237	237	158	146	229	237					
GRADE	20	237	237	158	146	229	237	237				
YEARS	21	239	239	160	147	229	237	237	239			
MONTHS	22	239	239	160	147	229	237	237	239	239		
G1	23	220	220	150	139	219	220	220	220	220	220	
G2	24	220	220	150	139	219	220	220	220	220	220	220
G3	25	220	220	150	139	219	220	220	220	220	220	220
G4	26	220	220	150	139	219	220	220	220	220	220	220
IQ	27	220	220	150	139	219	220	220	220	220	220	220
V1	28	218	218	147	136	217	218	218	218	218	216	216
GUESS1	29	239	239	160	147	229	237	237	239	239	220	220
V2	30	219	219	147	136	218	219	219	219	219	215	215
GUESS2	31	239	239	160	147	229	237	237	239	239	220	220
INDUCT	32	135	135	64	64	135	135	135	135	135	131	131
GUESS3	33	239	239	160	147	229	237	237	239	239	220	220
DSCALE	34	239	239	160	147	229	237	237	239	239	220	220
XSCALE	35	239	239	160	147	229	237	237	239	239	220	220
TOTAL1	119	179	179	121	109	171	177	177	179	179	164	164
TOTAL2	120	142	142	76	69	133	140	140	142	142	128	120
FACTOR1	152	171	171	136	127	171	171	171	171	171	171	171
FACTOR2	153	171	171	136	127	171	171	171	171	171	171	171
FACTOR3	154	171	171	136	127	171	171	171	171	171	171	171
FACTOR4	155	171	171	136	127	171	171	171	171	171	171	171
FACTOR5	156	171	171	136	127	171	171	171	171	171	171	171

		G3 25	G4 26	IQ 27	V1 28	GUESS1 29	V2 30	GUESS2 31	INDUCT 32	GUESS3 33	DSCALE 34	XSCALE 35
G3	25	220										
G4	26	220	220									
IQ	27	220	220	220								
V1	28	216	216	216	218							
GUESS1	29	220	220	220	218	239						
V2	30	215	215	215	217	219	219					
GUESS2	31	220	220	220	218	239	219	239				
INDUCT	32	131	131	131	133	135	135	135	135			
GUESS3	33	220	220	220	218	239	219	239	135	239		
DSCALE	34	220	220	220	218	239	219	239	135	239	239	
XSCALE	35	220	220	220	218	239	219	239	135	239	239	239
TOTAL1	119	164	164	164	164	179	166	179	110	179	179	179
TOTAL2	120	120	128	128	129	142	130	142	112	142	142	142
FACTOR1	152	171	171	171	171	171	171	171	95	171	171	171
FACTOR2	153	171	171	171	171	171	171	171	95	171	171	171
FACTOR3	154	171	171	171	171	171	171	171	95	171	171	171
FACTOR4	155	171	171	171	171	171	171	171	95	171	171	171
FACTOR5	156	171	171	171	171	171	171	171	95	171	171	171

		TOTAL1 119	TOTAL2 120	FACTOR1 152	FACTOR2 153	FACTOR3 154	FACTOR4 155	FACTOR5 156
TOTAL1	119	179						
TOTAL2	120	124	142					
FACTOR1	152	140	93	171				
FACTOR2	153	140	93	171	171			
FACTOR3	154	140	93	171	171	171		
FACTOR4	155	140	93	171	171	171	171	
FACTOR5	156	140	93	171	171	171	171	171

TABLE XXXVII

CORRELATION MATRIX FOR THE CONTROL GROUP

ESTIMATES OF CORRELATIONS — ALLVALUE

		INVOLVE 4	AFFILIAT 5	SUPPORT 6	TASK 7	COMPETE 8	ORDER 9	RULE 10	CONTROL 11	INNOVATE 12	RACE 13	LD 14
INVOLVE	4	1.0000										
AFFILIAT	5	0.4320	1.0000									
SUPPORT	6	0.5448	0.4163	1.0000								
TASK	7	0.3605	0.0902	0.1705	1.0000							
COMPETE	8	0.1491	0.2166	-0.0611	0.2274	1.0000						
ORDER	9	0.5510	0.2094	0.3790	0.4603	0.1049	1.0000					
RULE	10	0.2846	0.2141	0.1983	0.2865	0.2139	0.2852	1.0000				
CONTROL	11	-0.1767	-0.1547	-0.4109	0.3682	0.2991	-0.0601	0.3428	1.0000			
INNOVATE	12	0.2491	0.3632	0.2590	-0.0167	0.1460	0.0547	0.1869	0.0578	1.0000		
RACE	13	-0.0337	-0.0887	-0.0424	-0.0202	-0.0685	-0.0457	0.0447	0.0312	-0.0407	1.0000	
LD	14	-0.0039	0.0736	0.0801	-0.0117	-0.0162	0.0515	-0.0664	-0.0340	-0.0975	0.0050	1.0000
ESL	15	0.1517	-0.0565	0.0539	0.0926	-0.0064	0.0507	0.1612	0.0802	0.0272	0.0112	-0.0081
FOURTH	16	0.1789	0.1445	0.2254	0.1292	0.0159	0.0923	-0.0066	-0.2210	0.0703	-0.0210	-0.0105
FINAL	17	0.1025	0.1408	0.1408	0.0504	-0.0128	0.0477	0.0259	-0.1677	0.1535	-0.0017	-0.1274
AGE	18	0.3964	0.1446	0.4991	0.2071	-0.0811	0.3540	-0.0987	-0.4853	-0.0340	-0.0964	0.0681
SEX	19	-0.0262	-0.0540	-0.1121	-0.0806	-0.0107	0.0045	-0.1258	0.0733	0.0320	-0.0510	-0.0612
GRADE	20	0.4534	0.1932	0.5713	0.2757	-0.0303	0.3976	-0.0803	-0.5355	-0.0296	-0.0832	0.0470
YEARS	21	-0.2513	-0.1609	-0.3835	-0.2168	-0.0261	-0.3142	0.1330	0.4441	0.0448	0.1748	-0.0199
MONTHS	22	-0.3116	-0.1433	-0.4304	-0.2297	0.0800	-0.3372	0.1016	0.5017	0.0360	0.1044	-0.0321
G1	23	-0.0366	-0.0415	0.0127	0.0372	-0.0740	-0.0083	-0.1620	-0.1875	0.0275	0.0223	0.0167
G2	24	-0.0366	-0.0241	-0.0027	0.0091	0.0628	0.0222	-0.1031	-0.1042	0.0835	0.0060	-0.0015
G3	25	0.0149	0.0731	0.0750	0.1030	-0.0996	0.0076	0.0113	-0.1393	-0.0048	0.0088	0.0196
G4	26	0.0631	0.1156	0.0747	0.0722	0.0949	0.0096	-0.0430	-0.0886	0.1017	-0.0839	0.0488
IQ	27	0.0024	0.0288	0.0711	0.0835	-0.0142	0.0371	-0.1533	-0.2159	0.0622	0.0090	0.0118
V1	28	0.0021	0.0397	0.1703	0.0949	-0.0623	0.1397	-0.1212	-0.2548	-0.1076	0.0711	-0.0085
GUESS1	29	-0.2198	-0.1041	-0.2838	-0.1684	0.0284	-0.2599	-0.0071	0.3717	0.1014	0.1152	0.0649
V2	30	-0.0191	0.0095	0.0809	0.0409	0.0032	0.0474	-0.2433	-0.2291	-0.0083	0.0765	-0.0178
GUESS2	31	-0.2104	0.0011	-0.2407	-0.1782	0.0288	-0.2609	0.0624	0.3367	0.0785	0.1039	0.0337
INDUCT	32	-0.1707	-0.3715	-0.1902	0.0838	-0.1428	0.0104	-0.1362	-0.0571	-0.1618	-0.1692	0.1501
GUESS3	33	0.0759	-0.0114	0.2175	0.1799	0.0257	0.0858	-0.0463	-0.1034	-0.1302	0.0431	0.0588
DSCALE	34	0.1142	0.0821	0.1596	-0.0015	-0.0503	0.0776	-0.0619	-0.1647	0.1122	0.1725	-0.0209
XSCALE	35	0.1021	0.0671	0.0007	-0.0003	0.0092	0.0912	0.0530	0.0721	0.1966	0.0183	-0.0132
TOTAL1	119	0.0954	0.0212	0.0821	0.0812	-0.0616	0.2071	-0.1766	-0.1935	-0.0078	0.0382	0.0283
TOTAL2	120	0.1413	0.1735	0.2208	0.1460	0.0260	0.2644	-0.2205	-0.4332	0.0079	-0.0347	-0.0462
CITY1	123	0.0603	0.0782	0.1523	0.1263	-0.0195	0.1683	-0.1434	-0.2062	0.0121	0.0293	0.0031
SCHOOL1	124	-0.0060	0.0291	0.1441	0.0783	-0.0369	0.1091	-0.1929	-0.2681	-0.1091	0.0209	-0.0114
FACTOR1	152	0.7316	0.7291	0.7722	0.0632	0.1340	0.3103	0.3263	-0.2877	0.0431	-0.0780	0.0209
FACTOR2	153	-0.0071	-0.0078	-0.0312	0.0871	-0.0090	0.0850	-0.2188	-0.1381	0.0394	0.0177	0.0309
FACTOR3	154	0.0995	0.1276	0.2644	0.1030	-0.0210	0.1744	-0.0043	-0.1802	-0.0202	0.0282	-0.0181
FACTOR4	155	0.5760	0.1405	0.3447	0.7351	0.1798	0.8586	0.4708	-0.0290	-0.1494	-0.0228	0.0401
FACTOR5	156	0.0041	-0.0545	-0.2814	0.1021	0.3214	-0.0080	0.3843	1.0068	0.1529	0.0317	-0.0404

TABLE XXXVII CONTINUED

	ESL 15	FOURTH 16	FINAL 17	AGE 18	SEX 19	GRADE 20	YEARS 21	MONTHS 22	G1 23	G2 24	G3 25
ESL 15	1.0000										
FOURTH 16	-0.0511	1.0000									
FINAL 17	-0.0384	0.8656	1.0000								
AGE 18	-0.0550	0.1271	0.0249	1.0000							
SEX 19	0.0276	0.0221	-0.0347	0.0437	1.0000						
GRADE 20	-0.0621	0.2003	0.0820	0.9217	0.0325	1.0000					
YEARS 21	0.0064	-0.1745	-0.1125	-0.5968	-0.0646	-0.6614	1.0000				
MONTHS 22	0.0338	-0.1861	-0.0724	-0.7410	-0.0631	-0.8411	0.8205	1.0000			
G1 23	-0.1070	0.2098	0.2472	-0.0262	0.0531	0.0386	-0.1805	-0.1014	1.0000		
G2 24	-0.0985	0.2466	0.2033	0.1337	-0.0387	0.1660	-0.1603	-0.1548	0.3541	1.0000	
G3 25	-0.1950	0.2678	0.2643	0.0557	-0.0875	0.1101	-0.0491	-0.0722	0.3732	0.2763	1.0000
G4 26	-0.1793	0.3041	0.3256	0.1536	0.0787	0.1795	-0.0989	-0.1423	0.3687	0.4122	0.3562
IQ 27	-0.1601	0.2961	0.2955	0.1438	0.0256	0.2121	-0.1964	-0.2131	0.6406	0.7059	0.5901
V1 28	-0.1522	0.2730	0.2438	0.1913	0.0253	0.2745	-0.2669	-0.2865	0.3692	0.2290	0.2212
GUESS1 29	0.1129	-0.2320	-0.1944	-0.4795	-0.0568	-0.5715	0.4533	0.5366	-0.2391	-0.1998	-0.2175
V2 30	-0.1619	0.2349	0.2426	0.2091	0.0202	0.2470	-0.2846	-0.2206	0.2447	0.2701	0.1967
GUESS2 31	0.1385	-0.2029	-0.1726	-0.5389	-0.0729	-0.6030	0.4633	0.5468	-0.1276	-0.1930	-0.1905
INDUCT 32	0.0	0.2262	0.3885	-0.0250	-0.0042	-0.0016	-0.0490	-0.0675	0.2657	0.1257	0.2956
GUESS3 33	-0.0361	-0.0579	-0.1966	0.1869	-0.0456	0.2143	-0.1059	-0.1571	0.0030	0.0749	0.0037
DSCALE 34	-0.0471	-0.0322	-0.0364	0.1739	0.0210	0.1714	-0.1581	-0.1907	0.0436	0.0403	0.0045
XSCALE 35	-0.0298	-0.0608	0.0346	0.0434	0.0173	-0.0018	0.0233	0.0283	-0.0408	0.3445	-0.1284
TOTAL1 119	-0.0626	0.2808	0.2511	0.2394	0.0634	0.3205	-0.3107	-0.2947	0.2208	0.2177	0.1079
TOTAL2 120	-0.1331	0.5814	0.5402	0.4481	0.0420	0.5111	-0.5617	-0.5111	0.3965	0.4117	0.2915
CITY1 123	-0.2413	0.3606	0.3467	0.1864	0.0324	0.2617	-0.2737	-0.2936	0.6124	0.4711	0.4505
SCHOOL1 124	-0.1680	0.2821	0.2678	0.2193	0.0254	0.2892	-0.3025	-0.2835	0.3455	0.2720	0.2317
FACTOR1 152	0.0976	0.1043	0.0788	0.3367	-0.0701	0.3991	-0.2479	-0.3217	-0.0472	-0.0544	0.0037
FACTOR2 153	-0.2592	0.3319	0.3569	0.1134	0.0129	0.1484	-0.1551	-0.1453	0.7428	0.6215	0.6283
FACTOR3 154	-0.1148	0.2261	0.1301	0.1742	0.0370	0.2552	-0.2671	-0.3056	0.2075	0.1163	0.0719
FACTOR4 155	0.1648	0.0635	-0.0300	0.3379	-0.0919	0.3962	-0.3273	-0.3492	-0.0305	-0.0416	0.0431
FACTOR5 156	0.0615	-0.0647	-0.0404	-0.4219	0.0952	-0.4586	0.3766	0.4329	-0.1063	-0.0236	-0.0592

TABLE XXXVII CONTINUED

		G4 26	IQ 27	V1 28	GUESS1 29	V2 30	GUESS2 31	INDUCT 32	GUESS3 33	DSCALE 34	XSCALE 35	TOTAL1 119
G4	26	1.0000										
IQ	27	0.6459	1.0000									
V1	28	0.2343	0.3659	1.0000								
GUESS1	29	-0.2526	-0.2273	-0.6074	1.0000							
V2	30	0.2880	0.3507	0.6447	-0.4044	1.0000						
GUESS2	31	-0.2569	-0.2732	-0.3509	0.0212	-0.4507	1.0000					
INDUCT	32	0.1417	0.2705	0.1531	-0.0306	0.0268	-0.1347	1.0000				
GUESS3	33	0.0127	0.0214	0.1338	-0.0294	0.1781	-0.0620	-0.0562	1.0000			
DSCALE	34	0.0216	0.0585	0.0605	-0.0780	0.1404	-0.0851	-0.3149	-0.0734	1.0000		
XSCALE	35	0.0199	-0.0500	0.0437	0.0547	0.0559	-0.0060	-0.0988	-0.0470	0.1182	1.0000	
TOTAL1	119	0.2295	0.2970	0.4268	-0.3100	0.4923	-0.2718	0.2280	0.0800	0.0437	0.0502	1.0000
TOTAL2	120	0.4074	0.5069	0.5657	-0.4676	0.5646	-0.4206	0.1924	0.0493	0.0979	-0.0242	0.6029
CITY1	123	0.5920	0.6624	0.8496	-0.0173	0.6353	-0.3907	0.1564	0.0812	0.0950	0.0419	0.4035
SCHOOL1	124	0.24[illegible]7	0.3955	0.9288	-0.5704	0.8920	-0.4348	0.1071	0.1608	0.1054	0.0540	0.4523
FACTOR1	152	0.1169	0.0041	0.0208	-0.1824	-0.0116	-0.1236	-0.3222	0.0671	0.1477	0.0843	0.0312
FACTOR2	153	0.6704	0.8325	0.3714	-0.3363	0.4203	-0.2989	0.3247	-0.0014	0.0896	-0.0153	0.3160
FACTOR3	154	0.2475	0.1258	0.9372	-0.0078	0.5603	-0.3047	-0.0020	0.1258	0.0591	0.0793	0.3996
FACTOR4	155	-0.0130	-0.0065	0.1011	-0.2539	0.0021	-0.2439	0.0061	0.2168	-0.0097	0.0356	0.1289
FACTOR5	156	0.0291	-0.1022	-0.1145	0.2962	-0.1290	0.2948	-0.0735	-0.1159	-0.1728	0.1023	-0.1371

		TOTAL2 120	CITY1 123	SCHOOL1 124	FACTOR1 152	FACTOR2 153	FACTOR3 154	FACTOR4 155	FACTOR5 156
TOTAL2	120	1.0000							
CITY1	123	0.6209	1.0000						
SCHOOL1	124	0.6223	0.8316	1.0000					
FACTOR1	152	0.0947	0.0559	0.0072	1.0000				
FACTOR2	153	0.5270	0.7687	0.4327	-0.0649	1.0000			
FACTOR3	154	0.4453	0.7765	0.8492	0.1497	0.1938	1.0000		
FACTOR4	155	0.1573	0.0694	0.0633	0.2451	-0.0407	0.1465	1.0000	
FACTOR5	156	-0.3035	-0.0331	-0.1331	-0.1531	-0.0200	-0.0310	-0.0052	1.0000

FREQUENCY TABLE

		INVOLVE 4	AFFILIAT 5	SUPPORT 6	TASK 7	COMPETE 8	ORDER 9	RULE 10	CONTROL 11	INNOVATE 12	RACE 13	LD 14
INVOLVE	4	245										
AFFILIAT	5	245	245									
SUPPORT	6	245	245	245								
TASK	7	245	245	245	245							
COMPETE	8	245	245	245	245	245						
ORDER	9	245	245	245	245	245	245					
RULE	10	244	244	244	244	244	244	244				
CONTROL	11	245	245	245	245	245	245	244	245			
INNOVATE	12	245	245	245	245	245	245	244	245	245		
RACE	13	245	245	245	245	245	245	244	245	245	280	
LD	14	245	245	245	245	245	245	244	245	245	280	280
ESL	15	245	245	245	245	245	245	244	245	245	280	280
FOURTH	16	180	180	180	180	180	180	179	180	180	195	193
FINAL	17	181	181	181	181	181	181	180	181	181	196	196
AGE	18	244	244	244	244	244	244	243	244	244	270	270
SEX	19	245	245	245	245	245	245	244	245	245	274	274
GRADE	20	245	245	245	245	245	245	244	245	245	274	274
YEARS	21	245	245	245	245	245	245	244	245	245	280	280
MONTHS	22	245	245	245	245	245	245	244	245	245	280	280
G1	23	214	214	214	214	214	214	213	214	214	240	240
G2	24	214	214	214	214	214	214	213	214	214	240	240
G3	25	214	214	214	214	214	214	213	214	214	240	240
G4	26	214	214	214	214	214	214	213	214	214	240	240
IQ	27	214	214	214	214	214	214	213	214	214	240	240
V1	28	205	205	205	205	205	205	204	205	205	227	227
GUESS1	29	245	245	245	245	245	245	244	245	245	280	280
V2	30	205	205	205	205	205	205	204	205	205	227	227
GUESS2	31	245	245	245	245	245	245	244	245	245	280	280
INDUCT	32	38	38	38	38	38	38	38	38	38	43	43
GUESS3	33	245	245	245	245	245	245	244	245	245	280	280
DSCALE	34	245	245	245	245	245	245	244	245	245	280	280
XSCALE	35	245	245	245	245	245	245	244	245	245	280	280
TOTAL1	119	207	207	207	207	207	207	206	207	207	231	231
TOTAL2	120	172	172	172	172	172	172	171	172	172	184	184
CITY1	123	204	204	204	204	204	204	204	204	204	204	204
SCHOOL1	124	205	205	205	205	205	205	204	205	205	227	227
FACTOR1	152	204	204	204	204	204	204	204	204	204	204	204
FACTOR2	153	204	204	204	204	204	204	204	204	204	204	204
FACTOR3	154	204	204	204	204	204	204	204	204	204	204	204
FACTOR4	155	204	204	204	204	204	204	204	204	204	204	204
FACTOR5	156	204	204	204	204	204	204	204	204	204	204	204

		ESL 15	FOURTH 16	FINAL 17	AGE 18	SEX 19	GRADE 20	YEARS 21	MONTHS 22	G1 23	G2 24	G3 25
ESL	15	280										
FOURTH	16	195	195									
FINAL	17	196	194	196								
AGE	18	270	191	192	270							
SEX	19	274	194	195	270	274						
GRADE	20	274	194	195	270	274	274					
YEARS	21	280	195	196	270	274	274	280				
MONTHS	22	280	195	196	270	274	274	280	280			
G1	23	240	170	170	240	240	240	240	240	240		
G2	24	240	170	170	240	240	240	240	240	240	240	
G3	25	240	170	170	240	240	240	240	240	240	240	240
G4	26	240	170	170	240	240	240	240	240	240	240	240
IQ	27	240	170	170	240	240	240	240	240	240	240	240
V1	28	227	170	170	227	227	227	227	227	227	227	227
GUESS1	29	280	195	196	270	274	274	280	280	240	240	240
V2	30	227	170	170	227	227	227	227	227	227	227	227
GUESS2	31	280	195	196	270	274	274	280	280	240	240	240
INDUCT	32	43	42	42	43	43	43	43	43	43	43	43
GUESS3	33	280	195	196	270	274	274	280	280	240	240	240
DSCALE	34	280	196	196	270	274	274	280	280	240	240	240
XSCALE	35	280	195	196	270	274	274	280	280	240	240	240
TOTAL1	119	231	180	181	223	227	227	231	231	199	199	199
TOTAL2	120	184	182	183	182	184	184	184	184	161	161	161
CITY1	123	204	157	157	204	204	204	204	204	204	204	204
SCHOOL1	124	227	170	170	227	227	227	227	227	227	227	227
FACTOR1	152	204	157	157	204	204	204	204	204	204	204	204
FACTOR2	153	204	157	157	204	204	204	204	204	204	204	204
FACTOR3	154	204	157	157	204	204	204	204	204	204	204	204
FACTOR4	155	204	157	157	204	204	204	204	204	204	204	204
FACTOR5	156	204	157	157	204	204	204	204	204	204	204	204

		G4 26	IQ 27	V1 28	GUESS1 29	V2 30	GUESS2 31	INDUCT 32	GUESS3 33	DSCALE 34	XSCALE 35	TOTAL1 119
G4	26	240										
IQ	27	240	240									
V1	28	227	227	227								
GUESS1	29	240	240	227	280							
V2	30	227	227	227	227	227						
GUESS2	31	240	240	227	280	227	280					
INDUCT	32	43	43	43	43	43	43	43				
GUESS3	33	240	240	227	280	227	280	43	280			
DSCALE	34	240	240	227	280	227	280	43	280	280		
XSCALE	35	240	240	227	280	227	280	43	280	280	280	
TOTAL1	119	199	199	195	231	195	231	39	231	231	231	231
TOTAL2	120	161	161	161	184	161	184	37	184	184	184	173
CITY1	123	204	204	204	204	204	204	38	204	204	204	178
SCHOOL1	124	227	227	227	227	227	227	43	227	227	227	195
FACTOR1	152	204	204	204	204	204	204	38	204	204	204	178
FACTOR2	153	204	204	204	204	204	204	38	204	204	204	178
FACTOR3	154	204	204	204	204	204	204	38	204	204	204	178
FACTOR4	155	204	204	204	204	204	204	38	204	204	204	178
FACTOR5	156	204	204	204	204	204	204	38	204	204	204	178

		TOTAL2 120	CITY1 123	SCHOOL1 124	FACTOR1 152	FACTOR2 153	FACTOR3 154	FACTOR4 155	FACTOR5 156
TOTAL2	120	184							
CITY1	123	149	204						
SCHOOL1	124	161	204	227					
FACTOR1	152	149	204	204	204				
FACTOR2	153	149	204	204	204	204			
FACTOR3	154	149	204	204	204	204	204		
FACTOR4	155	149	204	204	204	204	204	204	
FACTOR5	156	149	204	204	204	204	204	204	204

APPENDIX K

RESULTS OF FACTOR ANALYSIS

NOTATION USED IN THE COMPUTER PRINTOUT

Variable Number	Variable Name	Expanded Name	Source
4	Involve	Involvement	CES
5	Affiliat	Affiliation	CES
6	Support	Teacher Support	CES
7	Task	Task Orientation	CES
8	Compete	Competition	CES
9	Order	Order and Organization	CES
10	Rule	Rule Clarity	CES
11	Control	Teacher Control	CES
12	Innovate	Innovation	CES
13	Race	Race	1 = White 2 = Black 3 = Other
14	LD	Learning Disability	0 = absent 1 = present
15	ESL	English as a Second Language	0 = absent 1 = present
16	Fourth	Fourth Term Grade	Teacher Report
17	Final	Final Grade	Teacher Report
18	Age	Age	CES or Culture Fair Test
21	Years	Years in the present school	CES
22	Months	Months in the present Class	CES
19	Sex	Sex	0 = Female 1 = Male
20	Age	Age	Culture Fair test or CES
23	G1	Test 1:Series	Culture Fair Test
24	G2	Test 2: Classifications	Culture Fair Test
25	G3	Test 3: Matrices	Culture Fair Test
26	G4	Test 4:Conditions (Topology)	Culture Fair Test
27	IQ	I.Q.	Culture Fair Test
28	V1	V-1	Kit of Factor Referenced Tests
29	Guess1	The number of wrong answers to V-1	
30	V2	V-2	Kit of Factor Referenced Tests
31	Guess2	The number of wrong answers to V-2	

		INVOLVE 4	AFFILIAT 5	SUPPORT 6	TASK 7	C PETE 8	ORDER 9	RULE 10	CONTROL 11	INNOVAT 1	G1 23	G2 24	G3 25	G4 26
INVOLVE	4	1.000												
AFFILIAT	5	0.475	1.000											
SUPPORT	6	0.537	0.417	1.000										
TASK	7	0.209	0.039	0.083	1.000									
COMPETE	8	0.132	0.155	-0.052	0.229	1.000								
ORDER	9	0.463	0.131	0.306	0.455	0.065	1.000							
RULE	10	0.225	0.163	0.226	0.330	0.117	0.362	1.000						
CONTROL	11	-0.062	-0.104	-0.284	0.131	0.268	0.002	0.351	1.000					
INNOVATE	12	0.390	0.391	0.363	-0.137	0.075	0.017	0.074	0.043	1.000				
G1	23	0.082	0.027	0.101	0.046	-0.090	0.132	-0.086	-0.186	0.081	1.000			
G2	24	0.042	-0.063	0.060	-0.013	0.000	0.111	-0.085	-0.164	0.009	0.298	1.000		
G3	25	0.050	0.068	0.098	0.079	0.101	0.105	0.013	-0.113	-0.007	0.435	0.245	1.000	
G4	26	0.094	0.111	0.131	0.035	0.048	0.099	-0.027	-0.128	0.082	0.322	0.372	0.323	1.000
V1	28	-0.188	-0.142	0.060	0.054	0.083	-0.024	-0.045	-0.223	-0.172	0.236	0.170	0.174	0.246
V2	30	-0.035	-0.047	0.140	0.010	0.071	0.074	-0.059	-0.248	-0.089	0.267	0.269	0.215	0.267

		V1 28	V2 30
V1	28	1.000	
V2	30	0.656	1.000

INVERSE OF CORRELATION MATRIX.

PARTIAL CORRELATIONS

		INVOLVE 4	AFFILIAT 5	SUPPORT 6	TASK 7	COMPETE 8	ORDER 9	RULE 10	CONTROL 11	INNOVATE 12	G1 23	G2 24	G3 25	G4 26
INVOLVE	4	1.000												
AFFILIAT	5	0.251	1.000											
SUPPORT	6	0.314	0.148	1.000										
TASK	7	0.079	-0.017	-0.019	1.000									
COMPETE	8	0.067	0.163	-0.093	0.204	1.000								
ORDER	9	0.338	-0.099	0.078	0.326	-0.018	1.000							
RULE	10	-0.039	0.111	0.225	0.161	-0.052	0.227	1.000						
CONTROL	11	0.003	-0.144	-0.305	0.038	0.220	-0.044	0.406	1.000					
INNOVATE	12	0.202	0.191	0.230	-0.178	0.031	-0.118	-0.021	0.167	1.000				
G1	23	0.029	-0.024	-0.044	0.030	-0.056	0.087	-0.085	-0.056	0.123	1.000			
G2	24	0.020	-0.130	-0.012	-0.058	0.004	0.078	-0.028	-0.079	0.021	0.122	1.000		
G3	25	-0.023	0.080	0.017	0.061	-0.108	-0.006	0.034	0.017	-0.059	0.332	0.080	1.000	
G4	26	0.009	0.089	0.011	-0.007	0.079	0.019	-0.026	0.002	0.046	0.114	0.264	0.173	1.000
V1	28	-0.164	-0.089	0.087	0.107	0.005	-0.087	0.067	-0.096	-0.064	0.086	-0.056	-0.010	0.119
V2	30	0.025	0.016	0.055	-0.070	0.011	0.074	-0.031	-0.04	-0.038	0.049	0.135	.048	0.037

		V1 28	V2 30
V1	28	1.000	
V2	30	0.595	1.000

THE ELEMENTS OF THIS MATRIX ARE THE PARTIAL CORRELATIONS OF EACH PAIR OF VARIABLES, PARTIALED ON ALL OTHER VARIABLES (I.E., HOLDING ALL OTHER VARIABLES FIXED).

COMMUNALITY ESTIMATES ARE SQUARED MULTIPLE CORRELATIONS (COVARIANCES).

EIGENVALUES OF UNALTERED CORRELATION MATRIX

2.873	2.638	1.733	1.238	1.071	0.926	0.804	0.678	0.575	0.499
0.494	0.469	0.384	0.315	0.302					

ITERATION FOR MAXIMUM LIKELIHOOD

ITERATION	MAXIMUM CHANGE IN SQRT(UNIQUENESS)	LIKELIHOOD CRITERION TO BE MINIMIZED	STEP HALVINGS
		0.564290	
1	0.440286	0.511393	0
2	0.335301	0.276148	0
3	0.054651	0.261869	0
4	0.112274	0.261481	0
5	0.015511	0.261409	0
6	0.024064	0.261405	0
7	0.008608	0.261405	0
8	0.002126	0.261405	0
9	0.000104		

AN ASTERISK (IF ANY) AFTER THE ITERATION NUMBER INDICATES THAT APPROXIMATE DERIVATIVES WERE USED.

TABLE XXXVIII

UNROTATED FACTOR MATRIX

		FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5
INVOLVE	4	-0.062	-0.212	0.755	-0.115	-0.072
AFFILIAT	5	-0.104	-0.174	0.498	-0.340	-0.068
SUPPORT	6	-0.284	-0.007	0.640	-0.231	-0.113
TASK	7	0.131	0.085	0.377	0.478	-0.114
COMPETE	8	0.268	-0.025	0.161	0.021	-0.054
ORDER	9	0.002	-0.024	0.645	0.462	-0.039
RULE	10	0.351	0.032	0.428	0.160	-0.188
CONTROL	11	1.000	-0.000	-0.000	-0.000	0.000
INNOVATE	12	0.043	-0.171	0.394	-0.537	0.054
G1	23	-0.186	0.204	0.206	0.038	0.541
G2	24	-0.164	0.142	0.125	0.077	0.464
G3	25	-0.113	0.157	0.189	0.077	0.500
G4	26	-0.128	0.227	0.231	-0.035	0.461
V1	28	-0.223	0.970	0.003	-0.004	-0.008
V2	30	-0.248	0.620	0.119	0.009	0.163
	VP	1.511	1.577	2.311	0.953	1.075

THE VP FOR EACH FACTOR IS THE SUM OF THE SQUARES OF THE ELEMENTS OF THE COLUMN OF THE FACTOR LOADING MA CORRESPONDING TO THAT FACTOR. THE VP IS THE VARIANCE EXPLAINED BY THE FACTOR.

COMMUNALITIES OBTAINED FROM 5 FACTORS AFTER 9 ITERATIONS.
THE COMMUNALITY OF A VARIABLE IS ITS SQUARED MULTIPLE CORRELATION (COVARIANCE) WITH THE FACTORS.

4	INVOLVE	0.6368
5	AFFILIAT	0.4088
6	SUPPORT	0.5559
7	TASK	0.4084
8	COMPETE	0.1017
9	ORDER	0.6316
10	RULE	0.3683
11	CONTROL	1.0000
12	INNOVATE	0.4775
23	G1	0.4128
24	G2	0.2835
25	G3	0.3288
26	G4	0.3348
28	V1	0.9904
30	V2	0.4870

FACTOR	VARIANCE EXPLAINED	CUMULATIVE PROPORTION OF TOTAL VARIANCE
1	1.511	0.101
2	1.577	0.206
3	2.311	0.360
4	0.953	0.423
5	1.075	0.495

TOTAL VARIANCE IS DEFINED AS THE SUM OF THE DIAGONAL ELEMENTS OF THE CORRELATION (COVARIANCE) MATRIX.

ROTATED FACTOR LOADINGS (PATTERN)

		FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5
INVOLVE	4	0.688	0.082	-0.114	0.377	0.044
AFFILIAT	5	0.634	0.013	-0.062	0.049	-0.002
SUPPORT	6	0.679	0.071	0.129	0.225	-0.148
TASK	7	-0.037	0.029	0.053	0.623	0.123
COMPETE	8	0.071	-0.049	-0.043	0.133	0.274
ORDER	9	0.205	0.162	-0.029	0.749	0.035
RULE	10	0.176	-0.096	0.029	0.433	0.374
CONTROL	11	-0.175	-0.135	-0.144	0.028	0.964
INNOVATE	12	0.636	0.064	-0.090	-0.188	0.161
G1	23	0.054	0.624	0.115	0.024	-0.079
G2	24	-0.012	0.521	0.059	0.024	-0.091
G3	25	0.019	0.566	0.063	0.055	-0.027
G4	26	0.113	0.545	0.156	0.003	-0.013
V1	28	-0.134	0.200	0.962	0.003	-0.084
V2	30	-0.010	0.330	0.601	0.039	-0.124
	VP	1.885	1.501	1.400	1.392	1.249

THE VP FOR EACH FACTOR IS THE SUM OF THE SQUARES OF THE ELEMENTS OF THE COLUMN OF THE FACTOR PATTERN CORRESPONDING TO THAT FACTOR. WHEN THE ROTATION IS ORTHOGONAL, THE VP IS THE VARIANCE EXPLAINED BY T

SORTED ROTATED FACTOR LOADINGS (PATTERN)

		FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5
INVOLVE	4	0.688	0.0	0.0	0.377	0.0
SUPPORT	6	0.679	0.0	0.0	0.0	0.0
INNOVATE	12	0.636	0.0	0.0	0.0	0.0
AFFILIAT	5	0.634	0.0	0.0	0.0	0.0
G1	23	0.0	0.624	0.0	0.0	0.0
G3	25	0.0	0.566	0.0	0.0	0.0
G4	26	0.0	0.545	0.0	0.0	0.0
G2	24	0.0	0.521	0.0	0.0	0.0
V1	28	0.0	0.0	0.962	0.0	0.0
V2	30	0.0	0.330	0.601	0.0	0.0
ORDER	9	0.0	0.0	0.0	0.749	0.0
TASK	7	0.0	0.0	0.0	0.623	0.0
CONTROL	11	0.0	0.0	0.0	0.0	0.964
RULE	10	0.0	0.0	0.0	0.433	0.374
COMPETE	8	0.0	0.0	0.0	0.0	0.274
	VP	1.885	1.501	1.400	1.392	1.249

THE ABOVE FACTOR LOADING MATRIX HAS BEEN REARRANGED SO THAT THE COLUMNS APPEAR IN DECREASING ORDER OF EXPLAINED BY FACTORS. THE ROWS HAVE BEEN REARRANGED SO THAT FOR EACH SUCCESSIVE FACTOR, LOADINGS GRE THAN 0.5000 APPEAR FIRST. LOADINGS LESS THAN 0.2500 HAVE BEEN REPLACED BY ZERO.

TABLE XL

FACTOR SCORE COEFFICIENTS

FACTOR SCORE COEFFICIENTS
THESE COEFFICIENTS ARE FOR THE STANDARDIZED VARIABLES. MEAN ZERO AND STANDARD DEVIATION ONE.

		FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5
INVOLVE	4	0.32647	0.00552	0.04560	0.13661	0.06284
AFFILIAT	5	0.22681	-0.02396	0.03936	-0.05809	0.04534
SUPPORT	6	0.29336	-0.04546	0.05708	0.02687	0.05459
TASK	7	-0.08248	-0.01596	-0.01027	0.28963	-0.02712
COMPETE	8	0.01973	-0.01304	0.00548	0.02876	0.00174
ORDER	9	-0.04494	0.07243	-0.02565	0.50706	-0.01652
RULE	10	0.04325	-0.06836	0.02085	0.15762	-0.00318
CONTROL	11	-0.08047	0.05280	0.06757	-0.06910	1.04190
INNOVATE-	12	0.29976	0.03480	0.03960	-0.20345	0.07105
G1	23	-0.01630	0.33779	-0.06859	-0.02805	0.03491
G2	24	-0.03290	0.23608	-0.05196	-0.01048	0.01963
G3	25	-0.02626	0.27469	-0.05848	-0.00676	0.02516
G4	26	0.01867	0.25454	-0.04571	-0.03952	0.03334
V1	28	-0.01201	-0.09395	1.05010	-0.00641	0.14116
V2	30	0.00653	0.12316	-0.01195	0.00000	0.01664

CORRELATION MATRIX

EXPERIMENTAL GROUP FACTOR ANALYSIS

		INVOLVE 4	AFFILIAT 5	SUPPORT 6	TASK 7	COMPETE 8	ORDER 9	RULE 10	CONTROL 11	INNOVATE 12	G1 23	G2 24	G3 25	G4 26
INVOLVE	4	1.000												
AFFILIAT	5	0.564	1.000											
SUPPORT	6	0.514	0.485	1.000										
TASK	7	-0.018	-0.008	-0.157	1.000									
COMPETE	8	0.071	0.056	-0.070	0.201	1.000								
ORDER	9	0.265	0.126	0.050	0.343	-0.001	1.000							
RULE	10	0.030	0.085	0.110	0.325	0.019	0.297	1.000						
CONTROL	11	0.040	-0.047	-0.038	0.308	0.247	0.266	0.462	1.000					
INNOVATE	12	0.571	0.400	0.566	-0.250	0.010	0.068	-0.042	0.014	1.000				
G1	23	0.081	0.124	0.144	-0.088	-0.184	0.105	-0.033	-0.137	0.156	1.000			
G2	24	-0.021	-0.083	0.044	-0.209	-0.128	-0.068	-0.155	-0.227	-0.017	0.366	1.000		
G3	25	-0.034	0.057	0.046	-0.083	-0.139	0.008	-0.011	-0.048	0.026	0.635	0.353	1.000	
G4	26	0.004	0.073	0.124	-0.167	-0.064	0.002	-0.067	-0.171	0.100	0.393	0.380	0.338	1.000
V1	28	-0.404	-0.281	-0.107	-0.041	-0.112	-0.294	-0.009	-0.184	-0.214	0.136	0.112	0.161	0.151
V2	30	-0.200	-0.070	0.080	-0.181	-0.176	-0.198	0.013	-0.242	-0.069	0.246	0.190	0.212	0.157

		V1 28	V2 30
V1	28	1.000	
V2	30	0.694	1.000

INVERSE OF CORRELATION MATRIX

		INVOLVE 4	AFFILIAT 5	SUPPORT 6	TASK 7	COMPETE 8	ORDER 9	RULE 10	CONTROL 11	INNOVATE 12	G1 23
INVOLVE	4	0.224E 01									
AFFILIAT	5	-0.648E 00	0.174E 01								
SUPPORT	6	-0.421E 00	-0.423E 00	0.187E 01							
TASK	7	-0.109E 00	-0.105E 00	0.639E-01	0.151E 01						
COMPETE	8	-0.902E-01	-0.114E 00	0.130E 00	-0.223E 00	0.118E 01					
ORDER	9	-0.337E 00	0.933E-01	0.111E 00	-0.413E 00	0.145E 00	0.145E 01				
RULE	10	0.116E 00	-0.154E 00	-0.276E 00	-0.266E 00	0.142E 00	-0.245E 00	0.152E 01			
CONTROL	11	0.311E-01	0.247E 00	0.410E-01	-0.125E 00	-0.305E 00	-0.150E 00	-0.650E 00	0.159E 01		
INNOVATE	12	-0.707E 00	-0.286E-01	-0.672E 00	0.421E 00	-0.564E-01	0.548E-02	0.147E 00	-0.194E 00	0.196E 01	
G1	23	-0.215E-01	-0.785E-01	0.195E-01	-0.102E 00	0.141E 00	-0.242E 00	0.497E-01	0.111E 00	-0.257E 00	0.201E 01
G2	24	-0.151E 00	0.264E 00	-0.859E-01	0.133E 00	0.174E-02	0.305E-01	0.689E-01	0.143E 00	0.180E 00	-0.223E 00
G3	25	0.939E-01	-0.144E 00	0.553E-01	0.344E-01	0.599E-01	0.780E-01	0.910E-02	-0.209E 00	0.841E-01	-0.103E 01
G4	26	0.123E 00	-0.112E 00	-0.815E-01	0.136E 00	-0.897E-01	-0.114E 00	-0.258E-01	0.113E 00	-0.735E-01	-0.277E 00
V1	28	0.399E 00	0.374E 00	-0.189E-01	-0.343E 00	-0.624E-02	0.387E 00	-0.418E-01	0.940E-01	-0.313E-01	-0.704E-03
V2	30	0.782E-02	-0.177E 00	-0.214E 00	0.331E 00	0.503E-01	-0.776E-01	-0.198E 00	0.201E 00	0.109E 00	-0.235E 00

		G2 24	G3 25	G4 26	V1 28	V2 30
G2	24	0.140E 01				
G3	25	-0.234E 00	0.180E 01			
G4	26	-0.342E 00	-0.134E 00	0.136E 01		
V1	28	0.138E 00	-0.763E-01	-0.227E 00	0.249E 01	
V2	30	-0.132E 00	-0.195E-01	0.138E 00	-0.156E 01	0.227E 01

PARTIAL CORRELATIONS

		INVOLVE 4	AFFILIAT 5	SUPPORT 6	TASK 7	COMPETE 8	ORDER 9	RULE 10	CONTROL 11	INNOVATE 12	G1 23	G2 24	G3 25	G4 26
INVOLVE	4	1.000												
AFFILIAT	5	0.328	1.000											
SUPPORT	6	0.206	0.234	1.000										
TASK	7	0.059	0.065	-0.038	1.000									
COMPETE	8	0.056	0.080	-0.087	0.167	1.000								
ORDER	9	0.187	-0.059	-0.067	0.279	-0.111	1.000							
RULE	10	-0.063	0.095	0.164	0.175	-0.107	0.165	1.000						
CONTROL	11	-0.016	-0.148	-0.024	0.080	0.223	0.099	0.419	1.000					
INNOVATE	12	0.338	0.015	0.351	-0.244	0.037	-0.003	-0.085	0.110	1.000				
G1	23	0.010	0.042	-0.010	0.058	-0.092	0.142	-0.028	-0.062	0.129	1.000			
G2	24	0.085	-0.169	0.053	-0.091	-0.001	-0.021	-0.047	-0.095	-0.109	0.133	1.000		
G3	25	-0.047	0.081	-0.030	-0.021	-0.041	-0.048	-0.006	0.124	-0.045	0.539	0.147	1.000	
G4	26	-0.071	0.073	0.051	-0.095	0.071	0.081	0.018	-0.077	0.045	0.168	0.248	0.086	1.000
V1	28	-0.169	-0.180	0.009	0.177	0.004	-0.204	0.022	-0.047	0.014	0.000	-0.074	0.036	0.123
V2	30	-0.003	0.089	0.104	-0.178	-0.031	0.043	0.107	-0.106	-0.052	0.110	0.074	0.010	-0.078

		V1 28	V2 30
V1	28	1.000	
V2	30	0.657	1.000

THE ELEMENTS OF THIS MATRIX ARE THE PARTIAL CORRELATIONS
OF EACH PAIR OF VARIABLES, PARTIALED ON ALL OTHER VARIABLES
(I.E., HOLDING ALL OTHER VARIABLES FIXED).

COMMUNALITY ESTIMATES ARE SQUARED MULTIPLE CORRELATIONS (COVARIANCES).

EIGENVALUES OF UNALTERED CORRELATION MATRIX

3.016	2.630	1.796	1.341	1.005	0.841	0.757	0.643	0.619	0.507
0.404	0.372	0.328	0.306	0.234					

ITERATION FOR MAXIMUM LIKELIHOOD

ITERATION	MAXIMUM CHANGE IN SQRT(UNIQUENESS)	LIKELIHOOD CRITERION TO BE MINIMIZED	STEP HALVINGS
		0.634811	
1	0.251033	0.592803	0
2	0.174421	0.328442	0
3	0.166226	0.318445	0
4	0.173339	0.316878	0
5	0.036488	0.316801	0
6	0.001935	0.316801	0
7	0.000004		

AN ASTERISK (IF ANY) AFTER THE ITERATION NUMBER INDICATES
THAT APPROXIMATE DERIVATIVES WERE USED.

CANONICAL CORRELATIONS

EXPERIMENTAL GROUP
FACTOR ANALYSIS

UNROTATED FACTOR LOADINGS (PATTERN)
FOR MAXIMUM LIKELIHOOD CANONICAL FACTORS

		FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5
INVOLVE	4	0.040	-0.644	0.395	-0.244	0.156
AFFILIAT	5	-0.247	-0.482	0.383	-0.206	0.207
SUPPORT	6	-0.028	-0.252	0.524	-0.406	0.056
TASK	7	0.308	0.019	-0.218	0.171	0.672
COMPETE	8	0.247	-0.100	-0.147	-0.058	0.073
ORDER	9	0.266	-0.269	0.097	0.198	0.380
RULE	10	0.402	0.349	0.071	-0.060	0.331
CONTROL	11	1.000	0.000	-0.000	0.000	-0.000
INNOVATE	12	0.014	-0.452	0.494	-0.340	-0.122
G1	23	-0.137	0.141	0.706	0.423	0.043
G2	24	-0.227	0.140	0.331	0.266	-0.174
G3	25	-0.043	0.223	0.576	0.934	-0.037
G4	26	-0.171	0.118	0.413	0.183	-0.031
V1	28	-0.134	0.838	0.143	-0.265	0.091
V2	30	-0.242	0.625	0.333	-0.276	0.053
	VP	1.641	2.252	2.146	1.076	0.847

ROTATED FACTOR LOADINGS (PATTERN)

		FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5
INVOLVE	4	0.766	-0.013	-0.237	0.008	0.112
AFFILIAT	5	0.653	0.041	-0.113	-0.066	0.148
SUPPORT	6	0.743	0.064	0.095	0.019	-0.053
TASK	7	-0.154	-0.165	-0.033	0.147	0.742
COMPETE	8	0.002	-0.205	-0.102	0.194	0.108
ORDER	9	0.158	0.063	-0.247	0.164	0.464
RULE	10	0.072	-0.069	0.088	0.415	0.390
CONTROL	11	-0.033	-0.128	-0.149	0.963	0.192
INNOVATE	12	0.726	0.074	-0.070	0.075	-0.191
G1	23	0.137	0.826	0.080	-0.034	0.098
G2	24	-0.034	0.485	0.041	-0.137	-0.154
G3	25	-0.010	0.750	0.075	0.054	0.041
G4	26	0.081	0.474	0.100	-0.082	-0.078
V1	28	-0.257	0.129	0.062	-0.037	-0.054
V2	30	-0.014	0.230	0.754	-0.086	-0.099
	VP	2.239	1.882	1.522	1.234	1.086

THE VP FOR EACH FACTOR IS THE SUM OF THE SQUARES OF THE ELEMENTS OF THE COLUMN OF THE FACTOR LOADING MATRIX CORRESPONDING TO THAT FACTOR. THE VP IS THE VARIANCE EXPLAINED BY THE FACTOR.

COMMUNALITIES OBTAINED FROM 5 FACTORS AFTER 7 ITERATIONS.
THE COMMUNALITY OF A VARIABLE IS ITS SQUARED MULTIPLE CORRELATION (COVARIANCE) WITH THE FACTORS.

4	INVOLVE	0.6558
5	AFFILIAT	0.4669
6	SUPPORT	0.5678
7	TASK	0.6242
8	COMPETE	0.1015
9	ORDER	0.3351
10	RULE	0.3344
11	CONTROL	1.0000
12	INNOVATE	0.5789
23	G1	0.7176
24	G2	0.2819
25	G3	0.8734
26	G4	0.2543
28	V1	0.8311
30	V2	0.6388

		SMC	MSA
TOTAL			0.70
4	INVOLVE	0.55325	0.772
5	AFFILIAT	0.42560	0.747
6	SUPPORT	0.40565	0.769
7	TASK	0.33945	0.657
8	COMPETE	0.15049	0.631
9	ORDER	0.31114	0.679
10	RULE	0.34049	0.600
11	CONTROL	0.37183	0.664
12	INNOVATE	0.48960	0.731
23	G1	0.50200	0.693
24	G2	0.28689	0.768
25	G3	0.44521	0.600
26	G4	0.26290	0.777
28	V1	0.59776	0.628
30	V2	0.55852	0.619

FACTOR	VARIANCE EXPLAINED	CUMULATIVE PROPORTION OF TOTAL VARIANCE
1	1.641	0.109
2	2.252	0.260
3	2.146	0.403
4	1.076	0.474
5	0.847	0.531

TOTAL VARIANCE IS DEFINED AS THE SUM OF THE DIAGONAL ELEMENTS OF THE CORRELATION (COVARIANCE) MATRIX.

EXPERIMENTAL GROUP FACTOR ANALYSIS

FACTOR SCORE COEFFICIENTS
THESE COEFFICIENTS ARE FOR THE STANDARDIZED VARIABLES, MEAN ZERO AND

		FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5
INVOLVE	4	0.34445	-0.04061	0.01508	-0.01140	0.10723
AFFILIAT	5	0.19525	-0.01411	0.03198	-0.00977	0.10369
SUPPORT	6	0.29636	-0.03332	0.11569	0.02717	-0.01830
TASK	7	-0.03753	-0.06059	0.05075	-0.11811	0.61669
COMPETE	8	0.00419	-0.03446	-0.00075	-0.00904	0.02372
ORDER	9	0.02698	0.03308	-0.02825	-0.03830	0.20778
RULE	10	0.03914	-0.01895	0.05914	-0.02159	0.15637
CONTROL	11	-0.03624	0.02833	0.00317	1.06636	-0.13131
INNOVATE	12	0.27383	-0.00711	0.04313	0.04281	-0.14599
G1	23	0.01106	0.52278	-0.05986	0.03621	0.13424
G2	24	-0.02913	0.12491	-0.03505	0.02121	-0.05816
G3	25	-0.04569	0.33074	-0.05213	0.02893	0.02906
G4	26	0.00433	0.11001	-0.00766	0.01790	-0.02262
V1	28	-0.01867	-0.05729	0.70869	0.09214	0.04784
V2	30	0.07837	0.01898	0.29799	0.05380	-0.01334

REPLICATION GROUP FACTOR ANALYSIS

CORRELATION MATRIX

		INVOLVE 4	AFFILIAT 5	SUPPORT 6	TASK 7	COMPLTE 8	ORDER 9	RULE 10	CONTROL 11	INNOVATE 12	G1 23	G2 24	G3 25	G4 26
INVOLVE	4	1.000												
AFFILIAT	5	0.427	1.000											
SUPPORT	6	0.516	0.407	1.000										
TASK	7	0.308	0.089	0.139	1.000									
COMPLTE	8	0.182	0.250	-0.063	0.247	1.000								
ORDER	9	0.527	0.201	0.337	0.447	0.130	1.000							
RULE	10	0.300	0.246	0.226	0.277	0.174	0.302	1.000						
CONTROL	11	-0.019	-0.156	-0.390	0.003	0.299	-0.059	0.347	1.000					
INNOVATE	12	0.247	0.381	0.253	-0.016	0.154	0.047	0.211	0.057	1.000				
G1	23	-0.014	-0.047	0.017	0.063	-0.057	0.049	-0.168	-0.195	0.011	1.000			
G2	24	-0.036	-0.027	-0.022	0.020	0.059	0.054	-0.127	-0.093	0.061	0.297	1.000		
G3	25	0.026	0.088	0.074	0.116	-0.112	0.062	-0.023	-0.135	-0.027	0.351	0.205	1.000	
G4	26	0.090	0.153	0.083	0.103	0.102	0.057	-0.055	-0.084	0.078	0.308	0.379	0.345	1.000
V1	28	0.004	0.036	0.179	0.101	-0.072	0.149	-0.122	-0.256	-0.105	0.358	0.237	0.206	0.354
V2	30	-0.016	0.003	0.083	0.045	-0.005	0.052	-0.237	-0.226	-0.082	0.244	0.262	0.172	0.325

		V1 28	V2 30
V1	28	1.000	
V2	30	0.220	1.000

INVERSE OF CORRELATION MATRIX

		INVOLVE 4	AFFILIAT 5	SUPPORT 6	TASK 7	COMPLTE 8	ORDER 9	RULE 10	CONTROL 11	INNOVATE 12	G1 23
INVOLVE	4	0.193E 01									
AFFILIAT	5	-0.356E 00	0.163E 01								
SUPPORT	6	-0.416E 00	-0.224E 00	0.193E 01							
TASK	7	-0.157E 00	0.129E 00	0.622E-02	0.141E 01						
COMPLTE	8	-0.113E 00	-0.407E 00	0.179E 00	-0.284E 00	0.137E 01					
ORDER	9	-0.278E 00	0.486E-01	-0.105E 00	-0.457E 00	-0.100E-01	0.169E 01				
RULE	10	-0.767E-01	-0.232E 00	-0.394E 00	-0.224E 00	0.556E-01	-0.250E 00	0.163E 01			
CONTROL	11	-0.408E-01	0.351E 00	0.710E 00	-0.250E-01	-0.398E 00	0.762E-01	-0.699E 00	0.178E 01		
INNOVATE	12	-0.104E 00	-0.393E 00	-0.263E 00	0.116E 00	-0.428E-01	0.119E 00	-0.106E 00	-0.184E 00	0.131E 01	
G1	23	-0.450E-01	0.167E 00	0.110E 00	-0.470E-01	-0.184E-01	-0.201E-01	0.115E 00	0.161E 00	-0.144E 00	0.130E 01
G2	24	0.891E-01	0.125E 00	0.676E-01	0.542E-01	-0.108E 00	-0.137E 00	0.533E-01	0.734E-01	-0.141E 00	-0.180E 00
G3	25	0.569E-01	-0.173E 00	-0.352E-02	-0.163E 00	0.224E 00	0.600E-02	-0.599E-01	0.173E-01	0.974E-01	-0.339E 00
G4	26	-0.114E 00	-0.153E 00	0.955E-02	-0.489E-01	-0.111E 00	0.118E 00	0.438E-01	-0.790E-01	-0.610E-01	-0.129E 00
V1	28	0.242E 00	-0.684E-01	-0.249E 00	-0.583E-01	0.106E 00	-0.207E 00	-0.813E-01	0.860E-01	0.185E 00	-0.366E 00
V2	30	-0.367E-01	0.367E-01	-0.937E-02	-0.203E-01	-0.111E 00	0.276E-01	0.281E 00	0.654E-01	0.791E-02	0.811E-01

		G2 24	G3 25	G4 26	V1 28	V2 30
G2	24	0.129E 01				
G3	25	-0.721E-01	0.130E 01			
G4	26	-0.356E 00	-0.317E 00	0.147E 01		
V1	28	-0.103E-01	0.561E-01	-0.260E 00	0.195E 01	
V2	30	-0.142E 00	-0.471E-01	-0.150E 00	-0.985E 00	0.177E 01

PARTIAL CORRELATIONS

REPLICATION GROUP FACTOR ANALYSIS

		INVOLVE 4	AFFILIAT 5	SUPPORT 6	TASK 7	COMPETE 8	ORDER 9	RULE 10	CONTROL 11	INNOVATE 12	G1 23	G2 24	G3 25	G4 26
INVOLVE	4	1.000												
AFFILIAT	5	0.197	1.000											
SUPPORT	6	0.319	0.126	1.000										
TASK	7	0.093	-0.085	-0.004	1.000									
COMPETE	8	0.070	0.272	-0.110	0.204	1.000								
ORDER	9	0.375	-0.029	0.058	0.296	0.012	1.000							
RULE	10	0.016	0.142	0.222	0.148	-0.037	0.150	1.000						
CONTROL	11	0.026	-0.206	-0.380	0.016	0.255	-0.044	0.410	1.000					
INNOVATE	12	0.005	0.268	0.165	-0.080	0.032	-0.060	0.072	0.120	1.000				
G1	23	0.028	-0.108	-0.067	0.034	0.013	0.013	-0.077	-0.102	0.107	1.000			
G2	24	-0.057	-0.080	-0.043	-0.040	0.082	0.093	-0.037	-0.049	0.108	0.135	1.000		
G3	25	-0.036	0.119	0.002	0.106	-0.168	-0.006	0.041	-0.011	-0.075	0.253	0.056	1.000	
G4	26	0.008	0.099	-0.006	0.034	0.078	-0.075	-0.028	0.049	0.037	0.091	0.259	0.230	1.000
V1	28	-0.125	0.036	0.128	0.035	-0.066	0.114	0.046	-0.046	-0.115	0.223	0.006	-0.035	0.159
V2	30	0.020	-0.023	0.005	0.013	0.071	-0.016	-0.166	-0.037	-0.005	-0.062	0.094	0.031	0.093

		V1 28	V2 30
V1	28	1.000	
V2	30	0.531	1.000

THE ELEMENTS OF THIS MATRIX ARE THE PARTIAL CORRELATIONS
OF EACH PAIR OF VARIABLES, PARTIALED ON ALL OTHER VARIABLES
(I.E., HOLDING ALL OTHER VARIABLES FIXED).

COMMUNALITY ESTIMATES ARE SQUARED MULTIPLE CORRELATIONS (COVARIANCES).

EIGENVALUES OF UNALTERED CORRELATION MATRIX

2.964	2.720	1.577	1.313	1.053	0.821	0.776	0.698	0.560	0.541
0.526	0.445	0.389	0.320	0.290					

ITERATION FOR MAXIMUM LIKELIHOOD

ITERATION	MAXIMUM CHANGE IN SQRT(UNIQUENESS)	LIKELIHOOD CRITERION TO BE MINIMIZED	STEP HALVINGS
		0.558234	
1	0.755651	0.465538	0
2	0.144354	0.332834	0
3	0.038925	0.329909	0
4	0.021894	0.329585	0
5	0.013936	0.329485	0
6	0.007062	0.329438	0
7	0.010472	0.329348	0
8	0.020759	0.329060	0
9	0.037721	0.328420	0
10	0.103760	0.327746	1
11	0.045483	0.327049	0
12	0.091847	0.326862	0
13	0.057655	0.326770	0
14	0.082622	0.326727	0
15	0.055947	0.326706	0
16	0.056160	0.326699	0

REPLICATION GROUP
FACTOR ANALYSIS

UNROTATED FACTOR LOADINGS (PATTERN)
FOR MAXIMUM LIKELIHOOD CANONICAL FACTORS

		FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5
INVOLVE	4	-0.016	0.613	0.442	-0.083	-0.015
AFFILIAT	5	0.003	0.516	0.260	-0.097	0.429
SUPPORT	6	0.063	0.708	0.095	-0.148	0.084
TASK	7	0.045	0.239	0.421	0.172	-0.303
COMPLETE	8	-0.005	-0.035	0.451	0.037	0.156
ORDER	9	0.052	0.508	0.447	0.077	-0.401
RULE	10	-0.237	0.140	0.577	-0.062	0.015
CONTROL	11	-0.226	-0.607	0.623	0.041	0.041
INNOVATE	12	-0.062	0.231	0.247	-0.051	0.454
G1	23	0.244	0.127	-0.143	0.517	-0.001
G2	24	0.262	0.041	-0.034	0.435	0.096
G3	25	0.172	0.160	-0.046	0.450	0.059
G4	26	0.325	0.149	0.076	0.526	0.242
V1	28	0.620	0.172	-0.050	0.247	-0.075
V2	30	1.000	-0.0	0.0	0.0	0.0
	VP	1.774	1.998	1.667	1.080	0.753

THE VP FOR EACH FACTOR IS THE SUM OF THE SQUARES OF THE ELEMENTS OF THE COLUMN OF THE FACTOR LOADING MATRIX CORRESPONDING TO THAT FACTOR. THE VP IS THE VARIANCE EXPLAINED BY THE FACTOR.

SQUARED MULTIPLE CORRELATIONS (SMC) OF EACH VARI.
VARIABLES AND KAISER'S (1972) MEASURE OF SAMPLIN

		SMC	MSA
TOTAL			0.70
4	INVOLVE	0.48116	0.757
5	AFFILIAT	0.30833	0.696
6	SUPPORT	0.48170	0.697
7	TASK	0.28156	0.726
8	COMPLETE	0.27669	0.586
9	ORDER	0.40984	0.728
10	RULE	0.36698	0.675
11	CONTROL	0.43775	0.564
12	INNOVATE	0.23944	0.672
23	G1	0.27730	0.752
24	G2	0.22230	0.754
25	G3	0.23012	0.695
26	G4	0.31967	0.775
28	V1	0.46712	0.678
30	V2	0.43376	0.696

ROTATED FACTOR LOADINGS (PATTERN)

		FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5
INVOLVE	4	0.580	-0.029	0.490	0.011	-0.004
AFFILIAT	5	0.148	0.046	0.710	0.010	0.000
SUPPORT	6	0.274	-0.001	0.542	0.005	-0.323
TASK	7	0.566	0.117	-0.005	0.029	0.153
COMPETE	8	0.133	0.020	0.200	0.021	0.415
ORDER	9	0.760	0.050	0.114	0.051	-0.010
RULE	10	0.283	-0.146	0.265	-0.170	0.384
CONTROL	11	-0.013	-0.157	-0.181	-0.142	0.657
INNOVATE	12	-0.026	0.029	0.544	-0.070	0.165
G1	23	0.036	0.577	-0.076	0.077	-0.130
G2	24	-0.020	0.503	-0.013	0.127	0.013
G3	25	0.064	0.504	0.028	0.030	-0.064
G4	26	0.615	0.639	0.165	0.162	0.081
V1	28	0.130	0.418	-0.031	0.516	-0.155
V2	30	-0.011	0.279	-0.025	0.958	-0.058
	VP	1.615	1.568	1.626	1.299	1.264

THE VP FOR EACH FACTOR IS THE SUM OF THE SQUARES OF THE ELEMENTS OF THE COLUMN OF THE FACTOR PATTERN MATRIX CORRESPONDING TO THAT FACTOR. WHEN THE ROTATION IS ORTHOGONAL. THE VP IS THE VARIANCE EXPLAINED BY THE FACTOR.

SORTED ROTATED FACTOR LOADINGS (PATTERN)

REPLICATION GROUP
FACTOR ANALYSIS

		FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5
ORDER	9	0.700	0.0	0.0	0.0	0.0
INVOLVE	4	0.580	0.0	0.490	0.0	0.0
TASK	7	0.5[illegible]	0.0	0.0	0.0	0.0
G4	26	0.0	0.639	0.0	0.0	0.0
G1	23	0.0	0.577	0.0	0.0	0.0
G3	25	0.0	0.504	0.0	0.0	0.0
G2	24	0.0	0.503	0.0	0.0	0.0
AFFILIAT	5	0.0	0.0	0.710	0.0	0.0
INNOVATE	12	0.0	0.0	0.544	0.0	0.0
SUPPORT	6	0.374	0.0	0.542	0.0	-0.323
V2	30	0.0	0.279	0.0	0.958	0.0
V1	28	0.0	0.416	0.0	0.516	0.0
CONTROL	11	0.0	0.0	0.0	0.0	0.657
COMPLETE	8	0.0	0.0	0.0	0.0	0.415
RULE	10	0.383	0.0	0.265	0.0	0.364
	VP	1.635	1.568	1.526	1.299	1.264

FACTOR SCORE COEFFICIENTS
THESE COEFFICIENTS ARE FOR THE STANDARDIZED VARIABLES, MEAN ZERO AND

		FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5
INVOLVE	4	0.22819	-0.05125	0.18665	0.02343	0.01599
AFFILIAT	5	-0.09125	0.01596	0.40623	0.00828	0.05845
SUPPORT	6	0.09376	-0.06346	0.23739	0.01948	-0.10024
TASK	7	0.27495	0.05291	-0.09438	-0.01313	0.03314
COMPLETE	8	0.00464	0.02164	0.07858	0.00238	0.10652
ORDER	9	0.51227	0.00114	-0.15014	0.00021	-0.07828
RULE	10	0.10919	-0.04263	0.08441	0.02312	0.11845
CONTROL	11	0.01179	-0.03138	-0.09463	0.05434	0.77927
INNOVATE	12	-0.10874	0.02799	0.25316	0.00196	0.08694
G1	23	0.02[illegible]	0.27908	-0.05494	-0.00347	-0.01090
G2	24	-0.01359	0.21184	-0.00406	-0.00034	0.02844
G3	25	0.01145	0.21709	-0.00650	-0.06283	0.00863
G4	26	-0.04610	0.37133	0.09004	-0.10141	0.08456
V1	28	0.07088	0.15855	-0.05330	-0.04874	-0.03228
V2	30	-0.06449	-0.11367	0.00910	1.00845	0.14736

THE ABOVE FACTOR LOADING MATRIX HAS BEEN REARRANGED SO THAT THE COLUMNS APPEAR IN DECREASING ORDER OF VARIANCE EXPLAINED BY FACTORS. THE ROWS HAVE BEEN REARRANGED SO THAT FOR EACH SUCCESSIVE FACTOR, LOADINGS GREATER THAN 0.5000 APPEAR FIRST. LOADINGS LESS THAN 0.2500 HAVE BEEN REPLACED BY ZERO.

COMMUNALITIES OBTAINED FROM 5 FACTORS AFTER 20 ITERATIONS.
THE COMMUNALITY OF A VARIABLE IS ITS SQUARED MULTIPLE CORRELATION (COVARIANCE) WITH THE FACTORS.

4	INVOLVE	0.5776
5	AFFILIAT	0.5276
6	SUPPORT	0.5462
7	TASK	0.3578
8	COMPLETE	0.4301
9	ORDER	0.6273
10	RULE	0.4146
11	CONTROL	0.[illegible]
12	INNOVATE	0.3296
23	G1	0.3630
24	G2	0.2700
25	G3	0.[illegible]
26	G4	0.4590
28	V1	0.4831
30	V2	1.0000

FACTOR	VARIANCE EXPLAINED	CUMULATIVE PROPORTION OF TOTAL VARIANCE
1	1.774	0.118
2	1.998	0.251
3	1.667	0.363
4	1.080	0.435
5	0.753	0.485

TOTAL VARIANCE IS DEFINED AS THE SUM OF THE DIAGONAL ELEMENTS OF THE CORRELATION (COVARIANCE) MATRIX.

APPENDIX L

HIGHER ORDER PARTIAL REGRESSION

COEFFICIENTS FOR THE

EXPERIMENTAL, AND

REPLICATION

GROUPS

NOTATION USED IN THE COMPUTER PRINTOUT

Variable Number	Variable Name	Expanded Name	Source
79	Z1	Z1	The classroom average of Factor 1
82	Z4	Z4	The classroom average of Factor 4
83	Z5	Z5	The classroom average of Factor 5
47	Y11	The interaction of Grade Level and Factor 2	
48	Y12	The interaction of Grade Level and Factor 3	
49	Y13	Grade Level X Z1	
50	Y14	Grade Level X Z4	
51	Y15	Grade Level X Z5	
52	Y16	Instructional Time X Factor 2	
53	Y17	Instructional Time X Factor 3	
54	Y18	Instructional Time X Z1	
55	Y19	Instructional Time X Z4	
56	Y20	Instructional Time X Z5	
57	Y21	Classize X Factor 2	
58	Y22	Classize X Factor 3	
59	Y23	Classize X Z1	
60	Y24	Classize X Z4	
61	Y25	Classize X Z5	
67	Y31	Factor 2 X Z1	
68	Y32	Factor 2 X Z4	
69	Y33	Factor 2 X Z5	
70	Y34	Factor 3 X Z1	
71	Y35	Factor 3 X Z4	
72	Y36	Factor 3 X Z5	
119	Total 1	The unit test score from test 1. For the experimental group this was a posttest; for the control group this was a pretest.	
120	Total2	The unit test score from test 2. For the experimental group this was a retention test; for the replication group this was a posttest.	
122	Eighth	Grade level	0 = high School 1 - eighth grade
133	Minutes	Instructional Time	
150	Classize	Classize	
153	Factor2	Factor 2	
154	Factor3	Factor 3	

STATISTICS FOR THE INDEPENDENT VARIABLES IN THE INITIAL LEARNING MODEL FOR THE EXPERIMENTAL GROUP **

Independent Variables	r_{Yi}	B_i	R^2_i	b_i	b_{se}	t_i	sr_i	pr_i	sr^2_i	pr^2_i	alpha	power
Grade Level	-.50	-.471	.917	-7.540	3.620	-2.08	.134	.182	.018	.033	.039	.52
Instructional Time	.31	.247	.865	.017	.012	1.40	.089	.122	.008	.015	.164	.27
Classize*	-.106	.241	.780	.296	.170	1.74	.114	.152	.013	.023	.084	.40
Factor 2*	.135	.175	.049	1.770	.673	2.62	.170	.226	.029	.051	.010	.99
Factor 3	.506	.224	.540	1.230	.527	2.33	.152	.202	.023	.041	.021	.99
Z1 *	-.244	.206	.930	1.870	2.220	.84	.055	.074	.003	.005	.402	.14
Z4	-.371	-.200	.795	-3.240	2.320	-1.39	-.090	-.122	.008	.015	.166	.28
Z5 *	.095	.106	.580	4.02	3.790	1.06	.069	.093	.005	.009	.291	.19

(N = 137; R^2= .458)

* When B_i falls outside the limits set by r_{Yi} and zero, then the independent variable should be considered a suppressor variable.

** This data was compiled from the regression analyses on the following pages.

STATISTICS FOR 'BEST' SUBSET

SQUARED MULTIPLE CORRELATION	0.29248
MULTIPLE CORRELATION	0.54081
ADJUSTED SQUARED MULT. CORR.	0.27921
RESIDUAL MEAN SQUARE	0.292226D 02
STANDARD ERROR OF EST.	0.538726D 01
F-STATISTIC	22.05
NUMERATOR DEGREES OF FREEDOM	3
DENOMINATOR DEGREES OF FREEDOM	160
SIGNIFICANCE	0.0000

VARIABLE NO.	NAME	REGRESSION COEFFICIENT	STANDARD ERROR	STAND. COEF.	T-STAT.	2TAIL SIG.	TOL-ERANCE
	INTERCEPT	0.185312D 02	0.253298D 01	2.920	7.32	0.000	
122	EIGHTH	-0.945366D 01	0.170120D 01	-0.625	-5.56	0.000	0.349995
133	MINUTES	0.256553D-02	0.685436D-02	0.035	0.37	0.709	0.495327
150	CLASSIZE	0.264740D 00	0.130846D 00	0.236	2.16	0.031	0.366559

MULTIPLE R 0.5735 STD. ERROR OF EST. 5.3077
MULTIPLE R-SQUARE 0.3289

ANALYSIS OF VARIANCE

	SUM OF SQUARES	DF	MEAN SQUARE	F RATIO	P(TAIL)
REGRESSION	1822.698	4	455.674	16.175	0.00000
RESIDUAL	3718.648	132	28.172		

VARIABLE		COEFFICIENT	STD. ERROR	STD. REG COEFF	T	P(2 TAIL)
INTERCEPT		19.071				
EIGHTH	122	-10.093	1.884	-0.631	-5.357	0.000
MINUTES	133	0.002	0.007	0.030	0.285	0.776
CLASSIZE	150	0.262	0.145	0.214	1.810	0.073
FACTOR2	153	1.966	0.727	0.195	2.705	0.008

REGRESSION TITLE. . . . . .CLASSROOM DATA -EXPERIMENTAL GROUP ANALYSIS
DEPENDENT VARIABLE. 119 TOTAL1
TOLERANCE 0.0100
ALL DATA CONSIDERED AS A SINGLE GROUP

MULTIPLE R 0.6239 STD. ERROR OF EST. 5.0829
MULTIPLE R-SQUARE 0.3892

ANALYSIS OF VARIANCE

	SUM OF SQUARES	DF	MEAN SQUARE	F RATIO	P(TAIL)
REGRESSION	2156.863	5	431.372	16.697	0.00000
RESIDUAL	3384.484	131	25.836		

VARIABLE		COEFFICIENT	STD. ERROR	STD. REG COEFF	T	P(2 TAIL)
INTERCEPT		17.314				
EIGHTH	122	-5.802	2.163	-0.363	-2.683	0.008
MINUTES	133	0.006	0.007	0.080	0.789	0.432
CLASSIZE	150	0.225	0.139	0.183	1.613	0.109
FACTOR2	153	2.146	0.698	0.213	3.076	0.003
FACTOR3	154	1.884	0.524	0.34[illegible]	3.596	0.000

REGRESSION TITLE. . . . . .CLASSROOM DATA -EXPERIMENTAL GROUP ANALYSIS
DEPENDENT VARIABLE. 119 TOTAL1
TOLERANCE 0.0100
ALL DATA CONSIDERED AS A SINGLE GROUP

MULTIPLE R 0.6685 STD. ERROR OF EST. 4.8558
MULTIPLE R-SQUARE 0.4468

ANALYSIS OF VARIANCE

	SUM OF SQUARES	DF	MEAN SQUARE	F RATIO	P(TAIL)
REGRESSION	2476.123	6	412.687	17.503	0.00000
RESIDUAL	3065.223	130	23.579		

VARIABLE		COEFFICIENT	STD. ERROR	STD. REG COEFF	T	P(2 TAIL)
INTERCEPT		8.227				
EIGHTH	122	-11.626	2.603	-0.727	-4.467	0.000
MINUTES	133	0.018	0.008	0.262	2.399	0.018
CLASSIZE	150	0.401	0.141	0.327	2.837	0.005
FACTOR2	153	1.751	0.675	0.174	2.594	0.011
FACTOR3	154	1.391	0.518	0.253	2.684	0.008
Z1	79	4.275	1.162	0.472	3.680	0.000

MULTIPLE R 0.6733 STD. ERROR OF EST. 4.8458
MULTIPLE R-SQUARE 0.4533

ANALYSIS OF VARIANCE

	SUM OF SQUARES	DF	MEAN SQUARE	F RATIO	P(TAIL)
REGRESSION	2512.136	7	358.876	15.283	0.00000
RESIDUAL	3029.210	129	23.482		

VARIABLE		COEFFICIENT	STD. ERROR	STD. REG COEFF	T	P(2 TAIL)
INTERCEPT		13.280				
EIGHTH	122	-9.101	3.302	-0.569	-2.756	0.007
MINUTES	133	0.010	0.010	0.141	0.970	0.334
CLASSIZE	150	0.397	0.141	0.323	2.810	0.006
FACTOR2	153	1.765	0.674	0.175	2.619	0.010
FACTOR3	154	1.324	0.520	0.241	2.546	0.012
Z1	79	1.924	2.225	0.212	0.865	0.389
Z4	82	-2.837	2.291	-0.176	-1.238	0.218

STATISTICS FOR 'BEST' SUBSET	
SQUARED MULTIPLE CORRELATION	0.45810
MULTIPLE CORRELATION	0.67683
ADJUSTED SQUARED MULT. CORR.	0.42424
RESIDUAL MEAN SQUARE	0.234633D 02
STANDARD ERROR OF EST.	0.484390D 01
F-STATISTIC	13.53
NUMERATOR DEGREES OF FREEDOM	8
DENOMINATOR DEGREES OF FREEDOM	128
SIGNIFICANCE	0.0000

VARIABLE NO.	NAME	REGRESSION COEFFICIENT	STANDARD ERROR	STAND. COEF.	T-STAT.	2TAIL SIG.	TOL-ERANCE
	INTERCEPT	0.122528D 02	0.544764D 01	1.920	2.25	0.026	
122	LIGHTH	-0.755519D 01	0.361665D 01	-0.471	-2.08	0.039	0.082762
133	MINUTES	0.171593D-01	0.122579D-01	0.247	1.40	0.164	0.135440
150	CLASSIZE	0.296159D 00	0.170039D 00	0.241	1.74	0.084	0.220473
153	FACTOR2	0.176810D 01	0.673607D 00	0.175	2.62	0.010	0.950322
154	FACTOR3	0.123030D 01	0.527137D 00	0.224	2.33	0.021	0.460344
79	Z1	0.187058D 01	0.222410D 01	0.206	0.84	0.402	0.070317
82	Z4	-0.323585D 01	0.232113D 01	-0.200	-1.39	0.166	0.204892
83	Z5	0.401252D 01	0.379144D 01	0.106	1.06	0.291	0.419941

PROBLEM NUMBER 1 COMPLETED.

MULTIPLE R 0.6769 STD. ERROR OF EST. 4.8620
MULTIPLE R-SQUARE 0.4582

ANALYSIS OF VARIANCE

	SUM OF SQUARES	DF	MEAN SQUARE	F RATIO	P(TAIL)
REGRESSION	2539.194	9	282.133	11.935	0.00000
RESIDUAL	3002.162	127	23.639		

VARIABLE		COEFFICIENT	STD. ERROR	STD. REG COEFF	T	P(2 TAIL)
INTERCEPT		12.292				
LIGHTH	122	-7.514	3.632	-0.470	-2.069	0.041
MINUTES	133	0.017	0.012	0.245	1.373	0.172
CLASSIZE	150	0.300	0.172	0.244	1.743	0.084
FACTOR2	153	1.702	0.651	0.177	2.616	0.010
FACTOR3	154	1.235	0.530	0.225	2.331	0.021
Z1	79	1.905	2.241	0.210	0.850	0.397
Z4	82	-3.281	2.344	-0.203	-1.400	0.164
Z5	83	3.995	3.808	0.106	1.049	0.296
Y31	67	-0.176	1.026	-0.014	-0.172	0.864

[illegible]

MULTIPLE R 0.6878
MULTIPLE R-SQUARE 0.4731

STD. ERROR OF EST. 4.0139

ANALYSIS OF VARIANCE

	SUM OF SQUARES	DF	MEAN SQUARE	F RATIO	F(TAIL)
REGRESSION	2621.495	10	262.149	11.313	0.00000
RESIDUAL	2719.852	120	23.173		

VARIABLE		COEFFICIENT	STD. ERROR	STD. REG COEFF	T	P(2 TAIL)
INTERCEPT		11.206				
EIGHTH	122	-8.096	3.609	-0.506	-2.243	0.027
MINUTES	133	0.016	0.012	0.230	1.302	0.195
CLASSIZE	150	0.346	0.172	0.282	2.014	0.046
FACTOR2	153	3.265	1.036	0.323	3.151	0.002
FACTOR3	154	1.157	0.526	0.211	2.199	0.030
Z1	79	2.278	2.228	0.251	1.022	0.309
Z4	82	-2.015	2.416	-0.125	-0.834	0.406
Z5	83	3.573	3.777	0.095	0.946	0.346
Y31	67	-1.028	1.112	-0.080	-0.924	0.357
Y32	68	-3.472	1.842	-0.211	-1.885	0.062

MULTIPLE R 0.6902
MULTIPLE R-SQUARE 0.4763

STD. ERROR OF EST. 4.8182

ANALYSIS OF VARIANCE

	SUM OF SQUARES	DF	MEAN SQUARE	F RATIO	F(TAIL)
REGRESSION	2639.482	11	239.953	10.336	0.00000
RESIDUAL	2901.864	125	23.215		

VARIABLE		COEFFICIENT	STD. ERROR	STD. REG COEFF	T	P(2 TAIL)
INTERCEPT		11.425				
EIGHTH	122	-7.642	3.649	-0.470	-2.094	0.038
MINUTES	133	0.016	0.012	0.231	1.308	0.193
CLASSIZE	150	0.333	0.173	0.271	1.927	0.056
FACTOR2	153	3.846	1.230	0.301	3.128	0.002
FACTOR3	154	1.175	0.527	0.214	2.230	0.028
Z1	79	2.099	2.239	0.232	0.937	0.350
Z4	82	-2.087	2.420	-0.129	-0.863	0.390
Z5	83	3.069	3.824	0.081	0.803	0.424
Y31	67	-1.125	1.118	-0.086	-1.006	0.316
Y32	68	-3.772	1.875	-0.229	-2.011	0.046
Y33	69	3.431	3.898	0.075	0.880	0.380

MULTIPLE R	0.6930	STD. ERROR OF EST.	4.8192		
MULTIPLE R-SQUARE	0.4803				

ANALYSIS OF VARIANCE

	SUM OF SQUARES	DF	MEAN SQUARE	F RATIO	P(TAIL)
REGRESSION	2661.540	12	221.795	9.550	0.00000
RESIDUAL	2879.807	124	23.224		

VARIABLE		COEFFICIENT	STD. ERROR	STD. REG COEFF	T	P(2 TAIL)
INTERCEPT		11.524				
EIGHTH	122	-5.762	4.128	-0.360	-1.396	0.165
MINUTES	133	0.016	0.012	0.226	1.276	0.204
CLASSIZE	150	0.332	0.173	0.270	1.919	0.057
FACTOR2	153	3.686	1.241	0.365	2.971	0.004
FACTOR3	154	1.160	0.527	0.211	2.200	0.030
Z1	79	1.537	2.313	0.170	0.665	0.507
Z4	82	-2.056	2.420	-0.127	-0.850	0.397
Z5	83	2.988	3.825	0.079	0.781	0.436
Y31	67	-1.003	1.126	-0.078	-0.891	0.375
Y32	68	-3.572	1.887	-0.217	-1.893	0.061
Y33	69	3.169	3.908	0.070	0.811	0.419
Y34	70	0.799	0.820	0.119	0.974	0.332

MULTIPLE R	0.6980	STD. ERROR OF EST.	4.8065		
MULTIPLE R-SQUARE	0.4872				

ANALYSIS OF VARIANCE

	SUM OF SQUARES	DF	MEAN SQUARE	F RATIO	P(TAIL)
REGRESSION	2699.785	13	207.676	8.989	0.00000
RESIDUAL	2841.561	123	23.102		

VARIABLE		COEFFICIENT	STD. ERROR	STD. REG COEFF	T	P(2 TAIL)
INTERCEPT		11.082				
EIGHTH	122	-8.146	4.515	-0.510	-1.804	0.074
MINUTES	133	0.014	0.012	0.202	1.139	0.257
CLASSIZE	150	0.365	0.174	0.297	2.094	0.038
FACTOR2	153	3.593	1.240	0.356	2.898	0.004
FACTOR3	154	2.046	0.866	0.372	2.362	0.020
Z1	79	1.701	2.310	0.188	0.736	0.463
Z4	82	-1.029	2.543	-0.064	-0.405	0.686
Z5	83	2.810	3.818	0.074	0.736	0.463
Y31	67	-1.009	1.123	-0.079	-0.899	0.371
Y32	68	-3.512	1.883	-0.214	-1.866	0.064
Y33	69	2.974	3.900	0.065	0.763	0.447
Y34	70	0.112	0.977	0.017	0.114	0.909
Y35	71	-2.030	1.578	-0.209	-1.287	0.201

STATISTICS FOR 'BEST' SUBSET

SQUARED MULTIPLE CORRELATION :	0.50376
MULTIPLE CORRELATION	0.70976
ADJUSTED SQUARED MULT. CORR.	0.44681
RESIDUAL MEAN SQUARE	0.225404D 02
STANDARD ERROR OF EST.	0.474767D 01
F-STATISTIC	6.85
NUMERATOR DEGREES OF FREEDOM	14
DENOMINATOR DEGREES OF FREEDOM	122
SIGNIFICANCE	0.0000

VARIABLE NO.	NAME	REGRESSION COEFFICIENT	STANDARD ERROR	STAND. COEF.	T-STAT.	2TAIL SIG.	TOL-ERANCE
	INTERCEPT	0.107935D 02	0.538623D 01	1.691	2.00	0.047	
122	EIGHTH	-0.896508D 01	0.447802D 01	-0.561	-2.00	0.048	0.051850
133	MINUTES	0.145791D-01	0.121533D-01	0.210	1.20	0.233	0.132377
150	CLASSIZE	0.354962D 00	0.172251D 00	0.289	2.06	0.041	0.206424
153	FACTOR2	0.378535D 01	0.122813D 01	0.375	3.08	0.003	0.274679
154	FACTOR3	0.283001D 01	0.939832D 00	0.515	3.01	0.003	0.139142
79	Z1	0.127961D 01	0.229153D 01	0.141	0.56	0.578	0.063642
82	Z4	-0.145612D 01	0.252048D 01	-0.090	-0.58	0.565	0.166950
83	Z5	0.138523D 01	0.383666D 01	0.037	0.36	0.719	0.394016
67	Y31	-0.103149D 01	0.110894D 01	-0.080	-0.93	0.354	0.543262
68	Y32	-0.350400D 01	0.186947D 01	-0.213	-1.88	0.062	0.317861
69	Y33	0.393937D 01	0.388209D 01	0.087	1.01	0.312	0.559165
70	Y34	-0.324237D 00	0.989263D 00	-0.048	-0.33	0.744	0.187964
71	Y35	-0.288999D 01	0.161579D 01	-0.298	-1.79	0.076	0.146612
72	Y36	0.585544D 01	0.290317D 01	0.177	2.02	0.045	0.525274

PROBLEM NUMBER 1 COMPLETED.

CORRELATIONS

		EIGHTH 122	MINUTES 133	CLASSIZE 150	FACTOR2 153	FACTOR3 154	Z1 79	Z4 82	Z5 83	Y31 67	Y32 68	Y33 69	Y34 70	Y35 71
EIGHTH	122	1.000												
MINUTES	133	-0.347	1.000											
CLASSIZE	150	0.550	0.350	1.000										
FACTOR2	153	0.121	-0.070	0.085	1.000									
FACTOR3	154	-0.699	0.169	-0.376	-0.129	1.000								
Z1	79	0.617	-0.735	-0.383	0.152	-0.293	1.000							
Z4	82	0.263	-0.059	0.385	-0.053	-0.358	-0.395	1.000						
Z5	83	-0.165	-0.408	-0.364	-0.001	0.230	0.017	0.139	1.000					
Y31	67	0.374	-0.363	0.972	0.191	-0.151	0.543	-0.252	0.002	1.000				
Y32	68	0.120	0.012	0.256	0.654	-0.275	-0.069	0.373	0.031	-0.186	1.000			
Y33	69	-0.122	-0.091	-0.058	-0.577	0.115	-0.058	0.050	0.247	-0.080	-0.289	1.000		
Y34	70	-0.761	0.020	-0.602	-0.022	0.594	-0.143	-0.504	0.183	-0.141	-0.248	0.100	1.000	
Y35	71	-0.636	0.267	-0.199	-0.180	0.760	-0.566	0.100	0.260	-0.305	-0.093	0.135	0.242	1.000
Y36	72	0.657	-0.374	0.207	0.041	-0.514	0.311	0.314	0.188	0.150	0.154	-0.034	-0.318	-0.305
Y11	47	0.407	-0.211	0.407	0.373	-0.440	0.391	0.110	-0.084	0.629	0.411	-0.261	-0.497	-0.370
Y12	48	-0.943	0.328	-0.524	-0.133	0.713	-0.583	-0.244	0.155	-0.377	-0.196	0.126	0.780	0.669
Y13	49	0.928	-0.347	0.559	0.134	-0.689	0.618	0.256	-0.163	0.391	0.201	-0.129	-0.744	-0.628
Y14	50	0.987	-0.344	0.519	0.090	-0.678	0.605	0.274	-0.170	0.327	0.162	-0.104	-0.723	-0.636
Y15	51	-0.993	0.345	-0.527	-0.097	0.682	-0.609	-0.272	0.169	-0.337	-0.169	0.108	0.728	0.637
Y16	52	0.075	0.019	0.097	0.979	-0.136	0.073	-0.033	-0.026	0.043	0.639	-0.622	-0.011	-0.142
Y17	53	-0.641	0.212	-0.328	-0.131	0.984	-0.311	-0.332	0.181	-0.151	-0.263	0.102	0.485	0.756
Y18	54	0.595	-0.767	-0.169	0.144	-0.289	0.992	-0.392	-0.003	0.534	-0.080	-0.067	-0.130	-0.564
Y19	55	0.144	0.272	0.439	-0.055	-0.277	-0.534	0.967	0.089	-0.321	0.367	0.051	-0.437	0.175
Y20	56	-0.069	-0.406	-0.044	0.017	0.162	0.092	0.173	0.989	0.043	0.048	0.231	0.123	0.100
Y21	57	0.221	-0.054	0.213	0.961	-0.200	0.162	0.020	-0.008	0.163	0.719	-0.521	-0.135	-0.201
Y22	58	-0.762	0.242	-0.391	-0.148	0.978	-0.405	-0.301	0.213	-0.236	-0.255	0.139	0.592	0.801
Y23	59	0.749	-0.757	0.042	0.164	-0.417	0.973	-0.200	0.036	0.548	0.025	-0.065	-0.307	-0.591
Y24	60	0.457	0.160	0.611	-0.001	-0.470	-0.289	0.947	0.034	-0.162	0.389	-0.001	-0.637	-0.062
Y25	61	-0.334	-0.402	-0.377	-0.015	0.352	0.068	-0.000	0.938	-0.009	-0.037	0.250	0.367	0.325
TOTAL1	119	-0.500	0.310	-0.106	0.135	0.506	-0.244	-0.371	0.095	-0.095	-0.125	-0.023	0.472	0.290

		Y36 72	Y11 47	Y12 48	Y13 49	Y14 50	Y15 51	Y16 52	Y17 53	Y18 54	Y19 55	Y20 56	Y21 57	Y22 58
Y36	72	1.000												
Y11	47	0.272	1.000											
Y12	48	-0.495	-0.611	1.000										
Y13	49	0.464	0.633	-0.944	1.000									
Y14	50	0.467	0.536	-0.928	0.978	1.000								
Y15	51	-0.468	-0.553	0.933	-0.904	-0.999	1.000							
Y16	52	0.012	0.297	-0.087	0.087	0.030	-0.055	1.000						
Y17	53	-0.072	-0.409	0.652	-0.641	-0.631	0.633	-0.106	1.000					
Y18	54	0.297	0.376	-0.564	0.597	0.585	-0.589	0.064	-0.308	1.000				
Y19	55	0.214	0.032	-0.133	0.138	0.154	-0.152	-0.015	-0.246	-0.544	1.000			
Y20	56	0.226	-0.027	0.064	-0.067	-0.073	0.073	-0.017	0.117	0.078	0.102	1.000		
Y21	57	0.105	0.510	-0.232	0.238	0.178	-0.168	0.957	-0.195	0.146	0.016	0.015	1.000	
Y22	58	-0.521	-0.510	0.792	-0.765	-0.742	0.748	-0.117	0.972	-0.403	-0.205	0.135	-0.226	1.000
Y23	59	0.405	0.496	-0.709	0.753	0.726	-0.732	0.082	-0.426	0.966	-0.358	0.124	0.201	-0.530
Y24	60	0.325	0.253	-0.429	0.463	0.461	-0.461	0.020	-0.422	-0.306	0.939	0.084	0.097	-0.429
Y25	61	0.113	-0.195	0.315	-0.333	-0.333	0.334	-0.044	0.284	0.070	-0.052	0.915	-0.059	0.335
TOTAL1	119	-0.271	-0.291	0.464	-0.498	-0.499	0.500	0.170	0.491	-0.269	-0.254	0.034	0.068	0.528

		Y23 59	Y24 60	Y25 61	TOTALI 119
Y23	59	1.000			
Y24	60	-0.089	1.000		
Y25	61	0.042	-0.167	1.000	
TOTALI	119	-0.355	-0.376	0.143	1.000

VARIABLE 122 EIGHTH IS NOT INCLUDED AS A PREDICTOR DUE TO LOW TOLERANCE.

VARIABLE 133 MINUTES IS NOT INCLUDED AS A PREDICTOR DUE TO LOW TOLERANCE.

VARIABLE 49 Y13 IS NOT INCLUDED AS A PREDICTOR DUE TO LOW TOLERANCE.

VARIABLE 50 Y14 IS NOT INCLUDED AS A PREDICTOR DUE TO LOW TOLERANCE.

VARIABLE 60 Y24 IS NOT INCLUDED AS A PREDICTOR DUE TO LOW TOLERANCE.

STATISTICS FOR 'BEST' SUBSET

SQUARED MULTIPLE CORRELATION	0.50396
MULTIPLE CORRELATION	0.70990
ADJUSTED SQUARED MULT. CORR.	0.44247
RESIDUAL MEAN SQUARE	0.227175D 02
STANDARD ERROR OF EST.	0.476629D 01
F-STATISTIC	8.20
NUMERATOR DEGREES OF FREEDOM	15
DENOMINATOR DEGREES OF FREEDOM	121
SIGNIFICANCE	0.0000

VARIABLE NO.	NAME	REGRESSION COEFFICIENT	STANDARD ERROR	STAND. COEF.	T-STAT.	2TAIL SIG.	TOL-ERANCE
	INTERCEPT	0.107972D 02	0.540738D 01	1.691	2.00	0.048	
122	EIGHTH	-0.477896D 01	0.194915D 02	-0.299	-0.25	0.807	0.002758
133	MINUTES	0.142114D-01	0.123142D-01	0.205	1.15	0.251	0.129954
150	CLASSIZE	0.365484D 00	0.179377D 00	0.298	2.04	0.044	0.191844
153	FACTOR2	0.375417D 01	0.124101D 01	0.372	3.03	0.003	0.271120
154	FACTOR3	0.278690D 01	0.963518D 00	0.507	2.89	0.005	0.133425
79	Z1	0.128463D 01	0.230066D 01	0.142	0.56	0.578	0.063634
82	Z4	-0.154191D 01	0.256004D 01	-0.095	-0.60	0.548	0.163101
83	Z5	0.134264D 01	0.385654D 01	0.036	0.35	0.728	0.393032
67	Y31	-0.937547D 00	0.119221D 01	-0.073	-0.79	0.433	0.473724
68	Y32	-0.339911D 01	0.192629D 01	-0.207	-1.76	0.080	0.298517
69	Y33	0.385069D 01	0.391797D 01	0.085	0.98	0.328	0.553284
70	Y34	-0.328741D 00	0.993352D 00	-0.049	-0.33	0.741	0.187884
71	Y35	-0.282070D 01	0.165222D 01	-0.291	-1.71	0.090	0.141320
72	Y36	0.578545D 01	0.293175D 01	0.175	1.97	0.051	0.519130
49	Y13	-0.417335D 01	0.189081D 02	-0.272	-0.22	0.826	0.002693

PROBLEM NUMBER 1 COMPLETED.

BMDP1R - MULTIPLE LINEAR REGRESSION
HEALTH SCIENCES COMPUTING FACILITY
UNIVERSITY OF CALIFORNIA, LOS ANGELES

PROGRAM REVISED APRIL, 1977
MANUAL DATE -- 1975

IN THIS VERSION OF BMDP1R

-- A REGRESSION PARAGRAPH MUST BE STATED FOR EACH PROBLEM.
-- WHEN THE CORRELATION MATRIX IS REQUESTED, THE CORRELATION OF THE REGRESSION COEFFICIENTS IS ALSO PRINTED IF MORE THAN ONE VARIABLE ENTERED THE EQUATION.

REGRESSION TITLE. . . . . .CLASSROOM DATA -EXPERIMENTAL GROUP ANALYSIS
DEPENDENT VARIABLE. 119 TOTAL1
TOLERANCE 0.0100
ALL DATA CONSIDERED AS A SINGLE GROUP

MULTIPLE R 0.7099 STD. ERROR OF EST. 4.7662
MULTIPLE R-SQUARE 0.5040

ANALYSIS OF VARIANCE

	SUM OF SQUARES	DF	MEAN SQUARE	F RATIO	P(TAIL)
REGRESSION	2792.586	15	186.172	8.195	0.00000
RESIDUAL	2748.760	121	22.717		

VARIABLE		COEFFICIENT	STD. ERROR	STD. REG COEFF	T	P(2 TAIL)	
INTERCEPT		10.797					
EIGHTH	122	-10.980	10.167	-0.687	-1.080	0.282	
MINUTES	133	0.014	0.012	0.205	1.154	0.251	
CLASSIZE	150	0.365	0.179	0.298	2.038	0.044	
FACTOR2	153	3.754	1.241	0.372	3.025	0.003	
FACTOR3	154	2.787	0.964	0.507	2.892	0.005	
Z1	79	1.284	2.301	0.142	0.558	0.578	
Z4	82	-1.542	2.560	-0.096	-0.602	0.548	
Z5	83	1.343	3.857	0.036	0.348	0.728	
Y31	67	-0.937	1.192	-0.073	-0.786	0.433	
Y32	68	-3.399	1.926	-0.207	-1.765	0.080	
Y33	69	3.851	3.918	0.085	0.983	0.328	
Y34	70	-0.329	0.993	-0.049	-0.331	0.741	
Y35	71	-2.820	1.652	-0.291	-1.707	0.090	
Y36	72	5.785	2.932	0.175	1.973	0.051	
Y13	49						REDUNDANT VARIABLE-NOT USED. TOLERANCE =
Y14	50	2.950	13.349	0.117	0.221	0.825	
Y15	51						REDUNDANT VARIABLE-NOT USED. TOLERANCE =

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STATISTICS FOR 'BEST' SUBSET
SQUARED MULTIPLE CORRELATION          0.56641
MULTIPLE CORRELATION                  0.75260
ADJUSTED SQUARED MULT. CORR.          0.47350
RESIDUAL MEAN SQUARE              0.214531D 02
STANDARD ERROR OF EST.            0.463175D 01
F-STATISTIC                              6.10
NUMERATOR DEGREES OF FREEDOM               24
DENOMINATOR DEGREES OF FREEDOM            112
SIGNIFICANCE                           0.0000
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VARIABLE NO.	NAME	REGRESSION COEFFICIENT	STANDARD ERROR	STAND. COEF.	T-STAT.	2TAIL SIG.	TOL-ERANCE
	INTERCEPT	0.145757D 02	0.164029D 02	2.283	0.89	0.376	
150	CLASSIZE	0.820592D 00	0.766856D 00	0.669	1.07	0.287	0.009913
153	FACTOR2	-0.830025D 01	0.111715D 02	-0.822	-0.74	0.459	0.003159
154	FACTOR3	-0.712679D 01	0.658603D 01	-1.297	-1.08	0.282	0.002697
79	Z1	0.409622D 00	0.199341D 02	0.045	0.02	0.984	0.000800
82	Z4	-0.312136D 01	0.121959D 02	-0.193	-0.26	0.798	0.006787
83	Z5	-0.141422D 03	0.802000D 02	-3.745	-1.76	0.081	0.000858
67	Y31	0.267765D 01	0.451415D 01	0.209	0.59	0.554	0.031204
68	Y32	0.107693D 01	0.440657D 01	0.066	0.24	0.807	0.053870
69	Y33	0.125745D 02	0.624205D 01	0.276	2.01	0.046	0.205848
70	Y34	0.398389D 01	0.271834D 01	0.592	1.47	0.146	0.023693
71	Y35	0.886338D 00	0.315065D 01	0.091	0.28	0.779	0.036700
72	Y36	0.653202D 01	0.462056D 01	0.198	1.41	0.160	0.197365
47	Y11	0.322038D 01	0.677199D 01	0.151	0.48	0.635	0.039240
48	Y12	-0.583742D 01	0.430054D 01	-0.612	-1.36	0.177	0.019072
51	Y15	-0.194865D 02	0.511602D 02	-0.174	-0.38	0.704	0.018445
52	Y16	0.470512D-01	0.216603D-01	2.253	2.29	0.030	0.003691
53	Y17	0.117954D-01	0.156750D-01	0.949	0.75	0.453	0.002433
54	Y18	-0.294770D-01	0.751293D-01	-1.487	-0.39	0.696	0.000270
55	Y19	-0.208247D-01	0.235121D-01	-0.611	-0.89	0.378	0.008143
56	Y20	0.149706D 00	0.134033D 00	1.806	1.12	0.266	0.001480
57	Y21	-0.572752D 00	0.308324D 00	-1.262	-1.86	0.066	0.008387
58	Y22	0.149741D 00	0.218276D 00	0.637	0.69	0.494	0.004490
59	Y23	0.149580D 00	0.677101D 00	0.394	0.22	0.826	0.001217
61	Y25	0.492556D 01	0.211041D 01	2.258	2.33	0.021	0.004210

PROBLEM NUMBER 1 COMPLETED.

STATISTICS FOR THE INDEPENDENT VARIABLES IN THE INITIAL LEARNING MODEL FOR THE REPLICATION GROUP ***

Independent Variables	r_{Yi}	B_i	R^2_i	b_i	b_{se}	t_i	sr_i	pr_i	sR^2_i	pR^2_i	Alpha	Power**
* Grade Level	-.64	-5.777	.999	-78.290	36.923	-2.12	-.113	-.176	.013	.031	.036	.55
* Intruction-al Time	.63	-4.941	.999	-.230	.126	-1.83	-.098	-.153	.010	.023	.070	.47
* Classize	-.603	.026	.957		.601	.10	.005	.008	.000	.000	.919	.02
Factor 2	.542	.244	.280	2.051	.529	3.88	.207	.312	.043	.097	.000	.97
Factor 3	.471	.129	.299	1.094	.543	2.01	.107	.167	.012	.028	.046	.53
** Z1	.146	-.179	.776	-3.834	2.415	-1.59	-.085	-.133	.007	.018	.115	.35
* Z4	.433	-.123	.910	-2.129	3.081	- .69	-.037	-.058	.001	.003	.491	.08
Z * Z5	-.522	.137	.872	1.579	1.719	.92	.049	.078	.002	.006	.360	.14

(N = 149; R^2 = .600)

* When B_i falls outside the limits set by r_{Yi} and zero, then the independent variable should be considered a suppressor variable.

** The power was caculated at alpha equals .05 from formulat #17.

*** This data was compiled from the regression analyses on the following pages.

STATISTICS FOR 'BEST' SUBSET
SQUARED MULTIPLE CORRELATION 0.50821
MULTIPLE CORRELATION 0.71289
ADJUSTED SQUARED MULT. CORR. 0.50001
RESIDUAL MEAN SQUARE 0.228209D 02
STANDARD ERROR OF EST. 0.477712D 01
F-STATISTIC 62.00
NUMERATOR DEGREES OF FREEDOM 3
DENOMINATOR DEGREES OF FREEDOM 180
SIGNIFICANCE 0.0000

VARIABLE NO.	NAME	REGRESSION COEFFICIENT	STANDARD ERROR	STAND. COEF.	T-STAT.	2TAIL SIG.	TOL-ERANCE
	INTERCEPT	0.375753D 03	0.625716D 02	55.618	6.01	0.000	
122	EIGHTH	-0.173418D 03	0.295734D 02	-12.666	-5.86	0.000	0.000567
133	MINUTES	-0.554269D 00	0.991586D-01	-11.993	-5.59	0.000	0.000594
150	CLASSIZE	0.586594D 00	0.349000D 00	0.246	1.68	0.095	0.127277

STATISTICS FOR 'BEST' SUBSET
SQUARED MULTIPLE CORRELATION 0.56208
MULTIPLE CORRELATION 0.74972
ADJUSTED SQUARED MULT. CORR. 0.54991
RESIDUAL MEAN SQUARE 0.205984D 02
STANDARD ERROR OF EST. 0.453854D 01
F-STATISTIC 46.21
NUMERATOR DEGREES OF FREEDOM 4
DENOMINATOR DEGREES OF FREEDOM 144
SIGNIFICANCE 0.0000

VARIABLE NO.	NAME	REGRESSION COEFFICIENT	STANDARD ERROR	STAND. COEF.	T-STAT.	2TAIL SIG.	TOL-ERANCE
	INTERCEPT	0.324261D 03	0.684700D 02	47.932	4.74	0.000	
122	EIGHTH	-0.148133D 03	0.316748D 02	-10.930	-4.68	0.000	0.000557
133	MINUTES	-0.475238D 00	0.107027D 00	-10.187	-4.44	0.000	0.000578
150	CLASSIZE	0.543469D 00	0.371754D 00	0.234	1.46	0.146	0.118604
153	FACTOR2	0.226696D 01	0.530190D 00	0.270	4.28	0.000	0.763234

STATISTICS FOR 'BEST' SUBSET
SQUARED MULTIPLE CORRELATION 0.57679
MULTIPLE CORRELATION 0.75947
ADJUSTED SQUARED MULT. CORR. 0.56199
RESIDUAL MEAN SQUARE 0.200455D 02
STANDARD ERROR OF EST. 0.447722D 01
F-STATISTIC 38.98
NUMERATOR DEGREES OF FREEDOM 5
DENOMINATOR DEGREES OF FREEDOM 143
SIGNIFICANCE 0.0000

VARIABLE NO.	NAME	REGRESSION COEFFICIENT	STANDARD ERROR	STAND. COEF.	T-STAT.	2TAIL SIG.	TOL-ERANCE
	INTERCEPT	0.290762D 03	0.691957D 02	42.980	4.20	0.000	
122	EIGHTH	-0.131085D 03	0.321686D 02	-9.672	-4.07	0.000	0.000525
133	MINUTES	-0.421763D 00	0.108270D 00	-9.040	-3.90	0.000	0.000549
150	CLASSIZE	0.448350D 00	0.369204D 00	0.193	1.21	0.227	0.117021
153	FACTOR2	0.231250D 01	0.523425D 00	0.275	4.42	0.000	0.762072
154	FACTOR3	0.122270D 01	0.548372D 00	0.144	2.23	0.027	0.712748

STATISTICS FOR 'BEST' SUBSET
SQUARED MULTIPLE CORRELATION 0.59720
MULTIPLE CORRELATION 0.77278
ADJUSTED SQUARED MULT. CORR. 0.58018
RESIDUAL MEAN SQUARE 0.192134D 02
STANDARD ERROR OF EST. 0.438331D 01
F-STATISTIC 35.09
NUMERATOR DEGREES OF FREEDOM 6
DENOMINATOR DEGREES OF FREEDOM 142
SIGNIFICANCE 0.0000

VARIABLE NO.	NAME	REGRESSION COEFFICIENT	STANDARD ERROR	STAND. COEF.	T-STAT.	2TAIL SIG.	TOL-ERANCE
	INTERCEPT	0.198537D 03	0.759715D 02	29.348	2.61	0.010	
122	EIGHTH	-0.853533D 02	0.358134D 02	-6.298	-2.38	0.018	0.000406
133	MINUTES	-0.266017D 00	0.120863D 00	-5.702	-2.20	0.029	0.000423
150	CLASSIZE	-0.334260D-01	0.403553D 00	-0.014	-0.08	0.934	0.093644
153	FACTOR2	0.203905D 01	0.522469D 00	0.243	3.90	0.000	0.733055
154	FACTOR3	0.114251D 01	0.537701D 00	0.134	2.12	0.035	0.710544
79	Z1	-0.484902D 01	0.180795D 01	-0.227	-2.68	0.008	0.397510

STATISTICS FOR 'BEST' SUBSET	
SQUARED MULTIPLE CORRELATION	0.59797
MULTIPLE CORRELATION	0.77329
ADJUSTED SQUARED MULT. CORR.	0.57601
RESIDUAL MEAN SQUARE	0.193124D 02
STANDARD ERROR OF EST.	0.439458D 01
F-STATISTIC	29.96
NUMERATOR DEGREES OF FREEDOM	7
DENOMINATOR DEGREES OF FREEDOM	141
SIGNIFICANCE	0.0000

VARIABLE NO.	NAME	REGRESSION COEFFICIENT	STANDARD ERROR	STAND. COEF.	T-STAT.	2TAIL SIG.	TOL-ERANCE
	INTERCEPT	0.191528D 03	0.773429D 02	28.312	2.48	0.014	
122	EIGHTH	-0.860322D 02	0.359291D 02	-6.348	-2.39	0.018	0.000406
133	MINUTES	-0.261809D 00	0.121442D 00	-5.612	-2.16	0.033	0.000421
150	CLASSIZE	0.166963D 00	0.585011D 00	0.081	0.32	0.750	0.044904
153	FACTOR2	0.207295D 01	0.527647D 00	0.247	3.93	0.000	0.721950
154	FACTOR3	0.115037D 01	0.539295D 00	0.135	2.13	0.035	0.709988
79	Z1	-0.402508D 01	0.240419D 01	-0.188	-1.67	0.096	0.225953
82	Z4	-0.157525D 01	0.301962D 01	-0.091	-0.52	0.603	0.093879

STATISTICS FOR 'BEST' SUBSET	
SQUARED MULTIPLE CORRELATION	0.60038
MULTIPLE CORRELATION	0.77484
ADJUSTED SQUARED MULT. CORR.	0.57754
RESIDUAL MEAN SQUARE	0.193235D 02
STANDARD ERROR OF EST.	0.439702D 01
F-STATISTIC	26.29
NUMERATOR DEGREES OF FREEDOM	8
DENOMINATOR DEGREES OF FREEDOM	140
SIGNIFICANCE	0.0000

VARIABLE NO.	NAME	REGRESSION COEFFICIENT	STANDARD ERROR	STAND. COEF.	T-STAT.	2TAIL SIG.	TOL-ERANCE
	INTERCEPT	0.174165D 03	0.795600D 02	25.745	2.19	0.030	
122	EIGHTH	-0.782914D 02	0.369234D 02	-5.777	-2.12	0.036	0.000385
133	MINUTES	-0.230529D 00	0.126191D 00	-4.941	-1.83	0.070	0.000390
150	CLASSIZE	0.611230D-01	0.601152D 00	0.026	0.10	0.919	0.042572
153	FACTOR2	0.205164D 01	0.526648D 00	0.244	3.88	0.000	0.720561
154	FACTOR3	0.109421D 01	0.543047D 00	0.129	2.01	0.046	0.700959
79	Z1	-0.383417D 01	0.241446D 01	-0.179	-1.59	0.115	0.224278
82	Z4	-0.212889D 01	0.308683D 01	-0.123	-0.69	0.491	0.090287
83	Z5	0.157872D 01	0.171860D 01	0.137	0.92	0.360	0.128050

STATISTICS FOR 'BEST' SUBSET	
SQUARED MULTIPLE CORRELATION	0.60384
MULTIPLE CORRELATION	0.77707
ADJUSTED SQUARED MULT. CORR.	0.57819
RESIDUAL MEAN SQUARE	0.193043D 02
STANDARD ERROR OF EST.	0.439366D 01
F-STATISTIC	23.54
NUMERATOR DEGREES OF FREEDOM	9
DENOMINATOR DEGREES OF FREEDOM	139
SIGNIFICANCE	0.0000

VARIABLE NO.	NAME	REGRESSION COEFFICIENT	STANDARD ERROR	STAND. COEF.	T-STAT.	2TAIL SIG.	TOL-ERANCE
	INTERCEPT	0.183958D 03	0.800944D 02	27.193	2.30	0.023	
122	EIGHTH	-0.835125D 02	0.371982D 02	-6.162	-2.25	0.026	0.000378
133	MINUTES	-0.247129D 00	0.126991D 00	-5.297	-1.95	0.054	0.000385
150	CLASSIZE	0.110284D 00	0.652354D 00	0.048	0.13	0.895	0.042339
153	FACTOR2	0.152394D 01	0.713593D 00	0.181	2.13	0.035	0.394868
154	FACTOR3	0.104375D 01	0.544561D 00	0.123	1.92	0.057	0.595030
79	Z1	-0.390004D 01	0.241338D 01	-0.182	-1.62	0.108	0.224141
82	Z4	-0.251102D 01	0.309795D 01	-0.145	-0.81	0.419	0.089155
83	Z5	0.157731D 01	0.171728D 01	0.137	0.92	0.360	0.128055
67	Y31	-0.199769D 01	0.151305D 01	-0.090	-1.19	0.272	0.423123

STATISTICS FOR 'BEST' SUBSET

SQUARED MULTIPLE CORRELATION	0.60633
MULTIPLE CORRELATION	0.77867
ADJUSTED SQUARED MULT. CORR.	0.57781
RESIDUAL MEAN SQUARE	0.193218D 02
STANDARD ERROR OF EST.	0.439566D 01
F-STATISTIC	21.25
NUMERATOR DEGREES OF FREEDOM	10
DENOMINATOR DEGREES OF FREEDOM	138
SIGNIFICANCE	0.0000

VARIABLE NO.	NAME	REGRESSION COEFFICIENT	STANDARD ERROR	STAND. COEF.	T-STAT.	2TAIL SIG.	TOL-ERANCE
	INTERCEPT	0.173080D 03	0.809714D 02	25.585	2.14	0.034	
122	EIGHTH	-0.764420D 02	0.379761D 02	-5.640	-2.01	0.046	0.000363
133	MINUTES	-0.224353D 00	0.129364D 00	-4.809	-1.73	0.085	0.000371
150	CLASSIZE	-0.888563D-01	0.639213D 00	-0.038	-0.14	0.890	0.037630
153	FACTOR2	0.170410D 01	0.739718D 00	0.203	2.30	0.023	0.367793
154	FACTOR3	0.109605D 01	0.547675D 00	0.129	2.00	0.047	0.688765
79	Z1	-0.421073D 01	0.243724D 01	-0.197	-1.73	0.086	0.219972
82	Z4	-0.224176D 01	0.311271D 01	-0.129	-0.72	0.473	0.086392
83	Z5	0.219790D 01	0.184189D 01	0.191	1.19	0.235	0.111412
67	Y31	-0.390998D 01	0.273411D 01	-0.177	-1.43	0.155	0.186229
68	Y32	0.170865D 01	0.182794D 01	0.122	0.93	0.352	0.167074

STATISTICS FOR 'BEST' SUBSET

SQUARED MULTIPLE CORRELATION	0.60891
MULTIPLE CORRELATION	0.78033
ADJUSTED SQUARED MULT. CORR.	0.57751
RESIDUAL MEAN SQUARE	0.193353D 02
STANDARD ERROR OF EST.	0.439719D 01
F-STATISTIC	19.39
NUMERATOR DEGREES OF FREEDOM	11
DENOMINATOR DEGREES OF FREEDOM	137
SIGNIFICANCE	0.0000

VARIABLE NO.	NAME	REGRESSION COEFFICIENT	STANDARD ERROR	STAND. COEF.	T-STAT.	2TAIL SIG.	TOL-ERANCE
	INTERCEPT	0.176190D 03	0.810656D 02	26.044	2.17	0.031	
122	EIGHTH	-0.806282D 02	0.382436D 02	-5.949	-2.11	0.037	0.000359
133	MINUTES	-0.236069D 00	0.129995D 00	-5.060	-1.82	0.072	0.000368
150	CLASSIZE	0.132673D 00	0.680563D 00	0.057	0.19	0.846	0.033219
153	FACTOR2	0.162052D 01	0.744460D 00	0.194	2.18	0.031	0.363375
154	FACTOR3	0.107967D 01	0.548136D 00	0.127	1.97	0.051	0.688085
79	Z1	-0.336966D 01	0.259362D 01	-0.157	-1.30	0.196	0.194382
82	Z4	-0.266129D 01	0.314490D 01	-0.154	-0.85	0.399	0.086651
83	Z5	0.202993D 01	0.185098D 01	0.176	1.10	0.275	0.110397
67	Y31	-0.430791D 01	0.276690D 01	-0.195	-1.56	0.122	0.181967
68	Y32	0.874751D 00	0.202804D 01	0.063	0.43	0.667	0.135826
69	Y33	-0.130654D 01	0.137418D 01	-0.081	-0.95	0.343	0.390960

STATISTICS FOR 'BEST' SUBSET

SQUARED MULTIPLE CORRELATION	0.61643
MULTIPLE CORRELATION	0.78513
ADJUSTED SQUARED MULT. CORR.	0.58259
RESIDUAL MEAN SQUARE	0.191029D 02
STANDARD ERROR OF EST.	0.437069D 01
F-STATISTIC	18.21
NUMERATOR DEGREES OF FREEDOM	12
DENOMINATOR DEGREES OF FREEDOM	136
SIGNIFICANCE	0.0000

VARIABLE NO.	NAME	REGRESSION COEFFICIENT	STANDARD ERROR	STAND. COEF.	T-STAT.	2TAIL SIG.	TOL-ERANCE
	INTERCEPT	0.174533D 03	0.805834D 02	25.799	2.17	0.032	
122	EIGHTH	-0.827150D 02	0.380346D 02	-6.103	-2.17	0.031	0.000358
133	MINUTES	-0.237392D 00	0.129214D 00	-5.088	-1.84	0.068	0.000366
150	CLASSIZE	0.284490D 00	0.682820D 00	0.123	0.42	0.678	0.032604
153	FACTOR2	0.141435D 01	0.751294D 00	0.168	1.88	0.062	0.352507
154	FACTOR3	0.146546D 00	0.789548D 00	0.017	0.19	0.853	0.327651
79	Z1	-0.309841D 01	0.258333D 01	-0.145	-1.20	0.232	0.193676
82	Z4	-0.321919D 01	0.314456D 01	-0.186	-1.02	0.308	0.085629
83	Z5	0.244752D 01	0.185751D 01	0.213	1.32	0.190	0.108305
67	Y31	-0.421763D 01	0.275078D 01	-0.191	-1.53	0.128	0.181694
68	Y32	0.506201D 00	0.202548D 01	0.036	0.25	0.804	0.134135
69	Y33	-0.137117D 01	0.136647D 01	-0.085	-1.00	0.317	0.356652
70	Y34	-0.312614D 01	0.191442D 01	-0.136	-1.63	0.105	0.408924

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STATISTICS FOR 'BEST' SUBSET
SQUARED MULTIPLE CORRELATION        0.61741
MULTIPLE CORRELATION                0.78575
ADJUSTED SQUARED MULT. CORR.        0.58056
RESIDUAL MEAN SQUARE             0.191956D 02
STANDARD ERROR OF EST.           0.438128D 01
F-STATISTIC                           16.76
NUMERATOR DEGREES OF FREEDOM             13
DENOMINATOR DEGREES OF FREEDOM          135
SIGNIFICANCE                         0.0000
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VARIABLE NO.	NAME	REGRESSION COEFFICIENT	STANDARD ERROR	STAND. COEF.	T-STAT.	2TAIL SIG.	TOL-ERANCE
	INTERCEPT	0.188085D 03	0.840267D 02	27.803	2.24	0.027	
122	EIGHTH	-0.904484D 02	0.403477D 02	-0.673	-2.24	0.027	0.000320
133	MINUTES	-0.262359D 00	0.130359D 00	-5.624	-1.92	0.056	0.000332
150	CLASSIZE	0.428175D 00	0.727698D 00	0.184	0.59	0.557	0.028693
153	FACTOR2	0.134690D 01	0.761843D 00	0.160	1.77	0.079	0.344476
154	FACTOR3	-0.740057D-01	0.876452D 00	-0.009	-0.08	0.933	0.207186
79	21	-0.286700D 01	0.263094D 01	-0.131	-1.09	0.279	0.186689
82	24	-0.316772D 01	0.315341D 01	-0.183	-1.00	0.317	0.085562
83	25	0.228030D 01	0.188376D 01	0.198	1.21	0.228	0.105818
67	Y31	-0.429182D 01	0.276036D 01	-0.194	-1.55	0.122	0.181511
68	Y32	0.391850D 00	0.204258D 01	0.026	0.19	0.848	0.132931
69	Y33	-0.146765D 01	0.137965D 01	-0.091	-1.06	0.289	0.385084
70	Y34	-0.212294D 01	0.257269D 01	-0.092	-0.83	0.411	0.227638
71	Y35	-0.113644D 01	0.194002D 01	-0.073	-0.59	0.559	0.180826

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STATISTICS FOR 'BEST' SUBSET
SQUARED MULTIPLE CORRELATION        0.62169
MULTIPLE CORRELATION                0.78848
ADJUSTED SQUARED MULT. CORR.        0.58217
RESIDUAL MEAN SQUARE             0.191221D 02
STANDARD ERROR OF EST.           0.437288D 01
F-STATISTIC                           15.73
NUMERATOR DEGREES OF FREEDOM             14
DENOMINATOR DEGREES OF FREEDOM          134
SIGNIFICANCE                         0.0000
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VARIABLE NO.	NAME	REGRESSION COEFFICIENT	STANDARD ERROR	STAND. COEF.	T-STAT.	2TAIL SIG.	TOL-ERANCE
	INTERCEPT	0.185137D 03	0.838998D 02	27.367	2.21	0.029	
122	EIGHTH	-0.946280D 02	0.404129D 02	-6.982	-2.34	0.021	0.000318
133	MINUTES	-0.269816D 00	0.136232D 00	-5.783	-1.98	0.050	0.000331
150	CLASSIZE	0.833084D 00	0.796611D 00	0.359	1.05	0.298	0.023978
153	FACTOR2	0.119755D 01	0.769996D 00	0.143	1.56	0.122	0.335933
154	FACTOR3	-0.624771D 00	0.982313D 00	-0.073	-0.64	0.526	0.211887
79	21	-0.187742D 01	0.273784D 01	-0.066	-0.69	0.494	0.172526
82	24	-0.356790D 01	0.316407D 01	-0.206	-1.13	0.261	0.084661
83	25	0.216346D 01	0.188254D 01	0.188	1.15	0.253	0.105549
67	Y31	-0.404973D 01	0.276200D 01	-0.183	-1.47	0.145	0.180593
68	Y32	-0.580305D-01	0.207109D 01	-0.004	-0.03	0.978	0.128862
69	Y33	-0.160844D 01	0.138174D 01	-0.100	-1.16	0.246	0.382452
70	Y34	-0.291541D 01	0.264647D 01	-0.126	-1.10	0.273	0.214200
71	Y35	-0.273747D 01	0.233163D 01	-0.177	-1.17	0.242	0.124707
72	Y36	-0.173755D 01	0.140985D 01	-0.111	-1.23	0.220	0.350590

STATISTICS FOR 'BEST' SUBSET

SQUARED MULTIPLE CORRELATION	0.62981
MULTIPLE CORRELATION	0.79361
ADJUSTED SQUARED MULT. CORR.	0.58806
RESIDUAL MEAN SQUARE	0.188524D 02
STANDARD ERROR OF EST.	0.434194D 01
F-STATISTIC	15.09
NUMERATOR DEGREES OF FREEDOM	15
DENOMINATOR DEGREES OF FREEDOM	133
SIGNIFICANCE	0.0000

VARIABLE NO.	NAME	REGRESSION COEFFICIENT	STANDARD ERROR	STAND. COEF.	T-STAT.	2TAIL SIG.	TOL-ERANCE
	INTERCEPT	0.386577D 02	0.119566D 03	5.714	0.32	0.747	
122	EIGHTH	-0.309032D 02	0.547947D 02	-2.280	-0.56	0.574	0.000170
123	MINUTES	-0.383358D-01	0.191490D 00	-0.822	-0.20	0.842	0.000165
150	CLASSIZE	0.694768D 00	0.795109D 00	0.299	0.87	0.384	0.023730
153	FACTOR2	0.136728D 01	0.770974D 00	0.163	1.77	0.078	0.330351
154	FACTOR3	-0.406032D 00	0.983736D 00	-0.048	-0.41	0.680	0.208295
79	Z1	-0.450097D 01	0.312248D 01	-0.210	-1.44	0.152	0.130763
82	Z4	-0.799013D 01	0.407124D 01	-0.461	-1.96	0.052	0.050414
83	Z5	0.673580D 01	0.326523D 01	0.585	2.06	0.041	0.034590
67	Y31	-0.390090D 01	0.274390D 01	-0.177	-1.42	0.157	0.180411
68	Y32	0.828345D 00	0.212092D 01	0.059	0.39	0.697	0.121089
69	Y33	-0.924259D 00	0.142925D 01	-0.057	-0.65	0.519	0.352404
70	Y34	-0.232485D 01	0.265040D 01	-0.101	-0.88	0.382	0.210554
71	Y35	-0.246949D 01	0.232043D 01	-0.159	-1.06	0.289	0.124138
72	Y36	-0.123918D 01	0.142996D 01	-0.079	-0.87	0.388	0.335990
49	Y13	0.109927D 02	0.643658D 01	0.416	1.71	0.090	0.046985

PROBLEM NUMBER 1 COMPLETED.

Y14 was not included as a predictor due to low tolerance

STATISTICS FOR 'BEST' SUBSET

SQUARED MULTIPLE CORRELATION	0.63913
MULTIPLE CORRELATION	0.79945
ADJUSTED SQUARED MULT. CORR.	0.59642
RESIDUAL MEAN SQUARE	0.183782D 02
STANDARD ERROR OF EST.	0.428698D 01
F-STATISTIC	16.70
NUMERATOR DEGREES OF FREEDOM	15
DENOMINATOR DEGREES OF FREEDOM	133
SIGNIFICANCE	0.0000

VARIABLE NO.	NAME	REGRESSION COEFFICIENT	STANDARD ERROR	STAND. COEF.	T- STAT.	2TAIL SIG.	TOL- ERANCE
	INTERCEPT	0.238470D 03	0.147316D 03	35.251	1.62	0.108	
122	EIGHTH'	-0.114654D 03	0.653690D 02	-8.459	-1.75	0.082	0.000117
133	MINUTES	-0.328419D 00	0.228239D 00	-7.040	-1.44	0.153	0.000113
153	FACTOR2	0.117779D 01	0.716400D 00	0.140	1.64	0.103	0.372974
154	FACTOR3	-0.460505D-01	0.968930D 00	-0.005	-0.05	0.962	0.209308
79	Z1	-0.472874D 01	0.235030D 01	-0.221	-2.00	0.047	0.223093
62	Z4'	0.203830D 01	0.495520D 01	0.118	0.41	0.681	0.033176
63	Z5	-0.407335D 00	0.473772D 01	-0.035	-0.09	0.932	0.016017
67	Y31	-0.328720D 01	0.223004D 01	-0.149	-1.47	0.143	0.256263
69	Y33	-0.124955D 01	0.123594D 01	-0.078	-1.01	0.314	0.459410
70	Y34	-0.132343D 01	0.266937D 01	-0.057	-0.50	0.621	0.202350
71	Y35	-0.237416D 01	0.225521D 01	-0.153	-1.05	0.294	0.128116
72	Y36	-0.888394D 00	0.140050D 01	-0.057	-0.63	0.527	0.341465
49	Y13	0.185780D 02	0.718621D 01	0.703	2.59	0.011	0.036746
50	Y14	-0.173510D 02	0.808665D 01	-0.965	-2.15	0.034	0.013423
51	Y15	0.118649D 02	0.620779D 01	0.692	1.91	0.058	0.020674

PROBLEM NUMBER 1 COMPLETED.

CORRELATIONS

		EIGHTH 122	MINUTES 133	CLASSIZE 150	FACTOR2 153	FACTOR3 154	Z1 79	Z4 82	Z5 83	Y31 67	Y32 68	Y33 69	Y34 70	Y35 71
EIGHTH	122	1.000												
MINUTES	133	-1.000	1.000											
CLASSIZE	150	0.934	-0.932	1.000										
FACTOR2	153	-0.418	0.412	-0.435	1.000									
FACTOR3	154	-0.497	0.493	-0.444	0.212	1.000								
Z1	79	-0.612	0.621	-0.650	0.088	0.190	1.000							
Z4	82	-0.850	0.656	-0.694	0.268	0.399	0.703	1.000						
Z5	83	0.902	-0.904	0.911	-0.359	-0.381	-0.632	-0.708	1.000					
Y31	67	0.443	-0.442	0.443	-0.719	-0.242	-0.265	-0.390	0.394	1.000				
Y32	68	0.431	-0.429	0.459	-0.729	-0.277	-0.227	-0.354	0.334	0.079	1.000			
Y33	69	-0.174	0.177	-0.143	0.408	0.096	0.244	0.245	-0.123	-0.659	-0.677	1.000		
Y34	70	0.324	-0.320	0.332	-0.223	-0.736	-0.132	-0.232	0.306	0.184	0.185	-0.048	1.000	
Y35	71	0.336	-0.333	0.387	-0.258	-0.755	-0.113	-0.179	0.310	0.195	0.235	-0.059	0.652	1.000
Y36	72	-0.141	0.144	-0.089	0.029	0.363	0.130	0.178	-0.117	-0.043	-0.052	0.061	-0.621	-0.642
Y11	47	-0.372	0.372	-0.356	0.783	0.235	0.202	0.343	-0.273	-0.849	-0.933	0.803	-0.170	-0.203
Y12	48	-0.341	0.341	-0.308	0.196	0.767	0.139	0.272	-0.272	-0.182	-0.208	0.087	-0.804	-0.916
Y13	49	-0.837	0.836	-0.835	0.326	0.357	0.765	0.801	-0.691	-0.412	-0.352	0.167	-0.292	-0.235
Y14	50	-0.964	0.964	-0.934	0.423	0.467	0.666	0.887	-0.886	-0.471	-0.467	0.186	-0.329	-0.332
Y15	51	0.876	-0.876	0.843	-0.297	-0.399	-0.701	-0.767	0.947	0.358	0.287	-0.144	0.206	0.247
Y16	52	-0.382	0.374	-0.412	0.965	0.175	0.028	0.201	-0.348	-0.572	-0.549	0.189	-0.216	-0.249
Y17	53	-0.497	0.491	-0.442	0.193	0.970	0.187	0.400	-0.377	-0.236	-0.270	0.087	-0.621	-0.603
Y18	54	-0.406	0.417	-0.457	-0.036	0.080	0.951	0.541	-0.405	-0.152	-0.132	0.240	-0.035	-0.037
Y19	55	-0.673	0.682	-0.454	0.134	0.307	0.643	0.953	-0.606	-0.289	-0.237	0.254	-0.141	-0.057
Y20	56	0.884	-0.887	0.909	-0.372	-0.360	-0.565	-0.662	0.991	0.395	0.341	-0.111	0.304	0.325
Y21	57	-0.416	0.411	-0.424	0.994	0.215	0.110	0.293	-0.349	-0.763	-0.773	0.492	-0.219	-0.253
Y22	58	-0.486	0.483	-0.427	0.210	0.993	0.194	0.406	-0.370	-0.240	-0.274	0.100	-0.774	-0.793
Y23	59	-0.678	0.685	-0.715	0.141	0.234	0.989	0.746	-0.707	-0.307	-0.267	0.234	-0.170	-0.144
Y24	60	-0.894	0.899	-0.773	0.314	0.425	0.713	0.991	-0.767	-0.421	-0.397	0.233	-0.262	-0.224
Y25	61	0.899	-0.901	0.896	-0.340	-0.392	-0.646	-0.731	0.998	0.390	0.323	-0.129	0.303	0.296
TOTAL2	120	-0.640	0.632	-0.603	0.642	0.471	0.146	0.433	-0.622	-0.458	-0.447	0.132	-0.392	-0.406

		Y36 72	Y11 47	Y12 48	Y13 49	Y14 50	Y15 51	Y16 52	Y17 53	Y18 54	Y19 55	Y20 56	Y21 57	Y22 58
Y36	72	1.000												
Y11	47	0.005	1.000											
Y12	48	0.804	0.200	1.000										
Y13	49	0.089	0.279	0.199	1.000									
Y14	50	0.121	0.387	0.310	0.900	1.000								
Y15	51	-0.134	-0.232	-0.245	-0.936	-0.868	1.000							
Y16	52	0.010	0.592	0.169	0.303	0.383	-0.286	1.000						
Y17	53	0.153	0.220	0.588	0.375	0.470	-0.410	0.156	1.000					
Y18	54	0.128	0.132	0.008	0.514	0.446	-0.474	-0.105	0.069	1.000				
Y19	55	0.194	0.273	0.214	0.639	0.706	-0.609	0.058	0.307	0.538	1.000			
Y20	56	-0.108	-0.281	-0.274	-0.844	-0.865	0.894	-0.367	-0.350	-0.365	-0.449	1.000		
Y21	57	0.035	0.840	0.199	0.324	0.425	-0.269	0.933	0.195	-0.008	0.171	-0.362	1.000	
Y22	58	0.457	0.237	0.829	0.345	0.457	-0.386	0.171	0.938	0.091	0.323	-0.350	0.214	1.000
Y23	59	0.123	0.223	0.153	0.840	0.741	-0.778	0.086	0.237	0.895	0.660	-0.655	0.158	0.233
Y24	60	0.164	0.362	0.285	0.850	0.930	-0.811	0.252	0.429	0.530	0.907	-0.724	0.333	0.428
Y25	61	-0.122	-0.265	-0.265	-0.911	-0.889	0.964	-0.337	-0.380	-0.414	-0.539	0.900	-0.339	-0.371
TOTAL2	120	0.109	0.412	0.337	0.475	0.602	-0.471	0.527	0.465	-0.032	0.269	-0.525	0.529	0.459

		Y23 59	Y24 60	Y25 61	TOTAL2 120
Y23	59	1.000			
Y24	60	0.767	1.000		
Y25	61	-0.723	-0.785	1.000	
TOTAL2	120	0.217	0.483	-0.511	1.000

```
VARIABLE  150 CLASSIZE IS NOT INCLUDED AS A PREDICTOR DUE TO LOW TOLERANCE.
VARIABLE   83 Z5       IS NOT INCLUDED AS A PREDICTOR DUE TO LOW TOLERANCE.
VARIABLE   47 Y11      IS NOT INCLUDED AS A PREDICTOR DUE TO LOW TOLERANCE.
VARIABLE   49 Y13      IS NOT INCLUDED AS A PREDICTOR DUE TO LOW TOLERANCE.
VARIABLE   53 Y17      IS NOT INCLUDED AS A PREDICTOR DUE TO LOW TOLERANCE.
VARIABLE   55 Y19      IS NOT INCLUDED AS A PREDICTOR DUE TO LOW TOLERANCE.
VARIABLE   56 Y20      IS NOT INCLUDED AS A PREDICTOR DUE TO LOW TOLERANCE.
VARIABLE   59 Y23      IS NOT INCLUDED AS A PREDICTOR DUE TO LOW TOLERANCE.
VARIABLE   60 Y24      IS NOT INCLUDED AS A PREDICTOR DUE TO LOW TOLERANCE.
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STATISTICS FOR 'BEST' SUBSET

SQUARED MULTIPLE CORRELATION	0.65316
MULTIPLE CORRELATION	0.80818
ADJUSTED SQUARED MULT. CORR.	0.59696
RESIDUAL MEAN SQUARE	0.183535D 02
STANDARD ERROR OF EST.	0.428410D 01
F-STATISTIC	12.05
NUMERATOR DEGREES OF FREEDOM	20
DENOMINATOR DEGREES OF FREEDOM	128
SIGNIFICANCE	0.0000

VARIABLE NO.	NAME	REGRESSION COEFFICIENT	STANDARD ERROR	STAND. COEF.	T-STAT.	2TAIL SIG.	TOL-ERANCE
	INTERCEPT	0.258897D 03	0.156536D 03	38.270	1.65	0.101	
122	EIGHTH	-0.124018D 03	0.698708D 02	-9.150	-1.77	0.078	0.000102
133	MINUTES	-0.360893D 00	0.242610D 00	-7.736	-1.49	0.139	0.000100
153	FACTOR2	0.257792D 02	0.256981D 02	3.069	1.00	0.318	0.000289
154	FACTOR3	-0.178050D 02	0.162477D 02	-2.092	-1.10	0.275	0.000743
79	Z1	0.324626D 02	0.158430D 02	1.517	2.05	0.043	0.004945
82	Z4	0.258862D 01	0.643512D 01	0.148	0.40	0.692	0.019645
67	Y31	-0.534641D 01	0.310679D 01	-0.242	-1.68	0.096	0.130210
68	Y32	0.425650D 01	0.429737D 01	0.304	0.99	0.324	0.028714
69	Y33	-0.216351D 01	0.240127D 01	-0.135	-0.90	0.369	0.121543
70	Y34	0.276670D 01	0.352584D 01	0.120	0.78	0.434	0.118827
71	Y35	-0.102347D 02	0.445942D 01	-0.660	-2.30	0.023	0.032722
72	Y36	0.213733D 01	0.239595D 01	0.136	0.89	0.374	0.116513
48	Y12	-0.130306D 02	0.674502D 01	-1.035	-1.93	0.056	0.009439
50	Y14	-0.177395D 02	0.100982D 02	-0.986	-1.76	0.081	0.006597
51	Y15	0.135191D 02	0.803106D 01	0.789	1.68	0.095	0.012336
52	Y16	-0.210489D-01	0.197222D-01	-1.259	-1.07	0.288	0.001946
54	Y18	-0.560222D-01	0.252761D-01	-1.309	-2.22	0.028	0.007769
57	Y21	-0.573944D 00	0.779830D 00	-1.532	-0.74	0.463	0.000625
58	Y22	0.993118D 00	0.843938D 00	2.578	1.18	0.241	0.000565
61	Y25	-0.920968D-01	0.271604D 00	-0.180	-0.34	0.735	0.009574

STATISTICS FOR THE INDEPENDENT VARIABLES IN THE RETENTION MODEL OF LEARNING FOR THE REPLICATION GROUP ***

Independent Variables	r_{Yi}	B_i	R^2_i	b_i	b_{se}	t_i	sr_i	pr_i	sr^2_i	pr^2_i	Alpha*	Power
** Grade Level	-.390	-.682	.917	-7.700	3.49	-2.21	-.196	-.238	.038	.057	.034	.62
** Instructional Time	-.001	.275	.749	.020	.01	1.55	.138	.170	.019	.029	.124	.37
** Classize	-.302	.036	.867	.037	.25	.15	.013	.017	.000	.000	.882	.00
Factor 2	.160	.140	.125	1.210	.82	1.47	.130	.161	.017	.026	.145	.35
Factor 3	.452	.224	.609	.947	.60	1.58	.140	.173	.020	.030	.118	.38
** Z1	.034	.747	.954	6.000	3.33	1.80	.160	.196	.026	.038	.075	.47
** Z4	-.410	.174	.920	2.160	3.89	.56	.050	.062	.002	.004	.580	.06
Z5	.225	.135	.509	3.900	3.66	1.07	.095	.118	.009	.014	.290	.14

(N = 90; R^2 = .362)

* The power was calculated at alpha equals .05 from formula # 17.

** When B_i falls outside the limits set by r_{Yi} and zero, then the independent variable should be considered a suppressor variable.

*** This data was compiled from the regression analyses on the following pages.

STATISTICS FOR 'BEST' SUBSET

SQUARED MULTIPLE CORRELATION	0.14582
MULTIPLE CORRELATION	0.38187
ADJUSTED SQUARED MULT. CORR.	0.12499
RESIDUAL MEAN SQUARE	0.209700D 02
STANDARD ERROR OF EST.	0.457930D 01
F-STATISTIC	7.00
NUMERATOR DEGREES OF FREEDOM	3
DENOMINATOR DEGREES OF FREEDOM	123
SIGNIFICANCE	0.0002

VARIABLE NO.	NAME	REGRESSION COEFFICIENT	STANDARD ERROR	STAND. COEF.	T-STAT.	2TAIL SIG.	TOL-ERANCE
	INTERCEPT	0.254096D 02	0.344299D 01	5.190	7.38	0.000	
122	EIGHTH	-0.547115D 01	0.180797D 01	-0.539	-3.03	0.003	0.218664
123	MINUTES	-0.126268D-01	0.695885D-02	-0.165	-1.82	0.072	0.845908
150	CLASSIZE	0.158968D 00	0.157977D 00	0.174	1.01	0.316	0.232188

MULTIPLE R 0.4453 STD. ERROR OF EST. 4.7154
MULTIPLE R-SQUARE 0.1983

ANALYSIS OF VARIANCE

	SUM OF SQUARES	DF	MEAN SQUARE	F RATIO	P(
REGRESSION	467.591	4	116.898	5.257	0.
RESIDUAL	1889.991	85	22.235		

VARIABLE		COEFFICIENT	STD. ERROR	STD. REG COEFF	T	P(2 TAIL)
INTERCEPT		24.668				
EIGHTH	122	-5.782	2.189	-0.512	-2.641	0.010
MINUTES	133	-0.008	0.008	-0.110	-1.032	0.305
CLASSIZE	150	0.107	0.197	0.104	0.543	0.588
FACTOR2	153	1.623	0.849	0.188	1.912	0.059

MULTIPLE R 0.5119 STD. ERROR OF EST.
MULTIPLE R-SQUARE 0.2621

ANALYSIS OF VARIANCE

	SUM OF SQUARES	DF	MEAN SQUARE	F RATIO	P(
REGRESSION	617.622	5	123.564	5.966	0.
RESIDUAL	1739.760	84	20.711		

VARIABLE		COEFFICIENT	STD. ERROR	STD. REG COEFF	T	P(2 TAIL)
INTERCEPT		22.240				
EIGHTH	122	-2.627	2.416	-0.233	-1.087	0.280
MINUTES	133	-0.004	0.006	-0.051	-0.488	0.627
CLASSIZE	150	0.104	0.190	0.101	0.546	0.587
FACTOR2	153	1.805	0.822	0.209	2.196	0.031
FACTOR3	154	1.575	0.585	0.373	2.693	0.009

MULTIPLE R 0.5928 STD. ERROR OF EST. 4.2921
MULTIPLE R-SQUARE 0.3514

ANALYSIS OF VARIANCE

	SUM OF SQUARES	DF	MEAN SQUARE	F RATIO	P
REGRESSION	828.548	6	138.091	7.496	0
RESIDUAL	1529.034	83	18.422		

VARIABLE		COEFFICIENT	STD. ERROR	STD. REG COEFF	T	P(2 TAIL)
INTERCEPT		14.360				
EIGHTH	122	-7.796	2.744	-0.690	-2.841	0.006
MINUTES	133	0.009	0.008	0.127	1.132	0.261
CLASSIZE	150	0.217	0.182	0.210	1.187	0.239
FACTOR2	153	1.096	0.803	0.127	1.364	0.176
FACTOR3	154	1.020	0.576	0.241	1.771	0.080
Z1	79	4.003	1.184	0.498	3.382	0.001

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REGRESSION TITLE. . . . . . . . . . . . . . . . . . . . .CLASSROOM DATA -EXPERIMENTAI
DEPENDENT VARIABLE. . . . . . . . . . . . . . . . . .        120  TOTAL2
TOLERANCE . . . . . . . . . . . . . . . . . . . . . .       0.0100
ALL DATA CONSIDERED AS A SINGLE GROUP
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MULTIPLE R	0.5945	STD. ERROR OF EST.	4.3114
MULTIPLE R-SQUARE	0.3535		

ANALYSIS OF VARIANCE

	SUM OF SQUARES	DF	MEAN SQUARE	F RATIO
REGRESSION	833.347	7	119.050	6.405
RESIDUAL	1524.235	82	18.588	

VARIABLE		COEFFICIENT	STD. ERROR	STD. REG COEFF	T	P(2 TAIL)
INTERCEPT		12.817				
EIGHTH	122	-8.759	3.345	-0.776	-2.618	0.011
MINUTES	133	0.013	0.011	0.179	1.173	0.244
CLASSIZE	150	0.147	0.228	0.143	0.646	0.520
FACTOR2	153	1.169	0.819	0.135	1.426	0.158
FACTOR3	154	1.074	0.588	0.254	1.827	0.071
Z1	79	5.571	3.307	0.693	1.685	0.096
Z4	82	1.975	3.886	0.159	0.508	0.613

```
STATISTICS FOR 'BEST' SUBSET
SQUARED MULTIPLE CORRELATION           0.40244
MULTIPLE CORRELATION                   0.6[illegible]
ADJUSTED SQUARED MULT. CORR.           0.[illegible]9947
RESIDUAL MEAN SQUARE               0.1[illegible]5750 02
STANDARD ERROR OF EST.             0.431764D 01
F-STATISTIC                               5.76
NUMERATOR DEGREES OF FREEDOM                 5
DENOMINATOR DEGREES OF FREEDOM              81
SIGNIFICANCE                           0.[illegible]
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VARIABLE NO.	NAME	REGRESSION COEFFICIENT	STANDARD ERROR	STAND. COEF.	T-STAT.	2TAIL SIG.	TOL-ERANCE
	INTERCEPT	0.116953D 02	0.543287D 01	2.272	2.15	0.034	
122	EIGHTH	-0.759922D 01	0.345662D 01	-0.662	-2.21	0.030	0.0[illegible]2555
133	MINUTES	0.203546D-01	0.131298D-01	0.275	1.55	0.124	0.251402
150	CLASSIZE	0.373758D-01	0.250374D 00	0.036	0.15	0.882	0.133174
153	FACTOR2	0.112568D 01	0.614560D 00	0.140	1.47	0.145	0.874659
154	FACTOR3	0.947548D 00	0.596372D 00	0.224	1.59	0.115	0.591572
79	Z1	0.600383D 01	0.335945D 01	0.747	1.80	0.075	0.045916
82	Z4	0.215376D 01	0.382696D 01	0.174	0.56	0.580	0.080597
83	Z5	0.389924D 01	0.365716D 01	0.135	1.07	0.290	0.491434

MULTIPLE R	0.6023	STD. ERROR OF EST.	4.3334
MULTIPLE R-SQUARE	0.3628		

ANALYSIS OF VARIANCE

	SUM OF SQUARES	DF	MEAN SQUARE	F RATIO	F(
REGRESSION	855.281	9	95.031	5.061	0.
RESIDUAL	1502.301	80	18.779		

VARIABLE		COEFFICIENT	STD. ERROR	STD. REG COEFF	T	P(2 TAIL)
INTERCEPT		11.850				
EIGHTH	122	-7.583	3.551	-0.672	-2.136	0.036
MINUTES	133	0.020	0.013	0.266	1.477	0.144
CLASSIZE	150	0.046	0.255	0.045	0.182	0.856
FACTOR2	153	1.303	0.942	0.151	1.383	0.170
FACTOR3	154	0.963	0.607	0.226	1.586	0.117
Z1	79	5.936	3.366	0.738	1.763	0.082
Z4	82	1.950	4.035	0.157	0.483	0.630
Z5	83	3.854	3.685	0.133	1.046	0.299
Y31	67	-0.284	1.346	-0.027	-0.211	0.834

MULTIPLE R 0.6161 STD. ERROR OF EST. 4.3028
MULTIPLE R-SQUARE 0.3796

ANALYSIS OF VARIANCE

	SUM OF SQUARES	DF	MEAN SQUARE	F RATIO
REGRESSION	894.946	10	89.495	4.834
RESIDUAL	1462.636	79	18.514	

VARIABLE		COEFFICIENT	STD. ERROR	STD. REG COEFF	T	P(2 TAIL)
INTERCEPT		10.865				
EIGHTH	122	-8.005	3.537	-0.709	-2.263	0.026
MINUTES	133	0.016	0.013	0.241	1.330	0.187
CLASSIZE	150	0.094	0.256	0.091	0.367	0.715
FACTOR2	153	3.528	1.785	0.408	1.977	0.052
FACTOR3	154	0.977	0.603	0.231	1.620	0.109
Z1	79	6.355	3.355	0.790	1.894	0.062
Z4	82	3.490	4.142	0.281	0.843	0.402
Z5	83	3.692	3.661	0.128	1.008	0.316
Y31	67	-1.693	1.647	-0.163	-1.028	0.307
Y32	68	-3.372	2.304	-0.282	-1.464	0.147

MULTIPLE R 0.6169 STD. ERROR OF EST. 4.3269
MULTIPLE R-SQUARE 0.3806

ANALYSIS OF VARIANCE

	SUM OF SQUARES	DF	MEAN SQUARE	F RATIO
REGRESSION	897.261	11	81.569	4.357
RESIDUAL	1460.321	78	18.722	

VARIABLE		COEFFICIENT	STD. ERROR	STD. REG COEFF	T	P(2 TAIL)
INTERCEPT		10.654				
EIGHTH	122	-8.291	3.649	-0.734	-2.272	0.026
MINUTES	133	0.018	0.013	0.242	1.330	0.187
CLASSIZE	150	0.096	0.257	0.093	0.371	0.711
FACTOR2	153	3.471	1.802	0.402	1.926	0.058
FACTOR3	154	0.964	0.608	0.228	1.586	0.117
Z1	79	6.570	3.428	0.817	1.916	0.059
Z4	82	3.772	4.242	0.303	0.889	0.377
Z5	83	4.005	3.788	0.139	1.057	0.294
Y31	67	-1.722	1.656	-0.166	-1.038	0.302
Y32	68	-3.465	2.332	-0.290	-1.486	0.141
Y33	69	-1.670	4.750	-0.036	-0.352	0.726

MULTIPLE R 0.6169 STD. ERROR OF EST. 4.3549
MULTIPLE R-SQUARE 0.3806

ANALYSIS OF VARIANCE

	SUM OF SQUARES	DF	MEAN SQUARE	F RATIO
REGRESSION	897.272	12	74.773	3.943
RESIDUAL	1460.310	77	18.965	

VARIABLE		COEFFICIENT	STD. ERROR	STD. REG COEFF	T	P(2 TAIL)
INTERCEPT		10.663				
EIGHTH	122	-8.248	4.040	-0.730	-2.042	0.045
MINUTES	133	0.018	0.014	0.242	1.319	0.191
CLASSIZE	150	0.095	0.259	0.093	0.366	0.714
FACTOR2	153	3.462	1.844	0.401	1.877	0.064
FACTOR3	154	0.955	0.699	0.225	1.367	0.176
Z1	79	6.557	3.469	0.815	1.879	0.064
Z4	82	3.777	4.274	0.304	0.884	0.380
Z5	83	4.016	3.835	0.139	1.047	0.298
Y31	67	-1.713	1.707	-0.165	-1.003	0.319
Y32	68	-3.462	2.349	-0.290	-1.474	0.145
Y33	69	-1.690	4.846	-0.038	-0.349	0.728
Y34	70	0.026	1.035	0.005	0.025	0.980

MULTIPLE R	0.6172	STD. ERROR OF EST.	4.3823
MULTIPLE R-SQUARE	0.3809		

ANALYSIS OF VARIANCE

	SUM OF SQUARES	DF	MEAN SQUARE	F RATIO
REGRESSION	898.029	13	69.079	3.597
RESIDUAL	1459.553	76	19.205	

VARIABLE		COEFFICIENT	STD. ERROR	STD. REG COEFF	T	P(2 TAIL)
INTERCEPT		10.932				
EIGHTH	122	-7.687	4.957	-0.681	-1.551	0.125
MINUTES	133	0.018	0.014	0.239	1.296	0.199
CLASSIZE	150	0.098	0.261	0.095	0.375	0.708
FACTOR2	153	3.454	1.856	0.400	1.861	0.067
FACTOR3	154	0.737	1.307	0.174	0.564	0.575
Z1	79	6.341	3.676	0.786	1.725	0.089
Z4	82	3.359	4.790	0.270	0.701	0.485
Z5	83	4.015	3.859	0.139	1.040	0.301
Y31	67	-1.739	1.723	-0.167	-1.009	0.316
Y32	68	-3.450	2.365	-0.289	-1.459	0.149
Y33	69	-1.672	4.877	-0.038	-0.343	0.733
Y34	70	0.218	1.421	0.045	0.153	0.879
Y35	71	0.370	1.868	0.051	0.198	0.844

STATISTICS FOR 'BEST' SUBSET

SQUARED MULTIPLE CORRELATION	0.41560
MULTIPLE CORRELATION	0.64467
ADJUSTED SQUARED MULT. CORR.	0.30651
RESIDUAL MEAN SQUARE	0.183709D 02
STANDARD ERROR OF EST.	0.428613D 01
F-STATISTIC	3.81
NUMERATOR DEGREES OF FREEDOM	14
DENOMINATOR DEGREES OF FREEDOM	75
SIGNIFICANCE	0.0001

VARIABLE NO.	NAME	REGRESSION COEFFICIENT	STANDARD ERROR	STAND. COEF.	T-STAT.	2TAIL SIG.	TOL-ERANCE
	INTERCEPT	0.115846D 02	0.570710D 01	2.251	2.03	0.046	
122	EIGHTH	-0.742153D 01	0.484924D 01	-0.657	-1.53	0.130	0.042255
133	MINUTES	0.133049D-01	0.135572D-01	0.180	0.98	0.330	0.232721
150	CLASSIZE	0.223510D 00	0.262220D 00	0.217	0.85	0.396	0.120193
153	FACTOR2	0.387855D 01	0.182658D 01	0.449	2.12	0.037	0.174318
154	FACTOR3	0.126648D 01	0.130324D 01	0.300	0.97	0.334	0.082016
79	Z1	0.421690D 01	0.373344D 01	0.524	1.13	0.262	0.035152
82	Z4	0.673942D 00	0.465400D 01	0.054	0.14	0.890	0.051103
83	Z5	0.246310D 01	0.384562D 01	0.085	0.64	0.524	0.439979
67	Y31	-0.216761D 01	0.169759D 01	-0.209	-1.28	0.206	0.291602
68	Y32	-0.367647D 01	0.231532D 01	-0.308	-1.59	0.117	0.207417
69	Y33	-0.236278D 00	0.481860D 01	-0.005	-0.05	0.961	0.650515
70	Y34	0.310240D-01	0.139254D 01	0.006	0.02	0.982	0.096066
71	Y35	-0.830722D-01	0.184002D 01	-0.011	-0.05	0.964	0.123482
72	Y36	0.603195D 01	0.285372D 01	0.235	2.11	0.038	0.628011

```
STATISTICS FOR 'BEST' SUBSET
SQUARED MULTIPLE CORRELATION          0.41615
MULTIPLE CORRELATION                  0.64510
ADJUSTED SQUARED MULT. CORR.          0.29780
RESIDUAL MEAN SQUARE              0.186016D 02
STANDARD ERROR OF EST.            0.431296D 01
F-STATISTIC                              3.52
NUMERATOR DEGREES OF FREEDOM               15
DENOMINATOR DEGREES OF FREEDOM             74
SIGNIFICANCE                           0.0002
```

VARIABLE NO.	NAME	REGRESSION COEFFICIENT	STANDARD ERROR	STAND. COEF.	T-STAT.	2TAIL SIG.	TOL-ERANCE
	INTERCEPT	0.119044D 02	0.586882D 01	2.313	2.03	0.046	
122	EIGHTH	-0.997818D 00	0.247803D 02	-0.088	-0.04	0.965	0.001638
133	MINUTES	0.113108D-01	0.155878D-01	0.153	0.73	0.470	0.172247
150	CLASSIZE	0.286446D 00	0.354599D 00	0.278	0.81	0.422	0.066551
153	FACTOR2	0.372276D 01	0.193015D 01	0.431	1.93	0.058	0.158073
154	FACTOR3	0.115120D 01	0.138178D 01	0.272	0.83	0.407	0.073851
79	Z1	0.354651D 01	0.453234D 01	0.441	0.78	0.436	0.024838
82	Z4	-0.381174D 00	0.630724D 01	-0.031	-0.06	0.952	0.030647
83	Z5	0.222987D 01	0.396896D 01	0.077	0.56	0.576	0.418246
67	Y31	-0.201229D 01	0.180640D 01	-0.194	-1.11	0.269	0.260765
68	Y32	-0.343295D 01	0.250524D 01	-0.287	-1.37	0.175	0.179385
69	Y33	-0.271944D 00	0.485062D 01	-0.006	-0.06	0.955	0.650015
70	Y34	0.612603D-01	0.140591D 01	0.013	0.04	0.965	0.095432
71	Y35	0.102955D 00	0.196075D 01	0.014	0.05	0.959	0.107902
72	Y36	0.611295D 01	0.289587D 01	0.237	2.11	0.038	0.624026
49	Y13	-0.612415D 01	0.231618D 02	-0.562	-0.26	0.792	0.001744

PROBLEM NUMBER 1 COMPLETED.

**Y14 was not included as a predictor due to low tolerance.

** Y15 was not included as a predictor due to low tolerance.

CORRELATIONS

		EIGHTH 122	MINUTES 133	CLASSIZE 150	FACTOR2 153	FACTOR3 154	Z1 79	Z4 82	Z5 83	Y31 67	Y32 68	Y33 69	Y34 70	Y35 71
EIGHTH	122	1.000												
MINUTES	133	-0.193	1.000											
CLASSIZE	150	0.636	0.033	1.000										
FACTOR2	153	0.075	0.031	0.135	1.000									
FACTOR3	154	-0.717	-0.013	-0.632	-0.117	1.000								
Z1	79	0.628	-0.540	0.393	0.163	-0.271	1.000							
Z4	82	0.737	0.243	0.422	-0.156	-0.390	-0.533	1.000						
Z5	83	-0.335	-0.363	-0.161	-0.074	0.305	-0.150	0.020	1.000					
Y31	67	0.202	-0.269	0.220	0.503	-0.377	0.551	-0.402	-0.003	1.000				
Y32	68	0.165	0.107	0.320	-0.641	-0.293	-0.133	0.401	-0.009	-0.074	1.000			
Y33	69	-0.159	-0.179	-0.082	-0.375	0.140	-0.098	0.105	0.335	-0.217	-0.235	1.000		
Y34	70	-0.835	0.046	-0.714	0.017	0.720	-0.258	-0.494	0.277	-0.127	-0.211	0.152	1.000	
Y35	71	-0.679	0.044	-0.459	-0.106	0.743	-0.528	0.090	0.420	-0.213	-0.123	0.174	0.335	1.000
Y36	72	0.419	-0.204	0.343	-0.051	-0.419	0.226	0.275	0.002	0.076	0.117	-0.034	-0.435	-0.194
Y11	47	0.535	-0.193	0.239	0.448	-0.390	0.367	0.080	-0.100	0.673	0.439	-0.378	-0.465	-0.314
Y12	48	-0.932	0.160	-0.706	-0.003	0.750	-0.587	-0.210	0.311	-0.290	-0.163	0.157	0.347	0.075
Y13	49	0.900	-0.193	0.849	0.092	-0.717	0.630	0.229	-0.331	0.323	0.170	-0.169	-0.808	-0.632
Y14	50	0.988	-0.191	0.793	0.037	-0.705	0.612	0.252	-0.338	0.248	0.135	-0.133	-0.785	-0.644
Y15	51	-0.992	0.192	-0.904	-0.045	0.709	-0.017	-0.249	0.338	-0.260	-0.142	0.139	0.721	0.644
Y16	52	0.052	0.135	0.134	0.906	-0.123	0.103	-0.133	-0.106	0.432	0.047	-0.424	0.028	-0.220
Y17	53	-0.697	0.001	-0.619	-0.125	0.993	-0.267	-0.309	0.305	-0.070	-0.395	0.125	0.756	0.737
Y18	54	0.622	-0.570	0.332	0.152	-0.270	0.991	-0.556	-0.106	0.555	-0.161	-0.124	-0.259	-0.528
Y19	55	0.143	0.445	0.411	-0.130	-0.328	-0.611	0.970	0.000	-0.434	0.404	0.091	-0.409	0.127
Y20	56	-0.265	-0.406	-0.395	-0.072	0.336	-0.123	0.058	0.993	-0.006	0.002	0.370	0.220	0.377
Y21	57	0.213	0.026	0.306	0.962	-0.218	0.207	-0.058	-0.085	0.507	0.709	-0.385	-0.123	-0.242
Y22	58	-0.810	0.031	-0.712	-0.132	0.978	-0.375	-0.339	0.385	-0.161	-0.270	0.178	0.836	0.782
Y23	59	0.700	-0.543	0.576	0.157	-0.427	0.964	-0.315	-0.162	0.536	-0.021	-0.105	-0.459	-0.554
Y24	60	0.483	0.316	0.673	-0.079	-0.544	-0.322	0.941	-0.127	-0.266	0.412	0.012	-0.642	-0.131
Y25	61	-0.557	-0.319	-0.416	-0.088	0.541	-0.224	-0.120	0.956	-0.124	-0.083	0.382	0.472	0.641
TOTAL2	120	-0.390	-0.001	-0.302	0.160	0.452	0.034	-0.410	0.226	0.099	-0.132	0.018	0.478	0.252

		Y36 72	Y11 47	Y12 48	Y13 49	Y14 50	Y15 51	Y16 52	Y17 53	Y18 54	Y19 55	Y20 56	Y21 57	Y22 58
Y36	72	1.000												
Y11	47	0.209	1.000											
Y12	48	-0.403	-0.522	1.000										
Y13	49	0.414	0.303	-0.932	1.000									
Y14	50	0.421	0.462	-0.916	0.975	1.000								
Y15	51	-0.421	-0.479	0.922	-0.902	-0.999	1.000							
Y16	52	-0.075	0.418	-0.061	0.067	0.015	-0.023	1.000						
Y17	53	-0.467	-0.337	0.729	-0.096	-0.535	0.609	-0.132	1.000					
Y18	54	0.213	0.353	-0.581	0.624	0.607	-0.612	0.069	-0.264	1.000				
Y19	55	0.235	0.337	-0.131	0.137	0.156	-0.153	-0.005	-0.328	-0.652	1.000			
Y20	56	0.014	-0.124	0.246	-0.262	-0.262	0.269	-0.190	0.319	-0.157	0.022	1.000		
Y21	57	0.035	0.045	-0.217	0.230	0.158	-0.170	0.948	-0.225	0.108	-0.039	-0.073	1.000	
Y22	58	-0.411	-0.477	0.353	-0.014	-0.768	0.794	-0.134	0.960	-0.375	-0.270	0.328	-0.252	1.0
Y23	59	0.325	0.476	-0.737	0.793	0.756	-0.754	0.095	-0.421	0.954	-0.418	-0.119	0.245	-0.5
Y24	60	0.303	0.231	-0.448	0.477	0.497	-0.487	-0.048	-0.534	-0.357	0.931	-0.074	0.051	-0.5
Y25	61	-0.033	-0.290	0.319	-0.555	-0.534	0.555	-0.117	0.515	-0.251	-0.127	0.920	-0.142	0.5
TOTAL2	120	-0.070	-0.191	0.366	-0.307	-0.309	0.390	0.169	0.440	0.008	-0.338	0.182	0.068	0.4

		Y23 59	Y24 60	Y25 61	TOTAL2 120
Y23	59	1.000			
Y24	60	-0.094	1.000		
Y25	61	-0.293	-0.328	1.000	
TOTAL2	120	-0.097	-0.445	0.329	1.000

```
VARIABLE  122 EIGHTH    IS NOT INCLUDED AS A PREDICTOR DUE TO LOW TOLERANCE.
VARIABLE  130 CLASSIZE  IS NOT INCLUDED AS A PREDICTOR DUE TO LOW TOLERANCE.
VARIABLE   37 Z5        IS NOT INCLUDED AS A PREDICTOR DUE TO LOW TOLERANCE.
VARIABLE   51 Y15       IS NOT INCLUDED AS A PREDICTOR DUE TO LOW TOLERANCE.
VARIABLE   54 Y18       IS NOT INCLUDED AS A PREDICTOR DUE TO LOW TOLERANCE.
VARIABLE   60 Y24       IS NOT INCLUDED AS A PREDICTOR DUE TO LOW TOLERANCE.
VARIABLE   61 Y25       IS NOT INCLUDED AS A PREDICTOR DUE TO LOW TOLERANCE.
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STATISTICS FOR 'BEST' SUBSET

SQUARED MULTIPLE CORRELATION	0.48604
MULTIPLE CORRELATION	0.69717
ADJUSTED SQUARED MULT. CORR.	0.31728
RESIDUAL MEAN SQUARE	0.180856D 02
STANDARD ERROR OF EST.	0.425272D 01
F-STATISTIC	2.88
NUMERATOR DEGREES OF FREEDOM	22
DENOMINATOR DEGREES OF FREEDOM	67
SIGNIFICANCE	0.0005

VARIABLE NO.	NAME	REGRESSION COEFFICIENT	STANDARD ERROR	STAND. COEF.	T-STAT.	2TAIL SIG.	TOL-ERANCE
	INTERCEPT	0.451103D 02	0.302620D 02	8.765	1.49	0.141	
133	MINUTE1	-0.489105D-01	0.680129D-01	-0.660	-0.72	0.475	0.009103
153	FACTOR2	-0.458607D 01	0.132309D 02	-0.531	-0.35	0.730	0.003271
154	FACTOR3	-0.134671D 02	0.753411D 01	-3.186	-1.79	0.078	0.002415
79	Z1	-0.108313D 02	0.319085D 02	-1.347	-0.34	0.735	0.000487
82	Z4	-0.375857D 02	0.305530D 02	-3.024	-1.23	0.223	0.001270
67	Y31	0.857268D 00	0.809748D 01	0.083	0.11	0.916	0.012617
68	Y32	-0.284250D-01	0.908289D 01	-0.002	-0.00	0.998	0.013268
69	Y33	0.560587D 01	0.618534D 01	0.127	0.91	0.368	0.388654
70	Y34	0.322377D 01	0.422796D 01	0.659	0.76	0.448	0.010260
71	Y35	0.193749D 01	0.534317D 01	0.265	0.36	0.718	0.014416
72	Y36	0.101431D 02	0.446731D 01	0.394	2.27	0.026	0.254949
47	Y11	0.449751D 01	0.745485D 01	0.297	0.60	0.548	0.031670
48	Y12	-0.331806D 01	0.447682D 01	-0.489	-0.74	0.461	0.017601
49	Y13	-0.469980D 01	0.356396D 02	-0.432	-0.13	0.895	0.000716
50	Y14	0.283653D 01	0.333394D 02	0.162	0.09	0.932	0.002107
52	Y16	0.438945D-01	0.291282D-01	2.117	1.51	0.137	0.003088
53	Y17	0.287954D-01	0.169276D-01	2.777	1.70	0.094	0.002877
55	Y19	0.737644D-01	0.587013D-01	2.841	1.26	0.213	0.001501
56	Y20	-0.489705D-02	0.126690D-01	-0.073	-0.39	0.700	0.214858
57	Y21	-0.647739D 00	0.535233D 00	-1.583	-1.21	0.230	0.004485
58	Y22	0.398257D-01	0.335521D 00	0.476	0.27	0.790	0.002423
59	Y23	0.480990D 00	0.174132D 01	1.414	0.28	0.783	0.000293

Note: The following regression model is based on the data from the experimental and replication groups. The data from both groups were pooled together to increase the power of the analysis. The major problem with this approach is that the dependent variables pooled together were not based on the same test, but rather were from approximately parallel forms of the same unit test.

CORRELATIONS

		EIGHTH 122	MINUTES 133	CLASSIZE 150	FACTOR2 153	FACTOR3 154	Z1 79	Z4 82	Z5 83	Y31 67	Y32 68	Y33 69	Y34 70	Y35 71
EIGHTH	122	1.000												
MINUTES	133	0.107	1.000											
CLASSIZE	150	0.455	0.575	1.000										
FACTOR2	153	-0.301	-0.227	-0.107	1.000									
FACTOR3	154	-0.539	0.090	-0.286	0.044	1.000								
Z1	79	0.467	0.078	0.286	-0.133	-0.201	1.000							
Z4	82	0.336	0.459	0.475	-0.296	-0.261	0.317	1.000						
Z5	83	0.768	0.619	0.481	-0.259	0.006	0.577	0.566	1.000					
Y31	67	-0.194	-0.241	-0.065	0.742	0.038	0.035	-0.298	-0.161	1.000				
Y32	68	-0.260	-0.127	-0.038	0.796	0.048	-0.161	-0.315	-0.158	0.760	1.000			
Y33	69	-0.220	-0.073	-0.055	0.733	0.110	-0.084	-0.182	-0.098	0.823	0.776	1.000		
Y34	70	-0.503	0.077	-0.299	0.052	0.721	-0.077	-0.164	0.118	0.016	0.021	0.092	1.000	
Y35	71	-0.468	0.123	-0.367	0.080	0.769	-0.212	-0.105	0.082	0.041	0.172	0.133	0.638	1.000
Y36	72	-0.336	-0.022	0.007	0.134	0.526	-0.323	-0.064	-0.024	0.132	0.132	0.155	0.611	0.715
Y13	49	0.031	0.169	0.427	-0.264	-0.535	0.558	0.336	0.334	-0.159	-0.224	-0.291	-0.588	-0.501
Y14	50	0.628	0.223	0.349	-0.378	-0.400	0.408	0.598	0.402	-0.292	-0.437	-0.347	-0.391	-0.509
Y15	51	0.762	0.417	0.296	-0.381	-0.264	0.356	0.365	0.650	-0.309	-0.285	-0.346	-0.167	-0.229
TOTAL1	119	-0.610	-0.009	-0.176	0.415	0.471	-0.303	-0.341	-0.137	0.314	0.326	0.396	0.421	0.354

		Y36 72	Y13 49	Y14 50	Y15 51	TOTAL1 119
Y36	72	1.000				
Y13	49	-0.359	1.000			
Y14	50	-0.255	0.798	1.000		
Y15	51	-0.308	0.702	0.741	1.000	
TOTAL1	119	0.311	-0.580	-0.555	-0.440	1.000

UNIVARIATE SUMMARY STATISTICS

	VARIABLE	MEAN	STANDARD DEVIATION	COEFFICIENT OF VARIATION	SMALLEST VALUE	LARGEST VALUE	SMALLEST STANDARD SCORE	LARGEST STANDARD SCORE	SKEWNESS	KURTOSIS
122	EIGHTH	0.28112	0.46651	1.276539	0.0	1.00000	-0.78	1.27	0.49	-1.77
135	MINUTES	527.16531	87.70983	0.166374	350.00000	585.00000	-2.02	0.66	-0.95	-0.92
150	CLASSIZE	23.90210	4.20912	0.176098	12.00000	29.00000	-2.83	1.21	-1.40	0.75
153	FACTOR2	0.07453	0.75852	10.177736	-3.15709	1.45425	-4.26	1.02	-0.79	1.00
154	FACTOR3	0.00773	0.98504	126.664237	-2.24113	1.98739	-2.28	2.01	-0.18	-0.66
79	Z1	0.64311	0.71081	1.105270	-0.63000	3.00000	-1.79	3.32	-0.43	-0.06
82	Z4	0.83073	0.62151	0.748142	-0.86000	4.00000	-2.72	5.10	1.10	5.32
83	Z5	1.35997	1.47063	1.097512	-0.49000	4.00000	-1.24	1.81	0.16	-1.60
67	Y31	-0.03348	0.76452	-22.559468	-5.39648	1.55752	-7.03	2.07	-1.04	8.02
68	Y32	-0.07696	0.97530	-12.674778	-8.09472	2.53087	-8.22	2.67	-3.55	23.27
69	Y33	-0.18774	1.53446	-8.173419	-8.09472	4.36279	-5.15	2.97	-0.92	3.67
70	Y34	-0.13521	0.96489	-7.136036	-4.83638	2.48983	-4.87	2.72	-0.47	1.76
71	Y35	-0.11627	0.89968	-7.737690	-3.84064	2.91100	-4.15	3.36	-0.51	1.30
72	Y36	0.01883	1.60281	85.197601	-4.82313	5.61690	-3.02	3.49	0.42	2.45
49	Y13	0.40598	0.55637	1.370442	0.0	3.00000	-0.73	4.66	1.18	1.70
50	Y14	0.41605	0.64175	1.542477	0.0	4.00000	-0.65	5.58	2.01	5.52
51	Y15	0.77329	1.29579	1.675685	-0.16000	4.00000	-0.72	2.49	1.09	-0.68
119	TOTAL1	22.72727	6.74777	0.296902	7.00000	38.00000	-2.33	2.26	0.19	-0.67

VALUES FOR KURTOSIS GREATER THAN ZERO INDICATE DISTRIBUTIONS WITH HEAVIER TAILS THAN THE NORMAL DISTRIBUTION.

TABLE XLVII

REGRESSION MODEL FOR COMBINED SAMPLE

STATISTICS FOR 'BEST' SUBSET	
SQUARED MULTIPLE CORRELATION	0.56778
MULTIPLE CORRELATION	0.75351
ADJUSTED SQUARED MULT. CORR.	0.54036
RESIDUAL MEAN SQUARE	0.209285D 02
STANDARD ERROR OF EST.	0.457477D 01
F-STATISTIC	20.71
NUMERATOR DEGREES OF FREEDOM	17
DENOMINATOR DEGREES OF FREEDOM	268
SIGNIFICANCE	0.0000

VARIABLE NO.	NAME	REGRESSION COEFFICIENT	STANDARD ERROR	STAND. COEF.	T-STAT.	2TAIL SIG.	TOL-ERANCE
	INTERCEPT	0.223448D 02	0.245940D 01	3.311	9.09	0.000	
122	EIGHTH	-0.617569D 01	0.245595D 01	-0.445	-2.51	0.013	0.051436
173	MINUTES	-0.577191D-02	0.594162D-02	-0.075	-0.97	0.332	0.270388
150	CLASSIZE	0.289290D 00	0.127995D 00	0.180	2.26	0.025	0.253003
153	FACTOR2	0.292987D 01	0.672460D 00	0.329	4.36	0.000	0.232247
154	FACTOR3	0.212911D 01	0.617530D 00	0.311	3.45	0.001	0.198096
79	Z1	-0.297246D 01	0.815396D 00	-0.313	-3.65	0.000	0.218598
82	Z4	-0.317469D 01	0.937136D 00	-0.292	-3.39	0.001	0.216469
83	Z5	0.215024D 01	0.556965D 00	0.460	3.86	0.000	0.109454
67	Y31	0.454096D-01	0.772726D 00	0.005	0.06	0.953	0.210408
68	Y32	-0.136639D 01	0.635611D 00	-0.198	-2.15	0.032	0.191051
69	Y33	0.431505D 00	0.385124D 00	0.098	1.12	0.264	0.210273
70	Y34	0.574888D 00	0.686064D 00	0.082	0.84	0.403	0.167576
71	Y35	-0.180706D 01	0.843298D 00	-0.241	-2.14	0.033	0.127573
72	Y36	0.209963D 00	0.410171D 00	0.050	0.51	0.609	0.169690
49	Y13	0.225011D 01	0.192686D 01	0.186	1.17	0.244	0.063895
50	Y14	0.933199D-01	0.159905D 01	0.009	0.06	0.954	0.069734
51	Y15	-0.105335D 01	0.946265D 00	-0.202	-1.11	0.267	0.048843

PROBLEM NUMBER 1 COMPLETED.

APPENDIX M

VERBAL STATEMENTS USED TO DESCRIBE EACH CES FACTOR

Statements Which Describe Factor 1- Student Centered Environment

1. Students are interested in class activities.
2. Students participate in class discussions.
3. Students enjoy the class.
4. Students feel a level of friendship for each other.
5. The teacher is willing to help the students.
6. The teacher spends time talking to the students.
7. The teacher is interested in the students.
8. The students contribute to planning the course.
9. The teacher encourages creative thinking.

Statements Which Describe Factor 4- High Structure Environment

1. The teacher emphasizes that the students are orderly and polite.
2. The teacher emphasizes staying on the subject matter.
3. The teacher emphasizes completing planned activities.
4. The teacher establishes and follows a clear set of rules.
5. The students know the consequences of breaking rules.
6. The teacher is consistent with those who break rules.
7. The students are calm and quiet.

Statements Which Describe Factor 5- High Discipline Environment

1. The teacher is strict in enforcing rules.
2. The punishment for breaking rules is severe.
3. It is easy for students to get in trouble.
4. The teacher emphasizes a clear set of rules.
5. The teacher is consistent with those who break rules.
6. It is difficult to achieve good grades in this class.
7. The teacher emphasizes the students competing with each other for grades and recognition.

VITA 2

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Candidate for the Degree of

Doctor of Philosophy

Thesis: A MODEL OF CLASSROOM LEARNING FOR EIGHTH GRADE AND HIGH SCHOOL STUDENTS BASED ON THE RELATIONSHIP BETWEEN STUDENT ABILITY, PERCEIVED CLASSROOM CLIMATE AND THEIR INTERACTION

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