

A FACTORIAL STUDY OF ASPECTS  
OF CRITICAL THINKING

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by  
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## TABLE OF CONTENTS

CHAPTER	PAGE
I. THE PROBLEM AND DEFINITIONS OF CRITICAL THINKING .	1
The Problem .....	1
Statement of the problem .....	1
Importance of the study .....	1
Definitions of Critical Thinking .....	5
Delimitations of the Problem .....	9
Organization of the Remainder of the Thesis .....	11
II. REVIEW OF THE LITERATURE .....	12
The Relationship of I.Q. to Critical Thinking ...	13
The Relationship of Creativity to	
Critical Thinking .....	18
The Relationship of Verbal Behavior to	
Critical Thinking .....	19
The Relationship of Reading Ability to	
Critical Thinking .....	20
The Relationship of Other Academic Abilities to	
Critical Thinking .....	23
The Relationship of Attitudes and	
Critical Thinking .....	26
The Relationship of Values to Critical Thinking .	29
The Relationship of Personality to	
Critical Thinking .....	32
The Relationship of Socio-Economic Status to	
Critical Thinking .....	35

CHAPTER	PAGE
The Relationship of Sex to Critical Thinking ...	36
The Relationship of Age to Critical Thinking ...	37
The Relationship of Untenable Factors to Critical Thinking .....	38
Summary of the Review of Literature .....	39
<b>III. THE MATERIALS, THE SAMPLE, AND THE PROCEDURES</b>	
USED .....	41
Measurement Instruments .....	41
The Watson-Glaser Critical Thinking Appraisal .....	41
Study of Values: A Scale for Measuring the Dominant Interests of Personality .....	44
Sixteen Personality Factor Questionnaire .....	47
The measure of intelligence .....	55
The measure of academic achievement .....	55
The indication of socio-economic status .....	56
The Sample .....	58
The Procedure for the Collection of the Data ...	59
Treatment of the Data .....	59
<b>IV. THE FINDINGS OF THE STUDY</b> .....	65
The Initial Principle Factor Analysis with Varimax Rotation .....	67
The Initial Canonical Correlation .....	78
The Multiple Regression Analyses .....	81

CHAPTER	PAGE
Canonical Correlation of Fifteen Variables .....	89
The Use of the Raw Score Regression	
Equation .....	91
V. SUMMARY AND CONCLUSIONS .....	94
Summary .....	94
Conclusions .....	95
BIBLIOGRAPHY .....	98
APPENDIX .....	108

## LIST OF TABLES

TABLE	PAGE
I. Means and Standard Deviations of the Forty Variables .....	66
II. Matrix of Intercorrelations of Predictors ( $R_{11}$ ) .....	68
III. Matrix of Intercorrelations of Criteria ( $R_{22}$ ) ...	72
IV. Matrix of Intercorrelations between Predictors and Criteria .....	73
V. Principle Factor Analysis: Varimax Rotation .....	74
VI. Communalities of the Factor Solutions .....	75
VII. Canonical Correlation of Thirty-six Variables ...	79
VIII. Multiple Regression Analysis. Total Critical Thinking on Nine Variables .....	83
IX. Multiple Regression Analysis. Total Critical Thinking on Ten Variables .....	84
X. Multiple Regression Analysis. Total Critical Thinking on Eleven Variables .....	85
XI. Multiple Regression Analysis. Total Critical Thinking on Nine Variables .....	87
XII. Multiple Regression Analysis. Total Critical Thinking on Nine Variables .....	88
XIII. Canonical Correlation of Fifteen Variables .....	90
XIV. Predicted and Actual Critical Thinking Scores of Thirty Students .....	92

LIST OF FIGURES

FIGURE	PAGE
I. A Comparison of the Skills Measured by the Three Critical Thinking Tests .....	7

## CHAPTER I

### THE PROBLEM AND DEFINITIONS OF CRITICAL THINKING

Many articles are being written and a good many opinions are being voiced in the field of Education dealing with the subject of critical thinking. Too often these ideas are pure conjecture based on casual observation. More experimental evidence is needed to better understand the concept of critical thinking.

#### I. THE PROBLEM

Statement of the problem. It was the purpose of this study to contribute to the body of knowledge on critical thinking by tying some aspects of critical thinking to other variables. More specifically the purpose was:

1. to describe the critical thinking space (criteria) in terms of such variables as personality, values, I.Q., socio-economic status, sex, and academic achievement (predictors),
2. to discover in what ways the two sets of data may be combined to make the correlation between components of the two sets a maximum, and
3. to use a small sample to validate the results of the study.

Importance of the study. Critical thinking is often



referred to as an important goal in the education of a child. For example, the President's Commission on Higher Education (20, p. 57) stated in 1947 that the major aim of general education is for the student "to acquire and use the skills and habits involved in critical and constructive thinking." More recently, in 1962, the Education Policies Commission of the National Educational Association (19, p. 5) wrote:

The traditionally accepted obligation of the school to teach the fundamental processes--an obligation stressed in 1918 and 1939 statements of educational purposes--is obviously directed toward the development of the ability to think. Each of the school's other traditional objectives can be better achieved as the pupils develop this ability and learn to apply it to all the problems that face them.

Dressel (35) suggests that critical thinking is the desired integrating principle or goal of education which promises that there will be a life-long interest in learning.

Similar statements are also to be found in Canadian outlines of the goals of education. A science programme of studies (17) in Manitoba says the following:

A major goal of the discovery approach is the development of intellectual independence. It seeks to raise thinking above mere memorization and recall. Pupils are expected to formulate their own problems, plan their own methods of attack, make their own observations, evaluate their own data, and reach their own conclusions. This discovery approach encourages curiosity, observation, inquisitiveness, and speculation. Careful thinking habits, and the ability to search for cause and effect and to make cautious conclusions are developed. Pupils must critically evaluate evidence and be critical of

unsupported statements, while remaining open-minded and tolerant of the opinions of others.

A general course in grade twelve social studies (18) also emphasizes the importance of critical thinking as follows:

Since many of the problems are current, students should be encouraged to read the daily newspaper and news magazines, to listen to broadcast news and commentaries, and to view programmes dealing with topics on the course. Students should also be helped to assess critically the writers and speakers, and to detect motives and bias in what is read, heard, or seen.

Now, with the increasing concern over the explosion of knowledge and with the added luxury of improved methods for making knowledge available such as worldwide communication and elaborate retrieval systems, the need to be able to think critically seems to be more and more important. The educator needs to know what is meant by critical thinking, whether it can be taught, and to what factors it is related. There is a definite need for research. Ennis (42) has outlined areas of needed research in critical thinking as follows:

1. Further refinement and definition of the concept: He says that aspects of critical thinking such as deduction and hypotheses testing must be intensively analysed so that we can be clear about just what it is we want to get across.
2. Development of critical thinking tests: Tests of various types are needed for all subject matter areas and for

all levels of instruction.

3. Discovery of the learning capabilities of children: This knowledge will give a clearer picture of the practical situation in which critical thinking must be taught.

4. Completion of developmental studies: These studies would indicate the patterns of human development in the various aspects of critical thinking under various environmental conditions.

5. The determination of subject areas that are particularly suited to the different aspects of critical thinking.

6. The development of theory: A theory needs to be developed which will tie the aspects of critical thinking ability to each other and to numerous other variables. This theory must be testable but abstract. Personality factors, I.Q., sex, socio-economic factors, vocational interest, school grades in specific subjects, class size, grouping, per pupil expenditure, religion, reading ability, leisure-time activities, and cultural background might be considered.

7. Teaching methods and curriculum organization for teaching critical thinking.

Especially limited and inconclusive has been that research dealing with factors which are related to critical thinking. We need to know whether an individual's ability to think critically is influenced by his set of values and

his socio-economic milieu. We need to know whether critical thinking is mainly due to intellectual ability, or whether it might be part of an individual's very personality, or whether it is independent of these factors and depends largely on training. This study has been directed toward that purpose.

## II. DEFINITIONS OF CRITICAL THINKING

A brief, precise definition of critical thinking does not seem to exist. On the contrary, there are as many definitions as there are attempts to explain the concept. Usually these definitions consist of a listing of abilities which the definer feels are necessary in exercising critical thinking. This study has used the definition of critical thinking which is given in the manual for the Watson-Glaser Critical Thinking Appraisal (16). Watson and Glaser view critical thinking as a composite of attitudes, knowledge, and skills. This composite includes (16, p. 10):

(1) attitudes of inquiry that involve an ability to recognize the existence of problems and an acceptance of the general need for evidence in support of what is asserted to be true; (2) knowledge of the nature of valid inference, abstractions, and generalizations in which the weight or accuracy of different kinds of evidence are logically determined; and (3) skills in employing and applying the above attitudes and knowledge.

The Critical Thinking Appraisal uses five subtests to test this composite of abilities. These are: (1) Infer-

ence, (2) Recognition of Assumptions, (3) Deduction, (4) Interpretation, and (5) Evaluation of Arguments.

Rust (90) has formed an interesting table on the factors of critical thinking and how they are distributed on three well-known tests of critical thinking. The table is shown on page 7 and includes the Watson-Glaser Critical Thinking Appraisal, the A.C.E. Test of Critical Thinking prepared by the American Council of Education, and the Test on the Principles of Critical Thinking developed by the project group at the University of Illinois. As the reader can see there are several additional definitions of critical thinking here beyond those given by Watson and Glaser.

Robert Ennis (41) says that the correct assessment of statements is basic to critical thinking and lists the following twelve abilities:

1. Grasping the meaning of a statement.
2. Judging whether there is ambiguity in a line of reasoning.
3. Judging whether certain statements contradict each other.
4. Judging whether a conclusion follows necessarily.
5. Judging whether a statement is specific enough.
6. Judging whether a statement is actually the application of a certain principle.
7. Judging whether an observation statement is

FIGURE I

## A COMPARISON OF THE SKILLS MEASURED BY THE THREE CRITICAL THINKING TESTS

A Priori Factor	Number of Items in Test		
	Watson-Gleser	ACE	Principles
<u>A. Relative to arguments</u>			
Ability to select pertinent information		7	
Determination of the truth of an assertion			7
Evaluation of arguments	14		
Evaluation of evidence			5
Knowledge of rules of logic			13
Recognition of fallacies			7
Recognition of what is needed to resolve an issue			7
<u>B. Relative to assumptions</u>			
Knowledge of what an assumption is			2
Recognition of unstated assumptions	16	16	5
<u>C. Relative to criteria</u>			
			1
<u>D. Relative to definitions</u>			
Ability to define problems		5	
Recognition of a real definition			6
<u>E. Relative to hypotheses</u>			
Ability to invent and evaluate hypotheses		15	
<u>F. Relative to inferences</u>			
Ability to make valid inferences		4	
Deduction -- recognition of necessary conclusions	25		
Evaluation of inferences	20	5	
Interpretation	24		
Total	99	52	53

reliable.

8. Judging whether an inductive conclusion is warranted.

9. Judging whether the problem has been identified.

10. Judging whether something is an assumption.

11. Judging whether a definition is adequate.

12. Judging whether a statement made by an alleged authority is acceptable.

Bloom (3), in the Taxonomy of Educational Objectives, lists five abilities inherent in critical thinking:

1. The ability to define a problem.

2. The ability to select pertinent information for the solution of a problem.

3. The ability to recognize stated and unstated assumptions.

4. The ability to formulate and select relevant and promising hypotheses.

5. The ability to draw conclusions validly and to judge the validity of inference.

Russell (71) lists three factors which are more encompassing:

1. Attitude factor--questioning and suspended judgment.

2. Conative factor--use of methods of logical inquiry and problem solving.

3. Judgment factor--evaluating in terms of some norm or standard or consensus.

Upon examination of this small sampling of definitions it becomes evident that a single definition of critical thinking is far from being agreed upon. However, the descriptions do have many common elements and certainly do not strongly contradict each other. Any studies or works which are compared or criticised in relation to critical thinking should be done with these thoughts in mind.

### III. DELIMITATIONS OF THE PROBLEM

1. Only the aspects of critical thinking measured by the Watson-Glaser test were considered, thus limiting the description of critical thinking. Several authors and tests suggest other aspects.

2. Similarly, the range of values and personality factors was limited by the respective tests.

3. The assumption was made that the validity as established for the tests was approximated in the experimental setting.

4. The sample of high school students used was above average in academic achievement and measures of intelligence and may not have been a good representation of the high school population.

5. The marks obtained on the six values measured by



the Study of Values were not independent of each other. A high score for one value would mean a lower score for another value.

6. Warner's Revised Scale for Rating Occupation which was utilized to obtain a student socio-economic rating may carry some error due to the following: (1) the scale was devised in 1949, (2) the scale was devised in U.S.A., and (3) the ratings were assigned in a somewhat subjective manner especially in the case of new kinds of occupations.

7. I.Q. scores were used as recorded in the school files. They were from four different I.Q. scales given by different administrators to the students at different age levels. These were all scaled to the same standard deviation and recorded as such. Some error may be present here although it was noted that when two or more I.Q. test scores were available for one student and these were rescaled, the I.Q.'s usually showed a close resemblance.

8. An average of marks used from several subject matter areas was used as an indicator of academic achievement. This means that marks were being used as given from dozens of teachers in several different schools. Some error is no doubt extant here. However, it was felt that the average mark does give an indication of academic achievement and that a better indication did not exist for the purpose

of this study.

#### IV. ORGANIZATION OF THE REMAINDER OF THE THESIS

Chapter two is a review of the literature which deals with the factors related to critical thinking. The chapter is organized so that the studies and writings dealing with each individual factor are grouped together. An attempt has been made to show general trends in the literature and to show the present status of the problem. In chapter three, the various measuring instruments which were used are described in considerable detail along with illustrative examples. The chapter also deals with the sample, the testing procedure and the statistical treatments used. Chapter four is a presentation of the findings of the study, while chapter five gives the conclusions and the summary of the thesis.

In summary, chapter one has defined the problem of the study and its importance in education. The nature of the critical thinking variable has been discussed with emphasis being placed on its nebulous characteristics, and the delimitations of the study have been laid out.

## CHAPTER II

### REVIEW OF THE LITERATURE

The literature on critical thinking might be sorted under the following headings:

1. Attempts to define critical thinking: Closely connected with the building of definitions are attempts to construct tests to measure critical thinking.

2. Explanations of the need for teaching critical thinking as well as descriptions of the role of critical thinking in society.

3. Techniques for teaching or improving critical thinking: The literature dealing with teaching techniques is lengthy, and includes every age group and numerous subject matter areas.

4. Factors which are related to critical thinking: The literature dealing with related factors is scanty and not too conclusive.

For the purposes of this paper, only that literature which deals directly with the factors which are related to critical thinking was included. It should also be noted that the literature on critical thinking is closely tied with literature on reading, problem solving, and various aspects of psychology. An effort has been made to include only the most relevant pieces of work.

## I. THE RELATIONSHIP OF I.Q. TO CRITICAL THINKING

The literature indicates that I.Q. and critical thinking have a positive relationship but there is little to indicate a strong positive relationship. This means that intelligence probably explains only part of the ability to think critically. There may be other factors involved. Constantinides (82) did a study with 240 fourth grade students. With the use of the Lorge-Thorndike Intelligence Test and a critical thinking test specially validated by the staff of the Division of Educational Research at the University of Virginia, he found a positive relationship between I.Q. and critical thinking, but a positive significant relationship between I.Q. and low critical thinkers only.

Shohen and Johnson both speak of intelligence in terms of verbal ability. Johnson (10) writes of a close relationship between verbal intelligence and the component of inference as measured by the Watson-Glaser Critical Thinking Appraisal whereas the components of recognition of assumptions, deduction, interpretation and evaluation of arguments appeared as independent of verbal ability. Shohen (91) examined the relationship between verbal intelligence as measured by the Wechsler Intelligence Scale and critical reading of superior readers as measured by the Diagnostic Social Studies Reading Exercises and found:

1. Verbal I.Q. has a definite but small relationship

to critical reading in the social studies.

2. Verbal I.Q. has a negligible to small relationship to elements of critical thinking ability.

3. Critical reading has a negligible to small relationship to elements of verbal I.Q.

4. Certain elements of verbal I.Q. have negligible to small relationship to certain elements of critical reading.

Glaser (49) found that the Watson-Glaser test correlated .48 with the Otis Gamma scores of intelligence in a group of 127 New York and Newark high school students. In addition he found a .41 correlation with the same critical thinking test and the A.C.E. Psychological Examination scores in a group of high school seniors in Brooklyn.

Furst (45), using a highly intelligent group composed of 60 college students and 63 high school students, administered the University of Chicago Critical Reading Test Series composed of fifteen tests and the American College Entrance Test. The University of Chicago test series was composed of definitions, analysis, and judgments. More specifically it consisted of the following: (1) analysis of poetry, (2) analysis of certain facts concerning social issues, (3) summarization of facts, (4) judging relationships, (5) interpretation of data, (6) grasp of the fundamentals of logic, and (7) graphic interpretation. Of the

total of fifteen tests, approximately one-third had a correlation of .40 or higher with the A.C.E. intelligence scores. One-half of the correlations were below .25. Hence, I.Q. and critical thinking exhibited only moderate positive correlation. This study is slightly marred because of the uncertain validity of the critical reading tests and the uniformly high intelligence of the sample.

A factor analysis by Westbrook and Sellers (79) revealed the presence of a strong general factor on the Watson-Glaser test although the loadings were reduced when varimax rotation was conducted. One factor was defined by the Quick Word Test, a vocabulary test, and the Henmon-Nelson Tests of Mental Ability, a highly verbal intelligence test. Both tests measure knowledge of word meanings and word discrimination to a greater extent than the Watson-Glaser variables. These studies further indicated that the critical thinking abilities of higher ability students might form a structure different from that found in normal populations.

Narrowing the range of aspects of critical thinking down to inference alone, Bedell (24) looked at I.Q., the ability to recall, and the ability to infer in specific learning situations. He had 324 eighth and ninth grade students read various paragraphs and subsequently answer questions concerning the material read without referring to the

paragraphs a second time. The subjects were then given a problem solving test in which inference had to be made from the paragraphs. The Terman Group Intelligence Test was given to all students. It was found that the I.Q. test correlated higher with inference than simple recall. Another study by Skelly (92) found that the Watson-Glaser test scores appeared to be based on intelligence levels rather than on divergent thinking levels for high school students.

The manual (16) which accompanies the Watson-Glaser Critical Thinking Appraisal claims that the tasks in intelligence tests are quite different from those in the Critical Thinking Appraisal. The correlations, however, between the critical thinking scores and measures of intelligence in the verbal area are moderately high, and range as given in the manual from .55 to .75 with the median at .68. The manual concludes that high intelligence may be a necessary but not sufficient attribute for high attainment in critical thinking and that tests of intelligence should not be substituted for the test of critical thinking.

One might also consider intelligence in terms of Guilford's (51) three-dimensional model where he proposes that intelligence is composed of: (1) the various operations or abilities, (2) the materials with which these operations deal, and (3) the products or outcomes of these operations. According to this system, all thinking--

including critical thinking--depends upon different combinations of these groups of factors and critical thinking would be considered as a small integral part of the whole intelligence.

In addition, Hendrickson (86), Eller and Dykstra (39), Alpern (21), Long and Welch (60), Techman (77), Hansen (52), and Johnson (54) all found positive relationships between intelligence and the ability to devise or choose tests of scientific hypothesis, the ability to think critically, the ability to reason inductively, the ability to reach conclusions on science items, and the ability to do problem solving.

There are some studies which contradict the preceding indications that intelligence and critical thinking are moderately correlated. Durrell and Chambers (37) use several examples of studies to make the claim that the ability to think rests upon training rather than intelligence. One interesting study which might support this was done by Ohmer Milton (63) on the primitive or magical thinking of a group of college students. He used a test on Magical Thinking which he assumed to be a measure of uncritical thinking, the verbal portion of D.A.T. and the W.G.C.T.A. He found little or no relationship between intelligence and "magical thinking" and a slight tendency for those who score high on magical thinking to score low on critical thinking.



Edwards (38) prepared instruments to measure pupil ability to think critically with the facts of science. He based these instruments on John Dewey's approach to critical thinking. The tests proved to be relatively independent of I.Q. with the correlations ranging from 0.0 to .17.

Maney (62) and Billings (26) both give indications that intelligence and critical thinking are not the same thing.

## II. THE RELATIONSHIP OF CREATIVITY TO CRITICAL THINKING

The relation of creativity to critical thinking has not been clearly defined. One study available was done by MacDougall (89) with fourth, fifth, and sixth grade children. She worked with the Ohio State University Critical Reading Test and Minnesota Tests of Creative Thinking and found:

1. a low significant relationship in grades four and five between creative and critical thinking,
2. verbal creative thinking was more highly related to critical thinking than non-verbal, and
3. of the factors of fluency, flexibility, originality, and elaboration in creative thinking, flexibility showed the highest relationship with critical thinking. She points out that a substantial relationship did not show up and that more definite research is needed to determine

whether creative thinking is inherent in the critical thinking process.

J. Gilbert (85) of the University of Buffalo found that high Watson-Glaser scores of eleventh grade students corresponded to high creativity scores and that they were significantly greater than those of low creativity scores.

Fluency and flexibility as described by Torrance (14) and Getzels and Jackson (16) are factors which are interwoven with judgment.

### III. THE RELATIONSHIP OF VERBAL BEHAVIOUR TO CRITICAL THINKING

A single, rather unique study by Hunt (87) should be included. She looked at the critical thinking of teachers as measured by the Watson-Glaser test and its relationship to the teacher's classroom verbal behaviour and the teacher's perceptions of teaching purposes. She found that teachers who scored high on critical thinking had:

1. significantly more convergent comments,
2. significantly more evaluative comments,
3. significantly more divergent comments,
4. significantly more supportive comments,
5. more goal setting comments,
6. no significant difference in cognitive memory comments, and
7. no significant difference in routine comments.

#### IV. THE RELATIONSHIP OF READING ABILITY TO CRITICAL THINKING

Writings and studies dealing with the ability to read as related to the ability to think critically are fairly numerous with perhaps more conclusions having been drawn about this relationship than some of the other relationships discussed in this paper. It might also be noted at this point that the notion of critical thinking has become so interwoven with ideas of critical reading that the investigator has not attempted to separate the two concepts in this review of literature. In fact, some writers, such as Robert Karlin (56), claim that critical reading and critical thinking are parts of the same mental operations.

Betts (25) and his examination of the works of Artley, Maney, and Sochor resulted in the conclusion that there is a positive but very low relationship between the ability to do literal reading and the ability to do certain types of critical thinking in both science and social studies. He further stated that the ability to do critical thinking in reading situations is not adequately measured by most reading tests in common use.

Looking more closely at Sochor's study (75) in which she developed instruments to measure literal and critical reading ability in social studies for fifth grade classes, it is noted that she found the following correlations:

1. .83 between I.Q. and general reading ability,
2. .72 between I.Q. and literal reading comprehension,
3. .69 between I.Q. and critical reading interpretation,
4. .61 between general reading ability and literal and critical reading interpretation of social study materials,
5. .76 and .64 between general reading ability and literal and critical reading comprehension respectively, and
6. .23 between literal and critical reading comprehension when I.Q. was controlled.

A study which might be generally related to these ideas was done by Balow (22) in which he looked at the relationship between reading and problem solving ability of 1400 sixth grade children. He found that general reading ability did have an effect on problem solving when intelligence was controlled.

Similarly, Trela (93) compared ninth graders on general reading comprehension and critical thinking. He says that the Gates and Stanford tests seem to be equally effective in giving an estimate of general reading ability and that this estimate may be utilized as a general indicator of corresponding performance in the areas measured by I.T.E.D., S.T.E.P., and the W.G.C.T.A. when they are used

in group situations.

The manual for the W.G.C.T.A. quotes correlations between critical thinking and reading ability ranging from .60 to .66 with a median of .64. The manual continues by saying that an ability to read is naturally necessary for good performance on the critical thinking test, then adds that the test items require mental operations which are more complicated than mere recognition of vocabulary and comprehension of the sentences.

Groff (50) says that general reading ability is most closely related to critical reading scores, and is followed by intelligence, attitude toward different content types of stories, attitude toward reading as a school activity, chronological age, socio-economic status, and attitudes toward school, classmates and teacher.

A larger relationship between a self-made critical thinking test and the California Reading Test was found by Hendrickson (86). The correlation was .69 and it was conjectured that the critical thinking test employed was influenced too much by verbal abilities.

However, a conclusion to the effect that reading ability and critical thinking ability have definite positive correlations does not always seem to be true. Studies exist which point to the opposite conclusion. For example, Maney (62) indicates that proficiency in the critical read-

ing of science cannot be predicted from: (1) literal reading tests in science, or (2) "general" reading tests. He suggests that critical reading comprehension in science is a complex of skills or abilities, each of which is relatively independent of the ability to read literally. When he partialled out I.Q., he found that the correlation between general reading ability and critical reading ability in science was .11. Gans (47) agrees and says that the ability to read with comprehension does not necessarily signify an ability to discriminate between relevant and irrelevant material. Gans found persons in the intermediate grades with ability to comprehend what was read who were often quite unable to read selectively in order to solve problems.

#### V. THE RELATIONSHIP OF OTHER ACADEMIC ABILITIES TO CRITICAL THINKING

Several studies seem to illustrate that science-minded people or people who have studied the sciences tend to be better critical thinkers. Kenneth George (48) found:

1. science education majors were significantly better on a test of critical thinking than all other academic majors tested, except mathematics, and
2. science majors in the school of education at the University of Kansas constituted the most homogeneous of all groups tested with respect to critical thinking ability.

Similarly, Craven (83) concluded that science-teacher candidates scored higher on the Cornell Critical Thinking Test than other teacher candidates. He used scholastic aptitudes and accumulative grade point averages as covariance controls.

Smith (74) found that critical thinking abilities and science understandings tended to reflect each other among the boys, but appeared to be of little or no consequence among the girls.

Bass (81) discovered a significant correlation between critical thinking as measured by the W.G.C.T.A. and the A.C.E. Test of Critical Thinking and Zoology I raw scores at the University of Oklahoma. He developed a regression equation whereby the success of future Zoology I students of the same population might be predicted with a standard error of estimate of 14.88 per cent with the A.C.E. test, and 16.18 per cent with the W.G.C.T.A. In the same vein, Tyler (94) found that a test covering important zoological information had a correlation of .29 with an inference test.

Dealing with the area of intercollegiate debating, Jackson (88) used the W.G.C.T.A. and found the following:

1. Freshman with high school debating experience had a greater advantage on pre-test critical thinking scores than those without such experience.

2. Students with a high grade point average made

significantly higher scores on critical thinking.

3. Juniors and Seniors scored higher than Sophomores and Freshmen.

Under this heading might be included the subject of propaganda, the resistance of which might involve critical thinking. Several authors agree that individuals might be knowledgeable, intelligent, and understand the techniques of propaganda but still be influenced by propaganda and not think critically in reaction to it. Eller and Dykstra (39) quote writings to this effect. Wayland Osborne (65) says that even the teaching of techniques of propaganda does not necessarily make one resistant to it.

Perhaps the work of Buck and Ojeman (28) should also be mentioned. They administered a test of critical thinking to twenty-three ninth grade students and found a correlation of .31 between that test and the pupils behavior in choice situations. The factors influencing the relationship of the two tests were: (1) absence of a well formed plan in the situational aspects presented in the study, and (2) the appreciation of careful work in realizing a goal.

Although various academic skills might be necessary for critical thinking, and a good academic achievement record might be an indication of an ability to think critically, this notion has been disputed by some investigations.



Edwards (38) claimed that the critical thinking measured by his tests was independent of academic achievement.

Glaser (49) found a  $-.12$  correlation between school grades and critical thinking.

Alterman's study (80) indicates that the critical thinking ability as measured by the W.G.C.T.A. does not significantly affect the ability of college students to solve mathematical or formula-type problems.

Finally, reference could be made to the studies of Burack (29), Burack and Moss (30), Duncker (36), Horracks (53), and Maier (61), which show that knowledge of the principles in a particular field of knowledge is in no way an assurance that these principles will be properly applied in problem-solving situations.

## VI. THE RELATIONSHIP OF ATTITUDES AND CRITICAL THINKING

Crossen, Groff, Piekarz, and Russell all emphasize the importance of the individual's attitude on his ability to deal with material critically. Groff (50) examined attitudes toward different content-type reading materials and the relationship of these attitudes to scores on critical reading tests. The four content-type areas were that of: (1) boys' sports activity, (2) girls' mild adventure,

(3) airplanes or flying, and (4) manners or social relations. He also measured attitudes toward classmates and teacher. Correlations between attitudes toward reading and critical reading scores ranged from .15 to .45. The correlations between attitudes toward school, classmates, and teacher and critical reading scores were low but positive.

Piekarz says there is a crucial relationship between attitudes and ability to read critically. In her study (68), she claims that it is possible to perceive printed words accurately and still misunderstand what is read because of the interference of attitudes on the conceptual processes. Helen Crossen (32) agrees with Piekarz and adds that the influence of attitudes increases when the reader is asked to make inferences. Crossen describes critical reading in four postulates:

1. gaining a clear and correct grasp of meaning,
2. gaining accurate perceptions of relationships, both expressed and implied,
3. evaluating content as to validity, comprehensiveness, accuracy, and usefulness to reader's purposes, and
4. drawing correct conclusions and making inferences about what is read.

Her critical thinking test involved expressed attitudes toward the Negro minority during World War II. Her sample of students was divided into three groups: (1) those favor-

able to Negroes, (2) those unfavorable to Negroes, and (3) those indifferent to Negroes. A significant difference occurred in the mean scores between "favorables" and "unfavorables".

Russell (72) indicates that critical thinking may depend less upon specific techniques and more upon attitude and experience. He suggests that part of the attitude factor in critical thinking is the objectivity which comes from the ability to shift perspective, or the ability to see one's own behavior and ideas as they may be viewed by others which may be part of the self-concept. The experience factor, he says, involves considerable participation in the social and linguistic community.

Anne McKillop (11) wanted to know whether readers' ability to answer questions in connection with the material in a reading passage was affected by the readers' attitudes about the material in the reading passage. In general, it was found that special detail questions were answered correctly and without bias, and that as long as the situation was clearly structured, attitudes did not enter into the required thinking. As the stimulus became less structured, more opportunity was present for attitudes to influence the reactions to the material.

In conclusion, this whole area seems rather vague in that the meanings associated with the word "attitude"

are not definite or alike for the various studies. It often seems that values and personality are both implied as being components of the concept of attitude.

#### VIII. THE RELATIONSHIP OF VALUES TO CRITICAL THINKING

Lehmann has done considerable work in this area.

In one study (50), he examined the changes in critical thinking and values in college students from freshmen to senior years. He found an improvement in critical thinking abilities, a lessening of stereotypic beliefs and unreceptivity to new ideas, and a movement away from the traditional-value orientation from freshmen years through to senior years. Seniors were also less homogeneous in certain attitudinal traits than freshmen, and were more "outer-directed" than they were as freshmen.

In another study (59), Lehmann used students from three midwestern colleges: (1) a Presbyterian Liberal Arts College (P), (2) a Congregational Liberal Arts College (C), and (3) a large State University (S). Among his conclusions were:

1. both males and females at (P) are least stereotypic in beliefs,
2. both males and females at (S) are better critical thinkers,
3. both males and females at (C) are poor critical

thinkers,

4. there is a statistically significant difference in critical thinking among the students (both male and female) at the three midwestern colleges,

5. after adjusting for initial differences in critical thinking ability among male students at the three different institutions, there still was a significant difference among male students in their stereotypic beliefs, and

6. after making adjustments for differences in critical thinking ability, no evidence was found that students attending three different types of colleges differ significantly in their attitudes and values.

Russell (71) suggests that critical thinking about materials which may be labelled "lewd" or "obscene" or "pornographic" is probably related to the reader's standards or tastes.

With the use of the W.G.C.T.A. and the Study of Values, and a group of secondary school principals, Cyphert (33) found the group to have the following characteristics:

1. the mean critical thinking score fell in the upper quartile of W.G.C.T.A. scores, meaning that the group was composed of good critical thinkers, and

2. the value hierarchy of the group was: (1) re-

ligious, (2) political, (3) theroretical, (4) economic, (5) social, and (6) aesthetic.

An experiment by Geckler (84) showed that:

1. dogmatism increased as critical thinking decreased, and that there was a significant difference in mean dogmatism of students who were grouped for critical thinking, and

2. critical thinking compared with dogmatism and religion was significant. Subjects of Episcopal denomination consistently ranked high on critical thinking and low in dogmatism. Baptist and Church of God affiliates ranked high in dogmatism and low in critical thinking.

Kemp (57) made a comparison of those who were low with those who were high in dogmatism with reference to their ability in critical thinking as indicated in problem solving. He found that high dogmatism or closed-mindedness decreased efficiency in critical thinking and concluded this was due to the following factors:

1. difficulty in tolerating ambiguities which leads to a "closure" before full consideration is given to each piece of contributing evidence,

2. a perceptual distortion of facts resulting in a decision which does not encompass all elements of the problem, and

3. lack of recognition or rejection of significant

parts of the whole problem in order to accomodate it into the preformed value pattern resulting in a poor or incorrect solution.

Thayer and Pronko (78) found that the subjects of their study ascribed characteristics they valued to a fictitious character. Their findings indicate that moral and ethical values color the reader's conceptualization and provide a stereotyped sociocultural frame of reference for structuring ambiguous reading situations.

A doubtful note to the above general notion of the relationship of values and critical thinking is indicated by Bledsoe (27). He did a study of the values and critical thinking of 46 graduate students in which he subjected them to an intensive course in research methodology. He found that a significant change occurred in the mean scores on the critical thinking test, but that there was no significant change in the values as measured by the Study of Values test. Perhaps this suggests a lack of relationship between values and critical thinking.

#### VIII. THE RELATIONSHIP OF PERSONALITY TO CRITICAL THINKING

Of the numerous tests of personality which are available, few have been used to study the personality of a critical thinker. A small number of studies was found.

Constaninides (82) used the California Test of Personality and found that high critical thinkers were good-natured, adaptable, intelligent, calm, and imaginative with good personality adjustment, whereas low critical thinkers were outgoing, cheerful, grateful, cooperative and friendly. He found, in general, that high critical thinkers had better personal, social, and total personality adjustment than low critical thinkers.

Two interesting correlations were found by Gaier (46). A rank order correlation between personality rigidity and knowledge of specific information was .73, whereas the rank order correlation between rigidity and ability to apply principles in new situations, or to critically compare ideas, was almost reversed and was  $-.71$ . He says that anxiety, rigidity, and negativism determine the nature of the individual's class participation, his ability to think critically, and his ability to relate ideas learned in a course to new situations.

Solomon (76) agrees with Gaier and notes that rigid persons are less able to grasp and apply the various factors which constitute the scientific method and are less able to organize ideas into comprehensive wholes.

Somewhat related is the work of Postman and Murphy (70) who found that mind-set can affect learning and therefore affects thinking. In this study twenty-eight children learned



pairs of words. Those pairs which more closely approximated the children's original attitudes were learned more quickly. Topics hinted at by each pair of words dealt with the United Nations and the Axis powers.

In the same theme, Frenkel-Brunswick (43) found that as a result of the early parent-child relationships there emerge degrees of variance in the ability of the youth to tolerate ambiguity, and that his emotional and social ambivalence manifests itself in the cognitive spheres.

In Eller and Dykstra (39), the suggestion is made that the student with psychological abnormalities is likely to be either totally uncritical or ultracritical and that those with low self-esteem are most malleable.

Three other sources, Allport and Postman (1), Postman, Bruner and McGinis (69), and Russell (72) suggest that accurate perception becomes difficult when the individual feels himself threatened or when a challenge is too severe. The individual may then assimilate his ideas in accordance with his values so as to ward off feelings of threat.

Similarly, Patrick (66) showed that after somewhat violent shocks were inflicted upon them, subjects who had previously made successful attempts at problem solving regressed to very inferior oft-tried approaches to solutions. Christie (31) also showed that persons tend to cling even more tenaciously to a given scheme of attack under frustrating conditions.

Barker, Dembo and Lewin (23) agree with Christie and go further to state that strong emotions may not only impede learning, but may also facilitate learning.

Hendrickson (86) found a correlation of .23 between pupil adjustment as measured by the S.R.A. Rating Scale for Pupil Adjustment and a self-made test of critical thinking.

An inference that might be drawn here is that personality may well be an important factor in the quality of thinking done by an individual. This small amount of information seems to point in that direction.

#### IX. THE RELATIONSHIP OF SOCIO-ECONOMIC STATUS TO CRITICAL THINKING

Very little material is available on the subject of socio-economic status as related to critical thinking. Geckler (84) concluded that there was no significant difference in critical thinking between social status groups when adjusted for verbal I.Q., however, he found a significant difference for unadjusted scores.

Constantinides (82) determined the occupation of the father or the mother of each subject and classified it as professional or non-professional and found, as opposed to Geckler, that grade four children who were critical thinkers were more likely to have professional parents and low critical thinkers were more apt to have non-professional parents.

Hendrickson (86), using a modified form of Warner's

Scale for Rating Occupation, found that the critical thinking scores of pupils whose parents were in the Professional group were significantly higher than those whose parents were in the Labor group, as well as those whose parents were in the Managerial and Clerk group being significantly higher than those whose parents were in the Labor group.

Somewhat connected with this topic is the investigation by Dolger and Ginandes (34). They dealt with a number of elementary school children from different socio-economic levels and questioned the children with respect to prescribing punishment for other children guilty of a particular offense. Children from the lower socio-economic level suggested more harsh techniques of punishment and were more rigid than constructive in their approach. Those children from higher socio-economic levels were more flexible and constructive regarding the disposition of the offenders. This might be connected with critical thinking as some indications of plan and forethought were taking place in the minds of the higher socio-economic children.

#### X. THE RELATIONSHIP OF SEX TO CRITICAL THINKING

Most studies favor males over females with respect to critical thinking. Referring to Smith's study (74) of high ability secondary school students, he found the boys significantly higher than the girls on critical thinking tests. Similarly, Jackson's (88) sample of college stu-

dents showed men to have significantly higher pre-test scores than women. Edwards (38) and Billings (26) both support these findings. In addition, Bedell (24) found that although girls were slightly better performers on intelligence tests and tests of recall, boys were significantly better on a test of inference.

Two experimenters refute the idea that males are more able to think critically than females. Lehmann (59), whose study of three Midwestern colleges has previously been mentioned, found that females at all three colleges were less stereotypic, better critical thinkers, more emergent-value oriented and less dogmatic. Hendrickson's work (86) also showed a sex difference in favor of girls.

#### XI. THE RELATIONSHIP OF AGE TO CRITICAL THINKING

Maney (62) claims that the mechanisms of critical thinking develop slowly, usually being present in the individual by age seven. However, Russell (71) thinks that critical thinking develops in some children before school age and that activities in critical thinking begin in primary grades, not with the "rational adult". Age might be part of the relationship which Jackson (88) found. He saw that Sophomores and Freshmen did not score as high on the W.G.C.T.A. as Juniors and Seniors, although other factors could well predominate here.

Friend and Zubek (44), using the W.G.C.T.A. found:

1. critical thinking matures later (mid-twenties) than does general intelligence (late teens, early twenties) and declines later. The maximum holds through age thirty-five and declines progressively through to the seventies,

2. the five subabilities of critical thinking show different patterns of development and declines. The abilities to draw inferences and detect assumptions peak ten years later, and

3. although elderly subjects as a whole scored poorly, many still show a high level of performance, as high or higher than many young adult subjects.

Inhelder and Piaget (9) are strong in their belief that there are stages of development in thinking and it is possible to infer from their work that there is a gradual improvement in the objectivity of a child's thinking as he grows older. They maintain that eleven years of age appears to be the time at which logical reasoning is found in children.

The studies of Edwards (38) and Smith (74) suggest, on the contrary, that age is not important to critical thinking proficiency.

## XII. THE RELATIONSHIP OF UNTENABLE FACTORS TO CRITICAL THINKING

Using a mechanical device, Morgan (64) revealed that when logically irrelevant factors appear in the setting of a

problem, a person may be so influenced by aspects of these details that he ceases to be intelligently critical.

### XIII. SUMMARY OF THE REVIEW OF LITERATURE

Only very general trends which may possibly be extant in the works reviewed in this paper can be pointed out in this summary. Frequently there is simply not enough material available on which to base a sound conclusion.

Critical thinking seems to have a positive relationship with I.Q., although not a high positive relationship. In particular, verbal I.Q. and verbal creativity may give positive indication of critical thinking ability. Aspects of creativity such as fluency and flexibility may also have some meaning in critical thinking. Those who think critically may display this thinking in verbal comments of an evaluative and judgmental nature.

When general and literal reading are correlated with critical reading and critical thinking, the correlations are moderately high, but seem to fall considerably when I.Q. is partialled out.

There is a fairly strong indication that science-minded people and people who have studied the sciences are better critical thinkers. Experience with debating also seems to develop critical thinking. Numerous studies hint at the idea that knowledge of the principles in a field of

knowledge in no way assures that the person is able to apply those principles or is able to deal with them critically.

Favorable attitudes toward others, toward oneself, and toward the material being dealt with seem to aid critical thinking. Experience with life and a self-awareness also seem to correlate with critical thinking. Personal beliefs and attitudes often influence the judgments one makes especially in an unstructured situation.

Inner-directedness, unreceptivity to new ideas, stereotypic beliefs, dogmatism, and closed-mindedness are often warnings of the uncritical mind; whereas, a good personality adjustment, high self-esteem, low rigidity, low anxiety, and feelings of security are possible positive correlates of the critical mind.

Finally, there may be a stronger likelihood of finding critical thinkers among young male adults of high socio-economic levels, rather than among low socio-economic levels, women, or the very young or the very old.

## CHAPTER III

### THE MATERIALS, THE SAMPLE, AND THE PROCEDURE USED

In this chapter, the measuring instruments which were used in the study are described in sufficient detail to give the reader an idea of what it was that was tested. These descriptions have, of course, been abbreviated and a highly detailed description of them might only be had by referring to the manuals which accompany the tests. The chapter also describes the sample and the testing procedures. Finally, a resume of the statistical treatment given to the data has been included.

#### I. MEASUREMENT INSTRUMENTS

The Watson-Glaser Critical Thinking Appraisal. The 1961 edition of Form YM was used in the study. The test consists of a series of 100 test exercises which include problems, statements, arguments, and interpretations of data similar to those which a citizen in a democracy might encounter in his everyday life as he works, reads newspaper or magazine articles, hears speeches, or participates in discussions. Some items deal with "neutral" topics, other items deal with a very controversial type of material. It tests five aspects of critical thinking:

1. Inference: Samples ability to discriminate among



degrees of truth or falsity of inference drawn from given data. An example taken from Form YM (15) is:

Two hundred eighth-grade students voluntarily attended a recent week-end student forum conference in a Midwestern city. At this conference the topics of race relations and means of achieving lasting world peace were discussed, since these were the problems the students selected as being most vital in today's world.

The majority of these students were between the ages of seventeen and eighteen. Is this statement true, probably true, false, probably false, or is there insufficient data on which to base a conclusion?

2. Recognition of Assumptions: Samples ability to recognize unstated assumptions or presuppositions which are taken for granted in given statements or assertions. An example is:

"Zenith is the city to live in--lowest taxes." Efficient management of a city implies lower taxes. Has this assertion been made or not made in the statement?

3. Deduction: Samples ability to reason deductively from given statements or premises; to recognize the relation of implication between propositions; to determine whether what may seem to be an implication or a necessary inference from given premises is indeed such. An example is:

Some holidays are rainy. All rainy days are boring. Therefore -  
No clear days are boring.  
Does this conclusion follow from the statement?

4. Interpretation: Samples ability to weigh evidence and to distinguish between: (1) generalizations from given data that are not warranted beyond a reasonable doubt,

and (2) generalizations which, although not absolutely certain or necessary, do seem to be warranted beyond a reasonable doubt. An example is:

A report of the U.S. Census during a certain year states that there are approximately 1,656,000 marriages and 264,000 divorces in the United States.

Getting a divorce is a relatively easy matter in the United States.

Does this conclusion follow from the given statement?

5. Evaluation of Arguments: Samples ability to distinguish between arguments which are strong and relevant and those which are weak or irrelevant to a particular question at issue. An example is:

Should all young men in the United States go to college?

No; excessive studying permanently warps an individual's personality.

Is the argument strong or weak?

The W.G.C.T.A. has no time limit; it is a test of power rather than speed. High school norms are supplied for both forms of the test based on 20,312 students across thirteen states. College and adult norms are also given.

Reliability data, consisting of split-half reliability coefficients derived from the scores of the various normative groups are given and range from .77 to .87. Reliability coefficients for the separate subtests of the W.G.C.T.A. are moderately low as they are based on a relatively small number of items. The manual does not recommend that these part scores be utilized to evaluate individual attainment in the several sub-skills.

characteristically takes a "cognitive" attitude, one that looks for identities and differences; one that divests itself of judgments regarding the beauty or utility of objects, and seeks only to observe and reason. His chief aim in life is to order and systematize his knowledge.

2. Economic: This man is interested in what is useful. Based originally upon the satisfaction of bodily needs (self-preservation), the interest in utilities develops to embrace the practical affairs of the business world--the production, marketing, and consumption of goods, the elaboration of credit, and the accumulation of tangible wealth. This type is thoroughly "practical" and conforms well to the prevailing stereotype of the average American businessman.

3. Aesthetic: This man sees his highest value in "form" and "harmony". Each single experience is judged from the standpoint of grace, symmetry, or fitness. He regards life as a procession of events; each single impression is enjoyed for its own sake. He need not be a creative artist, nor need he be effete; he is aesthetic if he but finds his chief interest in the artistic episodes of life.

4. Social: The highest value for this type is love of people. In the Study of Values it is the altruistic or philanthropic aspect of love that is measured. The social man prizes other persons as ends, and is therefore himself kind, sympathetic, and unselfish.

5. Political: This man is interested in power and wishes for personal power, influence, and renown, his activities not necessarily being restricted to politics.

6. Religious: The highest value of the religious man may be called unity. He is mystical, and seeks to comprehend the cosmos as a whole, to relate himself to its embracing totality. Spranger (13) defines the religious man as one "whose mental structure is permanently directed to the creation of the highest and absolutely satisfying value experience."

The reliability of the Study of Values seems adequate. Using split-half reliability on the items measuring each separate value, the mean reliability coefficient is .90. An item analysis shows a positive correlation for each item with the total score for its value, significant at the .01 level of confidence. The mean repeat reliability coefficient was .89 for a one-month study and .88 for a two-month study.

In spite of the fact that the scores on the six values are interdependent (a high score on one value requiring low scores on the other values) there are, in general, negative correlations between pairs of values.

The norms are based on a college population and the authors do not claim that they represent a systematic sampling of American colleges. There are different sex

The person who scores high tends to be quick to grasp ideas, a fast learner, intelligent.

3. Factor C (affected by feelings vs. emotionally stable): The person affected by feelings tends to be low in frustration tolerance for unsatisfactory conditions, changeable and plastic, evading necessary reality demands, neurotically fatigued, fretful, easily emotional and annoyed, active in dissatisfaction, having neurotic symptoms.

The person who scores high tends to be emotionally mature, stable, realistic about life, unruffled, possessing ego strength, better able to maintain solid group morale.

4. Factor E (humble vs. assertive): The humble person tends to give way to others, to be docile, and to conform. He is often dependent, confessing, anxious for obsessional correctness.

The opposite person is assertive, self-assured, and independent-minded. He tends to be austere, a law unto himself, hostile or extrapunitive, authoritarian, and disregards authority.

5. Factor F (sober vs. happy-go-lucky): The sober person tends to be reticent, restrained, introspective. He is sometimes dour, pessimistic, unduly deliberate, and considered smug and primly correct by observers. He tends to be a sober, dependable person.

The person who scores high on this factor tends to be

cheerful, active, talkative, frank, expressive, effervescent, carefree. He is frequently chosen as an elected leader. He may be impulsive and mercurial.

6. Factor G (expedient vs. conscientious): The person who scores low on this factor tends to be unsteady in purpose. He is often casual and lacking in effort for group undertakings and cultural demands.

The high scorer on Factor G tends to be exacting in character, dominated by sense of duty, persevering, responsible, planful. He is usually conscientious and moralistic, and he prefers hard-working people to witty companions.

7. Factor H (shy vs. venturesome): The shy person tends to be withdrawing, cautious, retiring, a "wallflower". He is usually slow and impeded in speech and in expressing himself, dislikes occupations with personal contacts, prefers one or two close friends to large groups, and is not given to keeping in contact with all that is going on around him. He often has inferiority feelings.

The opposite person tends to be bold, ready to try new things, spontaneous, and abundant in emotional response. He can be careless of detail, ignores danger signals, and consumes much time talking.

8. Factor I (tough-minded vs. tender-minded): The tough-minded person tends to be practical, realistic, masculine, independent, responsible, but skeptical of subject-

ive cultural elaborations. He is sometimes unmoved, hard, cynical, smug.

The tender-minded person tends to be day-dreaming, artistic, fastidious, feminine. He is sometimes demanding of attention and help, impatient, dependent, impractical. He dislikes crude people and rough occupations.

9. Factor L (trusting vs. suspicious): The person who scores low on Factor L tends to be free of jealous tendencies, adaptable, cheerful, un-competitive about other people, a good team worker.

The high scorer tends to be mistrusting and doubtful. He is often involved in his own ego, is self-opinionated and interested in internal, mental life. He is usually deliberate in his actions, unconcerned about other people, a poor team member.

10. Factor M (practical vs. imaginative): The practical person tends to be anxious to do the right things, attentive to practical matters, and subject to the dictation of what is obviously possible. He is concerned over detail, able to keep his head in emergencies, but sometimes unimaginative.

The person who scores high on Factor M tends to be unconventional, unconcerned over everyday matters, Bohemian, self-motivated, imaginatively-creative, concerned with essentials, and oblivious to particular people and physical

realities. His individuality tends to cause him to be rejected in group activities.

11. Factor N (forthright vs. shrewd): The person who scores low on this factor tends to be unsophisticated, sentimental, and simple. He is sometimes crude and awkward, but easily pleased and content with what comes, and is natural and spontaneous.

The person who scores high tends to be polished, experienced, worldly, shrewd. He is often hardhearted and analytical. He has an intellectual, unsentimental approach to situations, an approach akin to cynicism.

12. Factor O (placid vs. apprehensive): The placid person has unshakeable nerve. He has a mature, unanxious confidence in himself and his capacity to deal with things. He is resilient and secure, but to the point of being insensitive of when a group is not going to go along with him, so that he may evoke antipathy and distrust.

The person who scores high tends to be depressed, moody, a worrier, full of foreboding and brooding. He has a child-like tendency to anxiety in difficulties. He does not feel accepted in groups or free to participate.

13. Factor Q<sub>1</sub> (conservative vs. experimenting): The conservative person respects established ideas and is tolerant of traditional difficulties. He tends not to be interested in analytical "intellectual" thought.



The person who scores high tends to be interested in intellectual matters and has doubts on fundamental issues. He tends to be more well informed, less inclined to moralize, more inclined to experiment in life generally, and more tolerant of inconvenience and change.

14. Factor  $Q_2$  (group-dependent vs. self-sufficient): The low scorer is a "joiner" and a sound follower. He prefers to work and make decisions with other people, likes and depends on social approval and admiration.

The self-sufficient person is accustomed to going his own way, making decisions and taking action on his own. He does not dislike people, but simply does not need their agreement or support.

15. Factor  $Q_3$  (undisciplined vs. controlled): The person who scores low will not be bothered with will control and regard for social demands. He is not overly considerate, careful, or painstaking. He may feel maladjusted.

The person who scores high tends to have strong control of his emotions and general behaviour, is inclined to be socially aware and careful, and evidences what is commonly termed "self-respect" and regard for social reputation.

16. Factor  $Q_4$  (relaxed vs. tense): The relaxed person tends to be sedate, relaxed, composed and satisfied. This may lead to laziness and low performance.

The person who scores high tends to be tense, excitable, restless, fretful, impatient. He is often fatigued,

but is unable to remain inactive.

In addition to the above sixteen personality traits which the test incorporates, there are another four factors which Cattell suggested might be used, and which are his mathematical reduction of the original sixteen, with the exception of Factor B (less intelligent vs. more intelligent). Since these additional four factors were used in the study, they should also be described:

1. Factor 1 (low anxiety vs. high anxiety): The person who scores low on this factor tends to be one whose life is generally satisfying and one who is able to achieve those things that seem to him to be important.

The person who scores high is dissatisfied with the degree to which he is able to meet the demands of life and to achieve what he desires. Very high anxiety is generally disruptive of performance, and productive of physical disturbances.

2. Factor 2 (introversion vs. extraversion): The person who scores low tends to be shy, self-sufficient, and inhibited in interpersonal contacts.

The person who scores high is a socially outgoing, uninhibited person, good at making and maintaining interpersonal contacts.

3. Factor 3 (tenderminded emotionality vs. alert poise): The person who scores low is likely to be troubled

by pervasive emotionality, and may be of a discouraged, frustrated type. He is, however, sensitive to the subtleties of life, likely to be artistic and rather gentle.

The person who scores high is likely to be an enterprising, decisive, and resilient personality. However, he is likely to miss the subtle relationships of life, and to orient his behaviour too much toward the obvious.

4. Factor 4 (subduedness vs. independence): The low scorer is a group-dependent, chastened, passive personality. He is likely to desire and need support from other persons, and likely to orient his behaviour toward persons who give such support.

The high scorer tends to be aggressive, independent, daring, and incisive. He will seek those situations where such behaviour is at least tolerated and possibly rewarded, and is likely to exhibit considerable initiative.

The 16 PF reliabilities, as dependability coefficients after a six day lapse, range from .60 to .91 for the individual traits, with the exception of Factor B. These reliabilities show the stability of the traits, and not the test. Stability coefficients, after a lapse of two months, range from .68 to .88 on individual traits.

Homogeneity (internal) coefficients are kept at moderate values, reducing the correlations among items relative to their correlations with the factor, in order to

give maximum breadth to the measured personality factor. These range from .06 to .81. The Equivalence Coefficients between A and B forms range from .34 to .76 for individual traits.

The mean correlation of all single items with the factors they represent is about .37 and, assuming a mean intercorrelation of the items of .10, the mean correlation of each group of items with the factor it represents, i.e., the concept (or construct) validity, is about .85.

Direct validities (form A and form B) range from .74 to .92.

Circumstantial validities (form A or form B) range from .42 to .99.

The Measure of Intelligence. The results of the most recent intelligence test, as recorded in the school files, was used for the purpose of this study. Because not all the schools make use of the same intelligence tests, it was necessary to convert all the raw scores to the same standard deviation of 15, and the same mean of 100. In the entire sample of 197 students, scores from the following intelligence tests were used and adjusted where necessary: (1) Dominion A, (2) Lorge-Thorndike, (3) Otis, and (4) SCAT.

The Measure of Academic Achievement. A general indication of all-round academic achievement was used in the form of the most recent average mark recorded for each student

in the school records. This mark was the average of the marks from six to eight subject matter areas.

The Indication of Socio-Economic Status. A reproduction of the form used to obtain data on which to assign a socio-economic rating is shown in Appendix I. The students were asked to supply information on their parents' education and occupations. The amount of income was also asked for as a further aid to the researcher in assigning occupation ratings. However, students usually had little knowledge of their parents' yearly income, so this proved to be of little value. Occupation and education combined were thus used as an indication of the student's socio-economic background.

The validity of using occupation and education as an indication of socio-economic background is supported by several authors. Smith (73, p. 103) writes, "the data suggested that an evaluation of socio-economic status can be as effectively done using occupation of head of household as by investigating other variables such as dwelling area, house-type, and source of income."

Hollingshead and Redlich (8) used a three dimensional classification: residence (weighted 6), occupation (weighted 9), and education of head of household (weighted 5). The authors concluded that little would have been lost if occupation alone had been used as an index of social class.

Pfautz (67, p. 398) says, "when it comes to studies

employing a single criteria of status, occupation again takes the lead."

Kahl and Davis (55) developed a Tetrachoric Correlation Matrix of nineteen status indices including most of the known methods. The results indicated that many indices cluster around the same dimension and further analysis revealed that the best single index is an occupational scale.

Several other authors suggest that occupation should not be used alone to indicate socio-economic status. Riess (12, p. 141-42) writes, "it will doubtless prove advisable to supplement the occupational index with other measures, since the correlation between the occupational index and variables like income and education, at the individual level, is not very high." Hodges (7, p. 96) agrees and says, "correlative though they may be with class level, most investigators are wary of simple, single-factor indices. Most would instead prefer a combined and weighted measure."

For the purposes of this study, occupation was rated according to Warner's Revised Scale for Rating Occupation as shown in Appendix II. Because this scale was made in U.S.A. during the 1940's and because some subjectivity arises in assigning a rating especially in the case of new kinds of occupations, it seemed advisable to use education to strengthen the assignment of socio-economic rating. The

following method was used:

1. father's education was rated from 1 to 8,
2. mother's education was rated from 1 to 8,
3. the above ratings were averaged to obtain an educational rating from 1 to 8,
4. the head of the household's occupation was rated from 1 to 7 according to Warner's Scale (the number order being reversed for convenience).
5. the average education rating was added to the occupation rating to obtain a rating from 1 to 15; a high rating indicating a high socio-economic level.

In the statistical treatment, the head of household's occupation, the father's education rating, the mother's education rating, and the calculated student socio-economic rating were all included as separate predictors.

## II. THE SAMPLE

The total sample consisted of 197 high school students in grades ten to twelve from Greater Winnipeg. Since the testing was done at the end of the school term, a rather crucial time in terms of studying time, the students which were allowed to take part in the study were often those who had been granted examination exemptions and were thus of higher academic ability. The main sample of 167 students had a mean I.Q. of 125.35 and a mean academic average of 72.30.

### III. THE PROCEDURE FOR THE COLLECTION OF THE DATA

The socio-economic data form, and the question book-lets and answer sheets for: (1) The Watson-Glaser Critical Thinking Appraisal, (2) the Study of Values, and (3) the Sixteen Personality Factor Questionnaire were distributed as a packet to each student. The testing period involved about  $2\frac{1}{2}$  hours. Directions were given for each test in succession and time guidelines were called (none of the tests had a time limit). The order of presentation of the tests was rotated among the seven different groups tested to lessen the effects of fatigue on the reliability of the results. I.Q. and academic average were obtained from the school records.

### IV. TREATMENT OF THE DATA

When necessary, the raw scores on the intelligence tests were converted to a standard deviation of fifteen, and the corresponding I.Q. recorded. The average achievement mark was recorded as obtained from the school records. The total adjusted score for each value from the Study of Values was calculated and recorded, as were the W.G.C.T.A. scores. The 16 PF contained sixteen personality scores which were totalled as directed on the scoring sheet. These sixteen scores were then converted to Sten Scores (ranging from 1 to 10) according to male and female norms for high



school juniors and seniors and these were recorded. Later in the study, the sixteen personality scores were reduced to the four more general factors which have been previously described. The conversion was done according to mathematical directions in the manual.

The head of the household's occupation was rated according to Warner's Scale and recorded. The educations of the father and the mother were recorded as rated by the students on the eight-point scale. A socio-economic rating for each student was calculated as previously described and recorded. The form used for tabulating the data for each student is shown in Appendix III. Sex and age of each student were also included.

The study thus included forty variables, six of which were the critical thinking scores which were used as criteria scores and thirty-four of which were the predictor scores.

Means and standard deviations were found for the forty variables as well as a matrix of all possible simple intercorrelations.

Using the total thirty-six variables (this excludes the four reduced personality Factors), the data was initially subjected to a Principle Factor Analysis with a Varimax Rotation to obtain the factor structure of the correlation matrix. The technique of this treatment is to determine an axis in the  $m$ -dimensional test space along which the variance

is a maximum; then a second axis orthogonal to the first is determined, this axis accounting for as much of the remaining variance as possible, and so on with additional axes. The per cent variability explained by each factor is determined, as well as the proportion of variance accounted for by the factor space. In the Varimax Rotation, the factors or columns of the factor matrix are simplified, giving high loadings for a few variables, with the rest of the variables being near zero. Communalities, the sums of the squared loadings across the rows of the factor pattern, are determined, and give the proportion of the variance for each of the variables.

The total thirty-six variables were also subjected to a Canonical Correlation Analysis using the six critical thinking scores as criteria, and the remaining thirty variables as predictors. Canonical Correlation produces a maximum correlation between linear functions of the two sets of variables. More than one combination between the two sets may be possible, with each combination determined so as to maximize the correlation between the new pair of canonical variates.

Algebraically, one might consider  $N$  simultaneous equations, with  $p$  predictors and  $q$  criteria variables where  $x_{ij}$  and  $y_{ij}$  represent the two sets of measures:

$$x_1 = a_1 x_{11} + a_2 x_{12} + \dots + a_p x_{1p};$$

$$b_1 y_{11} + b_2 y_{12} + \dots + b_q y_{1q} + y_1$$

$$x_2 = a_1x_{21} + a_2x_{22} + \dots + a_px_{2p};$$

$$b_1y_{21} + b_2y_{22} + \dots + b_qy_{2q} = y_2$$

$$x_N = a_1x_{N1} + a_2x_{N2} + \dots + a_px_{Np};$$

$$b_1y_{N1} + b_2y_{N2} + \dots + b_qy_{Nq} = y_N.$$

The problem is to find two sets of weights  $a$  and  $b$ , that maximize the correlation between  $x$  and  $y$ , the derived canonical variates. Four matrices of intercorrelations are used in the analysis:

$R_{11}$  = intercorrelations among the  $p$  predictors.

$R_{22}$  = intercorrelations among the  $q$  criteria.

$R_{12}$  = intercorrelations of predictors with criteria.

$R_{21}$  = the transpose of  $R_{12}$ .

The matrix  $R$  is then formed:

$$R = \begin{bmatrix} R_{11} & | & R_{12} \\ \hline R_{21} & | & R_{22} \end{bmatrix}$$

and substituted into the following canonical equation:

$$(R_{22}^{-1}R_{21}R_{11}^{-1}R_{12} - \lambda_i I)b_i = 0$$

The solution involves finding values for the latent roots  $\lambda_i$  so that,

$$(R_{22}^{-1}R_{21}R_{11}^{-1}R_{12} - \lambda_i I) = 0.$$

The vector of coefficients of  $b_i$  is associated with  $\lambda_i$ . The vector  $a_i$  is obtained from:

$$a_i = (R_{11}^{-1}R_{12}b_i) / \sqrt{\lambda_i}.$$

The vectors  $a_i$  and  $b_i$  are applied to standard score vectors to obtain the canonical variates. The canonical correlation

$R_c$  between the  $i^{\text{th}}$  pair of new components is  $\sqrt{\lambda_i}$ .

A Chi-square test of significance with  $(p-r)(q-r)$  degrees of freedom (where  $r$  is the number of roots removed) may be used to reveal how many of the linear functions allow statistical interpretation.

Based on the results of the initial treatments and the examination of the simple intercorrelations, the data was then subjected to Multiple Regression Analyses. The total critical thinking score was used as the criterion with a fewer number of predictors than was used in the initial treatments.

The standard score regression equation for  $(m-1)$  predictors on the criterion variable  $m$  has the form:

$$\hat{z}_{mi} = \beta_1 z_{1i} + \beta_2 z_{2i} + \beta_3 z_{3i} + \dots + \beta_{(m-1)} z_{(m-1)i},$$

where  $z_{1i}$  and  $z_{2i}$  are standard scores of subject  $i$  on tests 1 and 2 and  $\beta_1$  and  $\beta_2$  are standard partial regression coefficients influenced by intercorrelations among the predictors.

The regressed raw score,  $\hat{X}_{mi}$  may also be computed and has the form:

$$\hat{X}_{mi} = b_1 X_{1i} + b_2 X_{2i} + b_3 X_{3i} + \dots + b_{m-1} X_{(m-1)i} + C$$

where the  $b$  coefficients are found by the formula:

$$b_j = (\hat{\sigma}_m / \hat{\sigma}_j) \beta_j,$$

where  $(\hat{\sigma}_m / \hat{\sigma}_j)$  is the ratio of the standard deviation of the criterion to the standard deviation of that predictor.  $C$  is the intercept constant.

Comparison of the  $\beta$  weights indicates the relative contributions of the corresponding variables to the prediction of the criterion.

A multiple correlation coefficient,  $R$ , with the range  $0 \leq R \leq 1$  may also be found.

Finally, the total critical thinking score and the five critical thinking sub-scores were subjected to another Canonical Correlation using the fewer number of predictors which were used in the Regression Analysis.

A smaller sample of thirty students was used to validate the results of the study by attempting the prediction of the critical thinking ability of each student with the use of the Multiple Regression equation.

In summary, this chapter has described the materials or the tests used, the sample, the procedure for the collection of the data, as well as giving an overview of the statistical treatment of the data.

## CHAPTER IV

### THE FINDINGS OF THE STUDY

The findings presented in this chapter attempt:

1. to describe the person space in terms of the variables: (1) critical thinking, (2) intelligence, (3) academic achievement, (4) sex, (5) personality, (6) values, (7) socio-economic status, and (8) age,
2. to describe the critical thinking space (the total critical thinking score and the five critical thinking sub-scores) in terms of the variables: (1) intelligence, (2) academic achievement, (3) sex, (4) personality, (5) values, and (6) socio-economic status,
3. to show how the variables which have a large influence on critical thinking may be used to form a regression equation for the prediction of the total critical thinking score, and
4. to further describe the critical thinking space (the total critical thinking score and the five critical thinking sub-scores) in terms of the variables used in the regression equation.

Means and standard deviations were determined for each of the forty variables and are shown in Table I on page 66.

The matrix of simple intercorrelations among the

TABLE I  
MEANS AND STANDARD DEVIATIONS OF THE FORTY VARIABLES

Variable	Mean	Standard Deviation
Sex	.54	.50
Age	17.09	.96
Occupation	3.91	1.62
Father's Education	3.86	1.68
Mother's Education	3.69	1.37
Socio-Economic Rating	8.15	5.05
Factor A	4.91	2.05
Factor B	8.23	1.25
Factor C	5.23	2.14
Factor E	5.17	2.21
Factor F	5.16	2.13
Factor G	5.11	2.05
Factor H	4.96	2.27
Factor I	6.24	2.56
Factor L	5.30	2.16
Factor M	5.26	2.10
Factor N	4.56	2.15
Factor O	5.87	1.83
Factor Q <sub>1</sub>	5.51	2.43
Factor Q <sub>2</sub>	6.10	1.94
Factor Q <sub>3</sub>	5.86	2.12
Factor Q <sub>4</sub>	5.84	1.78
Theoretical	40.04	8.09
Economic	38.80	8.42
Aesthetic	41.24	9.55
Social	42.60	8.53
Political	41.98	6.47
Religious	35.23	8.92
I.Q.	125.35	12.00
Academic Achievement	72.30	10.46
Inference	11.65	2.68
Recognition of Assumptions	11.57	3.32
Deduction	18.66	3.09
Interpretation	19.21	2.45
Evaluation of Arguments	9.74	2.01
Total Critical Thinking	70.84	8.50
Factor 1.	5.75	1.94
Factor 2.	4.78	2.29
Factor 3.	4.98	2.11
Factor 4.	5.77	2.27

thirty-four predictor variables, designated as  $R_{11}$ , is shown in Table II on page 68. Only those correlations of .15 or greater are shown, these having significance at the .05 level of confidence.

Similarly, the matrix of simple intercorrelations for the six criterion variables,  $R_{22}$ , is shown in Table III on page 72, and the matrix of simple intercorrelations between predictor and criteria variables,  $R_{12}$ , is shown in Table IV on page 73.

#### I. THE INITIAL PRINCIPLE FACTOR ANALYSIS WITH VARIMAX ROTATION

The intercorrelation matrix of the thirty-six variables was subjected to a Principle Factor Analysis with a Varimax Rotation. The rotated factor matrix is shown in Table V on page 74. Table VI on page 75 shows the communalities for the rotated factor matrix. The following observations might be made:

1. The rotated factor matrix is a description of the person space in terms of the thirty-six variables.
2. The analysis has determined six factors which account for 50.4 per cent of the total variance of the person space.
3. Factor one which describes 12.6 per cent of the variance has high loadings on all six critical thinking scores, academic achievement, I.Q., Factor B (less intelli-



TABLE II

MATRIX OF INTERCORRELATIONS OF PREDICTORS ( $R_{11}$ )

	Sex	Age	Occ	F-Ed	M-Ed	S-Ec	F-A	F-B	F-C	F-E
Sex	---									
Age	*	---								
Occ	*	*	---							
F-Ed	*	-.17	.78	---						
M-Ed	*	-.16	.51	.59	---					
S-Ec	*	*	.38	.43	.40	---				
F-A	*	*	*	*	*	*	---			
F-B	*	.16	*	*	*	*	*	---		
F-C	.24	*	*	*	*	-.19	*	*	---	
F-E	*	*	.15	.18	*	*	*	.19	*	---
F-F	.19	*	*	*	*	*	*	*	.22	.30
F-G	*	*	*	*	*	*	.18	*	.24	*
F-H	*	*	*	*	*	*	.28	*	.35	.40
F-I	.18	*	.18	.15	*	*	.20	*	*	*
F-L	.16	*	.17	.21	*	*	*	*	.35	.34
F-M	*	*	*	.20	*	*	*	*	*	*
F-N	.27	*	*	*	*	*	*	*	*	.41
F-O	*	*	*	*	*	*	*	*	.49	*
F-Q <sub>1</sub>	*	*	*	*	*	*	*	*	*	.38
F-Q <sub>2</sub>	*	.18	*	*	*	*	-.31	*	*	*
F-Q <sub>3</sub>	*	*	*	*	*	*	.15	*	.27	-.20
F-Q <sub>4</sub>	*	*	*	*	*	*	*	*	.51	*
Thoer	-.44	*	*	*	*	*	-.17	*	*	*
Econ.	-.35	*	*	*	*	*	*	*	*	-.28
Aesth	.35	.17	*	*	*	*	-.22	*	*	.21
Soc.	.33	*	*	*	*	*	.27	*	*	*
Pol.	-.32	*	*	*	*	*	*	*	*	*
Rel.	.26	*	*	*	*	*	*	*	*	*
I.Q.	*	-.18	.23	*	.16	*	*	.32	*	*
Ac-Av	*	-.59	.16	*	*	*	*	.32	*	*
Factor 1	*	*	*	*	*	.15	-.15	*	-.75	*
Factor 2	*	*	.19	.19	*	*	.36	*	.26	.56
Factor 3	*	*	-.15	-.15	*	*	-.52	*	.27	.20
Factor 4	*	*	*	*	*	*	-.44	*	*	.61

\*Indicates  $r > .15$ ,  $p < .05$ .

TABLE II (continued)

	F-F	F-G	F-H	F-I	F-L	F-M	F-N	F-O
Sex								
Age								
Occ								
F-Ed								
M-Ed								
S-Ec								
F-A								
F-B								
F-C								
F-E								
F-F	---							
F-G	*	---						
F-H	.56	.17	---					
F-I	*	*	*	---				
F-L	*	-.28	*	*	---			
F-M	*	*	*	.17	*	---		
F-N	-.25	.15	-.28	*	-.20	*	---	
F-O	-.18	-.19	-.27	*	.16	*	*	---
F-Q <sub>1</sub>	*	*	*	*	.17	.15	-.29	*
F-Q <sub>2</sub>	-.30	-.25	-.23	*	*	*	*	*
F-Q <sub>3</sub>	*	.49	*	*	-.25	*	*	-.26
F-Q <sub>4</sub>	*	-.16	-.20	*	.29	*	*	.53
Theor	-.23	*	*	-.33	*	*	*	*
Econ	*	*	*	-.45	-.22	-.33	*	*
Aesth	*	-.25	*	.36	.19	.20	*	*
Soc	*	*	*	.30	*	*	*	*
Pol	*	*	.17	-.28	*	*	*	*
Rel	*	.19	*	.24	*	*	*	*
I.Q.	*	*	*	*	*	*	*	*
Ac-AV	-.15	*	*	*	*	*	*	*
F-1	-.23	-.37	-.47	*	.51	*	*	.73
F-2	.78	*	.88	*	*	*	-.34	-.23
F-3	.27	*	*	-.82	*	-.34	*	-.18
F-4	*	-.43	*	*	.31	.42	-.34	*

TABLE II (continued)

	F-Q <sub>1</sub>	F-Q <sub>2</sub>	F-Q <sub>3</sub>	F-Q <sub>4</sub>	Theo	Econ	Aes
Sex							
Age							
Occ							
F-Ed							
M-Ed							
S-Ec							
F-A							
F-B							
F-C							
F-E							
F-F							
F-G							
F-H							
F-I							
F-L							
F-M							
F-N							
F-O							
F-Q <sub>1</sub>	---						
F-Q <sub>2</sub>	.16	---					
F-Q <sub>3</sub>	*	*	---				
F-Q <sub>4</sub>	*	*	-.38	---			
Theor	.18	*	*	*	---		
Econ	*	*	.17	*	.21	---	
Aesth	.15	.21	-.22	*	-.24	-.51	---
Soc	-.18	-.20	*	*	-.44	-.37	*
Pol	.17	*	*	*	*	.35	-.40
Rel	-.26	*	*	*	-.48	-.47	*
I.Q.	.20	*	*	*	*	-.16	*
Ac-Av	*	-.15	*	*	.16	-.16	*
F-1	*	.15	-.54	.81	*	*	.17
F-2	*	-.43	*	-.15	-.17	*	*
F-3	*	*	*	-.19	.22	.28	-.16
F-4	.68	.56	-.29	*	*	-.25	.36

TABLE II (continued)

	Soc	Pol	Rel	I.Q.	Ac-Av	F-1	F-2	F-3	F-4
Sex									
Age									
Occ									
F-Ed									
M-Ed									
S-Ec									
F-A									
F-B									
F-C									
F-E									
F-F									
F-G									
F-H									
F-I									
F-L									
F-M									
F-N									
F-O									
F-Q <sub>1</sub>									
F-Q <sub>2</sub>									
F-Q <sub>3</sub>									
F-Q <sub>4</sub>									
Theor									
Econ									
Aesth									
Soc	---								
Pol	-.31	---							
Rel	*	-.40	---						
I.Q.	*	*	*	---					
Ac-Av	*	*	*	.31	---				
F-1	*	*	*	*	*	---			
F-2	*	*	*	*	*	-.35	---		
F-3	-.32	.17	*	*	*	-.21	*	---	
F-4	-.17	*	-.15	.15	*	.19	*	*	---

TABLE III  
 MATRIX OF INTERCORRELATIONS OF CRITERIA ( $R_{22}$ )

	Inf	R.Ass	Ded	Inter	E.Arg	Total
Inf	-----					
R.Ass	*	-----				
Ded	.37	*	-----			
Inter	.41	.26	.33	-----		
E.Arg	.22	*	.27	*	-----	
Total	.69	.58	.69	.66	.47	-----

\*Indicates  $r > .15$ ,  $p < .05$ .

TABLE IV  
 MATRIX OF INTERCORRELATIONS BETWEEN PREDICTORS  
 AND CRITERIA ( $R_{12}$ )

	Inf	R.Ass	Ded	Inter	E.Arg	Total
Sex	*	*	*	*	*	*
Age	-.27	-.20	-.24	-.21	*	-.32
Occ	*	*	.32	*	*	*
F-Ed	*	*	.30	*	*	*
M-Ed	*	*	.17	*	*	*
S-Ec	*	*	.21	*	*	*
F-A	*	*	*	*	*	*
F-B	.26	*	.32	.15	*	.32
F-C	*	.17	*	*	*	*
F-E	.24	*	.20	.16	*	.20
F-F	*	*	*	*	*	*
F-G	*	*	*	*	*	*
F-H	*	*	*	*	*	*
F-I	*	*	*	*	.18	*
F-L	*	*	*	*	*	*
F-M	*	*	*	*	.23	.18
F-N	*	*	*	*	*	*
F-O	*	*	*	*	*	*
F-Q <sub>1</sub>	.17	*	*	*	*	*
F-Q <sub>2</sub>	*	*	*	*	*	*
F-Q <sub>3</sub>	*	*	*	*	*	*
F-Q <sub>4</sub>	*	*	*	*	*	*
Theor	*	*	*	*	*	*
Econ	*	*	*	*	-.32	-.18
Aesth	*	*	*	*	.18	*
Soc	*	*	*	*	*	*
Pol	*	*	*	*	*	*
Rel	*	*	*	*	*	*
I.Q.	.26	*	.41	.30	.19	.41
Ac-Av	.33	*	.38	.16	.31	.43
F-1	*	-.17	*	*	*	*
F-2	*	*	*	*	*	*
F-3	*	*	*	*	*	*
F-4	*	*	*	.20	.17	.20

\*Indicates  $r > .15$ ,  $p < .05$ .

TABLE V  
 PRINCIPLE FACTOR ANALYSIS  
 VARIMAX ROTATION

	factor one	factor two	factor three	factor four	factor five	factor six
Cumulative Per Cent of Variability	12.6	21.95	30.67	38.25	45.41	50.42
Sex	*	0.64	*	*	*	*
Age	0.53	*	*	*	*	*
Occ	*	*	*	-0.85	*	*
F-Ed	*	*	*	-0.88	*	*
M-Ed	*	*	*	-0.72	*	*
S-Ec	*	*	*	-0.61	*	*
F-A	*	*	*	*	*	-0.50
F-B	-0.48	*	*	*	*	*
F-C	*	*	0.78	*	*	*
F-E	*	*	*	*	0.69	*
F-F	*	*	*	*	0.74	*
F-G	*	*	0.51	*	*	*
F-H	*	*	*	*	0.69	*
F-I	*	0.58	*	*	*	*
F-L	*	*	-0.52	*	*	*
F-M	*	*	*	*	*	0.38
F-N	*	*	*	*	-0.61	*
F-O	*	*	-0.71	*	*	*
F-Q <sub>1</sub>	*	*	*	*	*	0.47
F-Q <sub>2</sub>	*	*	*	*	*	0.61
F-Q <sub>3</sub>	*	*	0.59	*	*	*
F-Q <sub>4</sub>	*	*	-0.75	*	*	*
Theor	*	-0.66	*	*	*	*
Econ	*	-0.72	*	*	*	*
Aesth	*	0.47	*	*	*	*
Soc	*	0.58	*	*	*	*
Pol	*	-0.60	*	*	*	*
Rel	*	0.66	*	*	*	*
I.Q.	-0.52	*	*	*	*	*
Ac-Av	-0.65	*	*	*	*	*
Inf	-0.70	*	*	*	*	*
R.Ass	-0.47	*	*	*	*	*
Ded	-0.67	*	*	*	*	*
Inter	-0.63	*	*	*	*	*
E.Arg	-0.41	*	*	*	*	*
Total	-0.93	*	*	*	*	*

Note: Only the largest loading for each variable has been shown. The complete Factor Analysis Table is shown in Appendix V.

TABLE VI

## COMMUNALITIES OF THE FACTOR SOLUTIONS

Variable	$h^2$
Sex	0.43
Age	0.42
Occ	0.75
F-Ed	0.81
M-Ed	0.53
S-Ec	0.44
F-A	0.31
F-B	0.25
F-C	0.69
F-E	0.60
F-F	0.63
F-G	0.44
F-H	0.67
F-I	0.40
F-L	0.42
F-M	0.20
F-N	0.44
F-O	0.54
F-Q <sub>1</sub>	0.46
F-Q <sub>2</sub>	0.44
F-Q <sub>3</sub>	0.46
F-Q <sub>4</sub>	0.59
Theor	0.55
Econ	0.68
Aesth	0.66
Soc	0.49
Pol	0.48
Rel	0.48
I.Q.	0.35
Ac-Av	0.51
Inf	0.54
R.Ass	0.30
Ded	0.54
Inter	0.44
E.Arg	0.30
Total	0.87



gent vs. more intelligent), and age. It might be noted at this point that age was excluded from further statistical treatment due to the fact that this variable was artificially influenced by the sample. Factor one thus describes various aspects of mental ability.

4. Factor two accounts for 9.4 per cent of the variance. The high loadings are on all six values, the highest being on Economic. Factor I and sex also have high loadings. Factor two is basically a description of the value structure of the person.

5. Factor three explains 8.7 per cent of the variance and has high loadings on Factor Q<sub>4</sub>, Factor Q<sub>3</sub>, Factor O, Factor L, Factor G, and Factor C. By referring to Appendix VI, it can be seen that F-Q<sub>4</sub>, F-Q<sub>3</sub>, F-L, and F-C fall into the more general Factor 1. In general, factor three seems to describe the person space in terms of Factor 1 (low anxiety vs. high anxiety).

6. Factor four of the Rotated Factor Matrix explains 7.58 per cent of the total variance. The high loadings in this factor fall on the variables measuring aspects of socioeconomic status, that is, occupation of head of household, father's education, mother's education, and the socioeconomic rating. Father's education and the occupation of the head of the household seem to hold the greatest importance.

7. Factor five accounts for 7.2 per cent of the variance and is loaded on Factor E, Factor F, Factor H, and Factor N. Factor five thus describes the person space in terms of personality. These four personality Factors could be part of either the more general personality Factor 2 or the more general personality Factor 3. Factor 2 is a measure of Introversion vs. Extraversion while Factor 3 is a measure of Tenderminded Emotionality vs. Alert Poise.

8. Factor six which describes 5.02 per cent of the variance has high loadings on Factor A, Factor M, Factor Q<sub>1</sub>, and Factor Q<sub>2</sub>. Hence, factor six is also a description of personality. The more general Factor 3 (Subduedness vs. Independence) seems to be the underlying principle.

9. With reference to the Table of Communalities on page 75, the sums of the squared loadings across the rows which are above .50 fall on the following variables:

(1) occupation of head of household, (2) father's education, (3) mother's education, (4) Factor C, (5) Factor E, (6) Factor F, (7) Factor H, (8) Factor O, (9) Factor Q<sub>4</sub>, (10) Theoretical, (11) Economic, (12) Aesthetic, (13) academic achievement, (14) Inference, (15) Deduction, and (16) Total Critical Thinking.

10. In general, the Rotated Factor Matrix indicates that the thirty-six variables describe the person space in terms of intellectual ability, socio-economic status, values,

and three general aspects of personality.

## II. THE INITIAL CANONICAL CORRELATION ANALYSIS

In order to describe the critical thinking space, the thirty predictor variables (excluding the four reduced personality Factors) and the six criteria variables which measured aspects of critical thinking were subjected to a Canonical Correlation Analysis.

The treatment produced five linear combinations. Chi-square values allowed statistical interpretation on the first two combinations. The coefficients or weights for the predictor and criteria variables for the first combination which produced a canonical correlation of .70 are shown in Table VII on page 79. The weights for the second combination which produced a canonical correlation of .58 are given in the same Table. The following observations might be made in respect to these two combinations.

1. The weights which represent the six value variables from the Study of Values are quite uniform in size and, in the second combination, are very large in comparison to the remaining variables. These effects were probably due to the fact that the scoring on these six measures was ipsative. This suggested that in subsequent statistical treatment, these variables would have to be treated separately. However, the relative importance of the six values

TABLE VII  
CANONICAL CORRELATION OF THIRTY-SIX VARIABLES

	First Combination	Second Combination
No. Eigenvalues removed	0.00	1.00
Largest Eigenvalue left	0.49	0.33
Canonical Correlation	.70***	.58*
Lambda	.15	.30
Chi-Square	278.81	178.76
Degrees of Freedom	180.0	145.0
Sex	-0.14	-0.08
Age	0.03	-0.15
Occ	0.04	-0.04
F-Ed	0.35	0.31
M-Ed	-0.07	-0.13
S-Ec	0.03	-0.16
F-A	-0.01	0.19
F-B	0.26	0.13
F-C	-0.28	0.18
F-E	0.37	-0.06
F-F	0.16	-0.29
F-G	-0.15	-0.31
F-H	-0.09	0.11
F-I	0.00	0.22
F-L	-0.15	0.19
F-M	0.13	-0.06
F-N	0.25	0.04
F-O	-0.09	0.12
F-Q <sub>1</sub>	-0.08	0.02
F-Q <sub>2</sub>	0.09	-0.30
F-Q <sub>3</sub>	-0.06	-0.06
F-Q <sub>4</sub>	-0.25	-0.22
Theor	0.47	8.46
Econ	0.38	9.09
Aesth	0.57	10.12
Soc	0.59	8.82
Pol	0.75	7.09
Rel	0.59	9.49
I.Q.	0.39	-0.21
Ac-Av	0.67	-0.08
Inf	0.38	0.51
R.Ass	-0.04	0.41
Ded	0.78	0.08
Inter	-0.27	-0.62
E.Arg	0.15	-0.40
Total	0.39	-0.16

\*\*\*Indicates  $p < .001$

\*Indicates  $p < .05$

to each other is still demonstrated to some extent. The Political variable has the largest weight in the first combination while the Aesthetic variable has the largest weight in the second combination.

2. Of the remaining predictor variables in the first combination, father's education, Factor B, Factor C, Factor E, Factor N, Factor  $Q_4$ , I.Q., and academic achievement have relatively large weights. In the second combination, father's education, Factor F, Factor G, Factor I, Factor  $Q_2$ , Factor  $Q_4$ , and I.Q. display fairly large weights.

3. The personality factors mentioned above, namely Factor C, Factor E, Factor N, Factor F, and Factor I, are included in the more general Factor 3 of personality. Reference could be made to Appendix VI.

4. Referring to the criteria variables, the Table shows that Deduction, Inference, and Total Critical Thinking have the largest weights in the first combination. Interpretation, Inference, and Recognition of Assumptions have the largest weights in the second combination.

5. In general, the Canonical Correlation suggests that the critical thinking space is best described in terms of father's education, Factor B (less intelligent vs. more intelligent), I.Q., academic average, and Factor 3 of personality. More experimentation is needed to determine the place of the six values in the critical thinking space.

Multiple Regression Analyses were carried out using the total critical thinking score as the criterion. Predictors were used based on the following conclusions drawn from the initial statistical treatments.

1. The variables measuring values had to be treated separately, with possibly Political, Economic, Aesthetic, or Theoretical having the most influence in critical thinking.

2. Since many of the sixteen personality Factors seemed to carry some weight in critical thinking and since the Rotated Factor Matrix seemed to place these Factors in groups corresponding to the four more general personality Factors, the decision was made to reduce the sixteen Factors to the four general Factors. Factor 1, Factor 3, and Factor 4 could have considerable influence in critical thinking.

3. The variables, head of household's occupation, father's education, Factor B (less intelligent vs. more intelligent), I.Q., and academic achievement seemed to carry considerable weight in critical thinking and were retained for further statistical analysis. The importance of sex, mother's education, socio-economic rating, Religion, and Social seemed more doubtful, and were experimented with.

### III. THE MULTIPLE REGRESSION ANALYSES

Several Multiple Regression Analyses were carried out

using total critical thinking as the criterion with different combinations of predictors. In all cases, I.Q., academic achievement, Factor B (less intelligent vs. more intelligent), Factor 1, Factor 3, Factor 4, father's education, and head of household's occupation were used.

The Regression which showed the highest Multiple Correlation Coefficient is shown in Table VIII on page 83. The predictors used were: (1) occupation of head of household, (2) father's education, (3) Factor B, (4) Political, (5) I.Q., (6) academic achievement, (7) Factor I, (8) Factor III, and (9) Factor IV. The Multiple Correlation Coefficient was .594 with a standard error of estimate of 7.02. The Analysis of Variance yielded an F-ratio, significant at the .001 level of confidence. Standard score or  $\beta$  weights and raw score or b weights are shown. The  $\beta$  weights, when compared, suggest that I.Q., academic achievement, and Factor 4 have considerable importance in predicting critical thinking. However, all the variables display  $\beta$  weights which are substantial. The T test suggests that the weights for occupation, father's education, Factor 1, and Factor 3 are not significant at the .05 level of confidence.

Tables IX and X show two other Multiple Regression Analyses. Sex and the Aesthetic variable were introduced in Table IX on page 84, while mother's education, socio-economic rating, and Factor 2 were introduced in the analysis shown in

TABLE VIII  
 MULTIPLE REGRESSION ANALYSIS  
 TOTAL CRITICAL THINKING  
 ON NINE VARIABLES

Variable	b	s.b.	T	$\beta$
Occ	-0.84	0.56	-0.50	-0.16
F-Ed	0.74	0.53	1.40	0.15
F-B	0.98	0.48	2.03*	0.14
Pol	0.18	0.09	2.04*	0.13
I.Q.	0.17	0.05	3.41***	0.24
Ac-Av	0.27	0.06	4.75***	0.34
F-1	-0.56	0.30	-1.90	-0.13
F-3	-0.48	0.28	-1.75**	-0.12
F-4	0.75	0.26	2.89**	0.20

Y Intercept = 15.49

Multiple Correlation Coefficient = 0.594

Standard Error of Estimate = 7.02

ANALYSIS OF VARIANCE

Source	SS	DF	MS	F
Regression	4240.23	9.	471.14	9.56***
Deviation	7740.15	157.	49.30	
Total	11980.38	166.	72.17	

\*\*\*Indicates  $p < .001$

\*\*Indicates  $p < .01$

\*Indicates  $p < .05$



TABLE IX  
 MULTIPLE REGRESSION ANALYSIS  
 TOTAL CRITICAL THINKING  
 ON TEN VARIABLES

Variable	b	s.b.	T	$\beta$
Sex	-0.01	1.24	-00.01	-0.00
Occ	-0.77	0.56	-1.36	-0.15
F-Ed	0.73	0.54	1.36	0.14
F-B	0.997	0.49	2.02*	0.15
Aesth	-0.08	0.07	-1.18	-0.09
I.Q.	0.18	0.05	3.47***	0.25
Ac-Av	0.26	0.06	4.40***	0.32
F-1	-0.53	0.30	-1.77	-0.12
F-3	-0.46	0.29	-1.59	-0.11
F-4	0.86	0.28	3.05***	0.23

Y Intercept = 25.59

Multiple Correlation Coefficient = 0.586

Standard Error of Estimate = 7.10

ANALYSIS OF VARIANCE

Source	SS	DF	MS	F
Regression	4120.13	10.	412.01	8.18***
Deviation	7860.25	156.	50.39	
Total	11980.38	166.	72.17	

\*\*\*Indicates  $p < .001$

\*Indicates  $p < .05$

TABLE X  
 MULTIPLE REGRESSION ANALYSIS  
 TOTAL CRITICAL THINKING  
 ON ELEVEN VARIABLES

Variable	b	s.b.	T	$\beta$
S-Ec	0.08	0.13	0.65	0.05
M-Ed	0.38	0.51	0.74	0.06
Occ	-0.76	0.57	-1.35	-0.15
F-Ed	0.31	0.58	0.53	0.06
Pol	0.18	0.09	2.02*	0.14
I.Q.	0.19	0.05	3.77***	0.27
Ac-Av	0.31	0.06	5.40***	0.38
F-1	-0.52	0.32	-1.61	-0.12
F-2	0.12	0.27	0.42	0.03
F-3	-0.50	0.28	-1.77	-0.12
F-4	0.84	0.27	3.16***	0.22

Y Intercept = 16.84

Multiple Correlation Coefficient = 0.585

Standard Error of Estimate = 7.13

ANALYSIS OF VARIANCE

Source	SS	DF	MS	F
Regression	4105.63	11.	373.24	7.35***
Deviation	7874.7578	155.	50.80	
Total	11980.38	166	72.17	

\*\*\*Indicates  $p < .001$

\*\*Indicates  $p < .01$

\*Indicates  $p < .05$

Table X on page 85. In both cases, the Multiple Correlation Coefficient tended to fall a slight degree, with the added variables showing low standard score or  $\beta$  weights. Therefore, the variables of sex, Aesthetic, mother's education, socio-economic rating, and Factor 2 contribute very little to the prediction of critical thinking. Two other Multiple Regressions were tried which involved the same variables as in Table VIII, with the exception that the Political variable was substituted by the Theoretical variable in one case and by the Economic variable in the other case. Again, the correlation coefficients were slightly lower and the  $\beta$  weights were small indicating that the Economic variable and the Theoretical variable do not contribute significantly to the prediction of critical thinking. Tables XI and XII on pages 87 and 88 illustrate these two statistical treatments.

Therefore, using the results of the Regression Analysis shown in Table VIII which resulted in a correlation coefficient of .594, the regressed standard score equation for subject  $i$  would take the following form for the prediction of the total critical thinking score.

$$\begin{aligned} \hat{Z}_i = & .20(\text{Factor 4})_i - .12(\text{Factor 3})_i - .13(\text{factor 1})_i \\ & + .34(\text{Ac-Av})_i + .24(\text{I.Q.})_i + .13(\text{Political})_i \\ & + .14(\text{Factor B})_i + .15(\text{F-Ed})_i - .16(\text{Occ})_i. \end{aligned}$$

The regressed raw score form of the equation would take the following form:

TABLE XI  
 MULTIPLE REGRESSION ANALYSIS  
 TOTAL CRITICAL THINKING  
 ON NINE VARIABLES

Variable	b	s.b.	T	$\beta$
Occ	-0.72	0.56	-1.27	-0.14
F-Ed	0.67	0.54	1.24	0.13
F-B	1.00	0.49	2.05*	0.15
Theor	-0.07	0.07	-0.93	-0.06
I.Q.	0.17	0.05	3.34***	0.24
Ac-AV	0.27	0.06	4.58***	0.33
F-1	-0.56	0.30	-1.88	-0.13
F-3	-0.33	0.28	-1.19	-0.08
F-4	0.77	0.26	2.93**	0.21

Y Intercept = 24.85

Multiple Correlation Coefficient = 0.583

Standard Error of Estimate = 7.09

ANALYSIS OF VARIANCE

Source	SS	DF	MS	F
Regression	4078.09	9.	453.12	9.00***
Deviation	7902.29	157.	50.33	
Total	11980.38	166.	72.17	

\*\*\*Indicates  $p < .001$

\*\*Indicates  $p < .01$

\*Indicates  $p < .05$

TABLE XII  
 MULTIPLE REGRESSION ANALYSIS  
 TOTAL CRITICAL THINKING  
 ON NINE VARIABLES

Variable	b	s.b.	T	$\beta$
Occ	-0.72	0.57	-1.25	-0.14
F-Ed	0.69	0.54	1.26	0.14
F-B	0.99	0.49	2.02*	0.15
Econ	-0.01	0.07	-0.20	-0.01
I.Q.	0.17	0.05	3.32***	0.24
Ac-Av	0.26	0.06	4.38***	0.32
F-1	-0.55	0.30	-1.84	-0.13
F-3	-0.37	0.29	-1.25	-0.09
F-4	0.72	0.27	2.64**	0.19

Y Intercept = 23.99

Multiple Correlation Coefficient = 0.580

Standard Error of Estimate = 7.11

ANALYSIS OF VARIANCE

Source	SS	DF	MS	F
Regression	4036.85	9.	448.54	8.87***
Deviation	7943.53	157.	50.60	
Total	11980.38	166.	72.17	

\*\*\*Indicates  $p < .001$

\*\*Indicates  $p < .01$

\*Indicates  $p < .05$

$$\begin{aligned} \hat{X}_i = & .75(\text{Factor } 4)_i - .48(\text{Factor } 3)_i - .56(\text{Factor } 1)_i \\ & + .27(\text{Ac-Av})_i + .17(\text{I.Q.})_i + .18(\text{Political})_i \\ & + .98(\text{Factor } B)_i + .74(\text{F-Ed})_i - .84(\text{Occ})_i. \end{aligned}$$

#### IV. CANONICAL CORRELATION OF FIFTEEN VARIABLES

The nine predictor variables used in the regression equation for the prediction of the total critical thinking score and the six critical thinking scores were subjected to a final Canonical Correlation. The treatment produced five linear combinations. Chi-square values allowed statistical interpretation of the first two combinations. The coefficient weights for the variables for both linear combinations are shown in Table XIII on page 90. The following observations might be made:

1. In the first combination, the criteria variables which have large weights are Inference and Deduction. Heavy weights are shown on the predictors of academic achievement, father's education and I.Q.

2. In the second combination, heavy loadings fall on the criteria variables of Deduction and Interpretation. The predictors which have large weights in this combination are father's or head of household's occupation, Factor 4, Factor 3, and Factor 1.

3. Of the six criteria variables, Deduction seems to be best described in terms of the nine predictor variables used in the Regression Analysis.

TABLE XIII

## CANONICAL CORRELATION OF FIFTEEN VARIABLES

	First Combination	Second Combination
No. Eigenvalues removed	0.00	1.00
Largest Eigenvalue left	0.42	0.17
Canonical Correlation	0.64***	0.41*
Lambda	0.39	0.67
Chi-Square	149.45	64.01
Degrees of Freedom	54.0	40.0
Occ	-0.05	-0.59
F-Ed	0.41	-0.16
F-B	0.32	-0.08
Pol	0.32	-0.16
I.Q.	0.42	0.22
Ac-Av	0.73	0.16
F-1	-0.09	-0.34
F-3	-0.09	-0.35
F-4	0.28	0.45
Inf	0.48	-0.09
R.Ass	0.10	0.34
Ded	0.81	-0.57
Inter	-0.15	0.66
E.Arg	0.24	0.36
Total	0.15	0.06

\*\*\*Indicates  $p < .001$

\*Indicates  $p < .05$

## V. THE USE OF THE RAW SCORE REGRESSION EQUATION

A small sample of thirty students was used to attempt the prediction of each student's total critical thinking score by the use of the Raw Score Regression Equation. The Regression Analysis had a standard error of estimate of 7.02 which meant that the total critical thinking score could be predicted within 7.02 points, 68 per cent of the time.

Table XIV on page 92 shows the actual critical thinking score obtained by each of the thirty students as compared to the predicted critical thinking score. As can be seen from the Table, the total critical thinking score in this small sample was predicted within 7 points, 56 per cent of the time, and within 10 points, 73 per cent of the time.

As an example of the calculations which were done for each student, the following mathematical manipulations are shown:

Student 4 obtained the following scores on the nine predictor variables:

Factor 4 = 6.7  
 Factor 3 = 6.1  
 Factor 1 = 3.0  
 Ac-Av = 86.5  
 I.Q. = 156.  
 Pol = 31.  
 Factor B = 9.  
 F-Ed = 5.  
 Occ = 3.

The regressed raw score equation would take the following form:



TABLE XIV  
 PREDICTED AND ACTUAL CRITICAL THINKING SCORES  
 OF THIRTY STUDENTS

Student	Actual Score	Predicted Score	Difference
1	78	78	0
2	77	77	0
3	88	87	1
4	82	81	1
5	89	87	2
6	79	77	2
7	78	74	4
8	78	74	4
9	78	74	4
10	80	76	4
11	81	76	5
12	80	75	5
13	83	77	6
14	79	73	6
15	77	71	6
16	81	74	7
17	86	79	7
18	81	73	8
19	77	68	9
20	85	75	10
21	77	67	10
22	78	68	10
23	77	66	11
24	77	66	11
25	84	72	12
26	80	67	13
27	78	65	13
28	84	70	14
29	85	71	14
30	89	73	16

$$\begin{aligned}\hat{X}_4 &= .75(\text{Factor } 4)_4 - .48(\text{Factor } 3)_4 - .56(\text{Factor } 1)_4 \\ &+ .27(\text{Ac-Av})_4 + .17(\text{I.Q.})_4 + .18(\text{Pol})_4 + .98(\text{F-B})_4 \\ &+ .74(\text{F-Ed})_4 - .84(\text{Occ})_4 + 15.49.\end{aligned}$$

By substitution, the equation becomes:

$$\begin{aligned}\hat{X}_4 &= .75(6.7) - .48(6.1) - .56(3.0) + .27(86.5) \\ &+ .27(156) + .18(31) + .98(9) + .74(5) - .84(3) \\ &+ 15.49.\end{aligned}$$

and the predicted critical thinking score ( $\hat{X}$ ) has the value of 81. The actual critical thinking score for student 4 was 82, a difference of one point.

Chapter Four has been a report of the findings of the study. The results of subjecting the initial thirty-six variables to a Factor Analysis with Varimax Rotation and a Canonical Correlation were described. The development of a Regression Equation for the prediction of the total critical thinking score using nine predictor variables has been illustrated. The success of the regression equation in the prediction of the total critical thinking score for each individual in a small sample of thirty students has been described.

CHAPTER V  
SUMMARY AND CONCLUSIONS

I. SUMMARY

This study was initiated with the purpose of broadening the concept of critical thinking by finding factors which define the critical thinking space. A review of the literature which incorporates studies and writings related to critical thinking revealed how little is known about the critically-minded individual, even though there seems to be a fair number of seemingly isolated attempts at description.

The study dealt with a sample of 197 students from grades ten to twelve in Winnipeg high schools, and examined factors incorporating values, personality, sex, measures of intellectual ability, indications of socio-economic status, and indications of academic achievement. Each of these variables were measured in as valid a manner as possible under the conditions of the study. Critical thinking, personality, and values were measured by the Watson-Glaser Critical Thinking Appraisal, the Sixteen Personality Factor Questionnaire, and the Study of Values respectively. Socio-economic status was indicated by using a combination of the factors of parent's education and occupation. I.Q. and academic achievement were used as measured by the individual schools.

The statistical treatment involved a description of

the person space in terms of the entire collection of measured variables with the use of a Factor Analysis with Varimax Rotation. This description was followed by a description of the critical thinking space (as given by the six critical thinking scores on the W.G.C.T.A.) in terms of the remaining measured variables, which was accomplished by using a Canonical Correlation. Based on the ideas gleaned from the initial statistical treatment, a regression equation for the prediction of the total critical thinking score was developed. This regression equation called for the use of nine variables. These nine predictor variables were further used to define the six critical thinking scores in another Canonical Correlation. Finally, a small sample of thirty students was used to test the workability of the regression equation.

## II. CONCLUSIONS

The conclusions of the study can be outlined in two separate ways: (1) conclusions which can be drawn in relation to the total critical thinking score, and (2) conclusions which can be drawn in relation to the six critical thinking scores (five of which are the subscores). All conclusions which are drawn are in relation to a similar sample of high school students using measures of a similar type.

The regression equation which was formed using nine pre-

dictors of critical thinking indicates the following:

(1) I.Q. and academic achievement are the best predictors of an individual's ability to think critically. The intelligence factor measured in the 16 PF also predicts critical thinking.

(2) A measure of the individual's personality in terms of subduedness vs. independence is a good predictor of a critically minded person. A high measure on this factor indicating independence shows critical mindedness. The independent person is described as being aggressive, daring, and incisive. He is a person who will seek those situations where such behavior is tolerated, and is likely to exhibit initiative.

(3) The person who measures high in political mindedness is apt to be a critical thinker. This person, as indicated in the Study of Values, tends to be interested in power, influence, and renown.

(4) A student who has a father with a good education and one who lives in a home where the head of the household has an occupation which rates high on Warner's Scale is likely to be a critical thinker.

(5) A measure of personality in terms of anxiety also helps to describe the critical thinking space. A person with high anxiety or a person who is generally dissatisfied with the degree to which he is able to meet

the demands of life and to achieve what he desires fits into this category. This variable is not a strong predictor.

(6) A personality involving alert poise as opposed to tenderminded emotionality indicates the critical thinker to a small extent. This person is likely to be an enterprising, decisive, and resilient individual.

(7) In general, the student who is intelligent, achieves well in school, is politically minded, rates high on socio-economic measures, is independent, has high anxiety, and has alert poise will probably be able to think critically, in terms of obtaining a high total score on the W.G.C.T.A.

The final Canonical Correlation offers a description of the five subscores in terms of the nine predictor variables as follows:

(1) The aspects of critical thinking referred to as Deduction and Inference are best described in terms of a high academic achievement record, high intelligence, political values, and a father with a good education.

(2) The aspects of critical thinking referred to as Interpretation and Deduction (as well as Recognition of Assumptions and Evaluation of Arguments to a small degree) are best described in terms of a high occupation rating for the head of the household, high anxiety, alert poise, and independence.

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APPENDIX



## APPENDIX II

## REVISED SCALE FOR RATING OCCUPATION\*

Rating Assigned to Occupation	Professionals	Proprietors and Managers	Business Men
1	Lawyers, doctors, dentists, engineers, judges, high-school superintendents, veterinarians, ministers (graduated from divinity school), chemists, etc. with post-graduate training, architects	Businesses valued at \$75,000 and over	Regional and divisional managers of large financial and industrial enterprises
2	High-school teachers, trained nurses, chiropodists, chiropactors, undertakers, ministers (some training), newspaper editors, librarians (graduate)	Businesses valued at \$20,000 to \$75,000	Assistant managers and office and department managers of large businesses, assistants to executives
3	Social Workers, grade-school teachers, optometrists, librarians (not graduate) undertaker's assistants, ministers (no training)	Businesses valued at \$5,000 to \$20,000	All minor officials of businesses
4		Businesses valued at \$2,000 to \$5,000	
5		Businesses valued at \$500 to \$2,000	
6		Businesses valued at less than \$500	
7			

## APPENDIX II (continued)

Rating Assigned to Occupation	Clerks and Kindred Workers, Etc.	Manual Workers
1	Certified Public Accountants	
2	Accountants, salesmen of real estate, of insurance, postmasters	
3	Auto salesmen, bank clerks and cashiers, postal clerks, secretaries to executives, supervisors of railroad, telephone, etc., justices of the peace	Contractors
4	Stenographers, bookkeepers, rural mail clerks, railroad ticket agents, sales people in dry goods store, etc.	Factory foremen, electricians, plumbers, carpenters, watchmakers who own business
5	Dime store clerks, hardware salesmen, beauty operators, telephone operators	Carpenters, plumbers, electricians (apprentice) timekeepers, linemen, telephone, telegraph, radio repairmen, medium skill workers
6		Moulders, semi-skill workers assistants to carpenters, etc.
7		Heavy labor, migrant work

## APPENDIX II (continued)

Rating Assigned to Occupation	Protective and Service Workers	Farmers
1		Gentleman Farmers
2		Large farm owners, farm owners
3		
4	Dry cleaners, butchers, sheriffs, railroad engineers and conductors	
5	Barbers, firemen, butcher's apprentices, practical nurses, policemen, seamstresses, cooks in restaurant, bartenders	Tenant Farmers
6	Baggage men, night policemen and watchmen, taxi and truck drivers, gas station attendants, waitresses in restaurant	Small Tenant farmers
7	Janitors, scrubwomen, newsboys	Migrant farm laborers

\*W. Lloyd Warner, Marchia Meeker, and Kenneth Eells, Social Class in America: A Manual of Procedure for the Measurement of Social Status (New York: American Book-Stratford Press, Inc., 1949), pp. 140-41.

STUDENT RECORD SHEETAPPENDIX III

NAME: \_\_\_\_\_ SCHOOL: \_\_\_\_\_  
 ADDRESS: \_\_\_\_\_  
 SEX: \_\_\_\_\_ AGE: \_\_\_\_\_ YRS. \_\_\_\_\_ MOS.

FATHER'S OCCUPATION RATING: \_\_\_\_\_  
 MOTHER'S OCCUPATION RATING: \_\_\_\_\_  
 FATHER'S EDUCATION RATING: \_\_\_\_\_  
 MOTHER'S EDUCATION RATING: \_\_\_\_\_  
 \_\_\_\_\_ STUDENT'S SOCIO-ECONOMIC RATING

SIXTEEN PERSONALITY FACTOR QUESTIONNAIRE

\_\_\_\_\_ FACTOR A (reserved-vs.-outgoing)  
 \_\_\_\_\_ FACTOR B (less intelligent-vs.-more intelligent)  
 \_\_\_\_\_ FACTOR C (affected by feelings-vs.-emotionally stable)  
 \_\_\_\_\_ FACTOR E (humble-vs.-assertive)  
 \_\_\_\_\_ FACTOR F (sober-vs.-happy-go-lucky)  
 \_\_\_\_\_ FACTOR G (expedient-vs.-conscientious)  
 \_\_\_\_\_ FACTOR H (shy-vs.-venturesome)  
 \_\_\_\_\_ FACTOR I (tough-minded-vs.-tender-minded)  
 \_\_\_\_\_ FACTOR L (trusting-vs.-suspicious)  
 \_\_\_\_\_ FACTOR M (practical-vs.-imaginative)  
 \_\_\_\_\_ FACTOR N (forthright-vs.-shrewd)  
 \_\_\_\_\_ FACTOR O (placid-vs.-apprehensive)  
 \_\_\_\_\_ FACTOR Q<sub>1</sub> (conservative-vs.-experimenting)  
 \_\_\_\_\_ FACTOR Q<sub>2</sub> (group-dependent-vs.-self-sufficient)  
 \_\_\_\_\_ FACTOR Q<sub>3</sub> (undisciplined-vs.-controlled)  
 \_\_\_\_\_ FACTOR Q<sub>4</sub> (relaxed-vs.-tense)

ALLPORT-VERNON-LINDZEY STUDY OF VALUES

\_\_\_\_\_ THEORETICAL  
 \_\_\_\_\_ ECONOMIC  
 \_\_\_\_\_ AESTHETIC  
 \_\_\_\_\_ SOCIAL  
 \_\_\_\_\_ POLITICAL  
 \_\_\_\_\_ RELIGIOUS

WATSON-GLASER CRITICAL THINKING SCALE

\_\_\_\_\_ INFERENCE  
 \_\_\_\_\_ RECOGNITION OF ASSUMPTIONS  
 \_\_\_\_\_ DEDUCTION  
 \_\_\_\_\_ INTERPRETATION  
 \_\_\_\_\_ EVALUATION OF ARGUMENTS  
 \_\_\_\_\_ TOTAL

\_\_\_\_\_ STUDENT'S I.Q.

\_\_\_\_\_ STUDENT'S AVERAGE

## APPENDIX V

PRINCIPLE FACTOR ANALYSIS  
VARIMAX ROTATION

	factor one	factor two	factor three	factor four	factor five	factor six
Cumulative Per Cent of Variability	12.6	21.95	30.67	38.25	45.41	50.42
Sex	-0.00	0.64	0.09	-0.09	0.10	0.04
Age	0.53	0.02	-0.02	0.15	0.18	0.29
Occ	-0.09	-0.02	-0.01	-0.85	0.12	-0.01
F-Ed	-0.08	0.04	-0.04	-0.88	0.13	0.02
M-Ed	-0.10	0.07	0.02	-0.72	0.05	-0.04
S-Ec	-0.01	0.10	-0.11	-0.61	-0.20	-0.06
F-A	0.07	0.06	0.10	-0.15	0.12	-0.50
F-B	-0.48	-0.01	-0.08	0.12	0.10	0.04
F-C	0.01	0.13	0.78	0.15	0.21	0.06
F-E	-0.19	0.07	-0.09	-0.12	0.69	0.24
F-F	0.01	0.12	0.09	-0.03	0.74	-0.26
F-G	0.00	-0.02	0.51	-0.20	-0.24	-0.30
F-H	0.10	0.07	0.34	-0.08	0.69	-0.26
F-I	-0.06	0.58	-0.06	-0.17	-0.08	0.13
F-L	-0.10	0.17	-0.52	-0.18	0.27	0.12
F-M	-0.13	0.12	-0.02	-0.11	0.09	0.38
F-N	0.01	0.18	0.17	-0.06	-0.61	-0.05
F-O	0.10	-0.05	-0.71	0.03	-0.16	-0.02
F-Q <sub>1</sub>	-0.09	-0.26	-0.04	-0.10	0.38	0.47
F-Q <sub>2</sub>	0.06	-0.10	-0.11	0.14	-0.16	0.61
F-Q <sub>3</sub>	0.02	-0.06	0.59	-0.10	-0.25	-0.20
F-Q <sub>4</sub>	0.09	0.05	-0.75	-0.12	-0.07	0.01
Theor	-0.13	-0.66	0.11	0.02	-0.11	0.27
Econ	0.17	-0.72	0.07	0.01	-0.15	-0.32
Aesth	0.06	0.47	-0.10	-0.09	0.05	0.65
Soc	-0.04	0.58	-0.13	-0.01	0.10	-0.36
Pol	-0.03	-0.60	-0.05	-0.01	0.26	-0.21
Rel	-0.05	0.66	0.10	0.08	-0.10	-0.15
I.Q.	-0.52	0.03	0.06	-0.21	0.02	0.21
Ac-Av	-0.65	0.05	0.02	-0.16	-0.22	-0.12
Inf	-0.70	-0.10	-0.06	-0.02	0.19	-0.02
R.Ass	-0.47	0.06	0.21	0.18	-0.07	-0.02
Ded	-0.67	-0.03	-0.06	-0.29	0.07	0.03
Inter	-0.63	0.02	0.03	0.17	0.08	0.10
E.Arg	-0.41	0.21	0.01	-0.12	-0.07	0.27
Total	-0.93	0.04	0.05	-0.02	0.07	0.09

## APPENDIX VI

WEIGHTS TO GET SECOND-ORDER STEN SCORES  
FROM 16 PF PRIMARY STENS\*

## FACTOR 1: LOW VS. HIGH ANXIETY

Start out with constant	38
Add 2 times sten on Factor L	+ _____
Add 3 times sten on Factor O	+ _____
Add 4 times sten on Factor Q <sub>4</sub>	+ _____
Subtotal	_____
Subtract 2 times sten on Factor C	- _____
Subtract 2 times sten on Factor H	- _____
Subtract 2 times sten on Factor Q <sub>3</sub>	- _____
Total	_____

Divide by 10 to give sten score which  
is higher as more Anxiety.

## FACTOR 2: INTROVERSION VS. EXTRAVERSION

Take 2 times sten on Factor A	_____
Add 3 times sten on Factor E	+ _____
Add 4 times sten on Factor F	+ _____
Add 5 times sten on Factor H	+ _____
Subtotal	_____
Subtract 2 times sten on Factor Q <sub>2</sub>	- _____
Subtract constant, always 11	- <u>11</u>
Total	_____

Divide by 10 to give sten score which  
is higher as more Extraversion.

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\*Raymond B. Cattell, and Herbert W. Eber, Manual: Sixteen Personality Factor Questionnaire (Champaign, Illinois: Institute for Personality and Ability Testing, 1962), p. 19.



## APPENDIX VI (continued)

## FACTOR 3: TENDERMINDED EMOTIONALITY VS. ALERT POISE

Start out with constant	77
Add 2 times sten on Factor C	+ _____
Add 2 times sten on Factor E	+ _____
Add 2 times sten on Factor F	+ _____
Add 2 times sten on Factor N	+ _____
	Subtotal _____
Subtract 4 times sten on Factor A	- _____
Subtract 6 times sten on Factor I	- _____
Subtract 2 times sten on Factor M	- _____
	Total _____

Divide by 10 to give sten score which is higher as more Alertly Poised.

## FACTOR 4: SUBDUEENESS VS. INDEPENDENCE

Take 4 times sten on Factor E	_____
Add 3 times sten on Factor M	_____
Add 4 times sten on Factor Q <sub>1</sub>	_____
Add 4 times sten on Factor Q <sub>2</sub>	_____
	Subtotal _____
Subtract 3 times sten on Factor A	- _____
Subtract 2 times sten on Factor G	- _____
	Total _____

Divide by 10 to give sten score which is higher as more Independent.