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AN APPLICATION OF GUILFORD'S STRUCTURE OF INTELLECT TO PROGRAMMED INSTRUCTION. FINAL REPORT.

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Single-score measures of intelligence are inadequate to predict performance on a programed instruction format. Guilford's model of the intellect accounts for three dimensions relevant to learner abilities. The content dimension refers to the kind of material involved, the product dimension to the kind of output required, and the process dimension to the operation involved in learning. Four studies were conducted to investigate the usefulness of Guilford's model in predicting types of stimulus-materials most consistent with learner characteristics. Eighth graders worked with two versions of a self-instructional program for teaching logic. A total of 160 subjects were randomly assigned to a semantic or a symbolic version. A regression analysis was carried out to determine the relationship between achievement in each program variation and intellectual abilities as assessed by Guilford's measures. Based on regression results, 180 eighth graders were assigned to the program versions according to predicted success. There was no evidence that the stimulus-content dimension is critical from an instructional point of view. Efforts at determining the instructional utility of Guilford's model would be better aimed at analyses in terms of the products demanded and the operations involved. (LS)

FINAL REPORT

An Application of Guilford's Structure of Intellect to Programmed Instruction

Principal Investigator

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Arizona State University

CLASSROOM LEARNING LABORATORY

experimental analyses of student behavior

Department of Educational Psychology
Arizona State University
Tempe, Arizona

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PREFACE

Determination of the utility of a psychometric model in an instructional context is not a function of simple or literal verbal translations. If a model is to provide direct procedural cues for the manipulation of one or more aspects of the learning environment, an adequate empirical foundation must be carefully specified and constructed. The several studies reported herein constitute progress in this direction. In reality, this document is a progress report of the first steps in what hopefully will become a programatic effort to maximize the contribution of psychometric theory and practice to the development of instructional materials and strategies.

Although full responsibility for the conduct of the project is accepted by the principal investigator, its several measures of strength must be shared with others. A persisting fear that the effects of frail instructional materials would be mistaken for treatment effects led Dr. Richard E. Schutz, now of the Southwest Regional Laboratory for Educational Research and Development, to provoke greater attention to the formulation, design, and development of the experimental materials. Dr. Howard J. Sullivan, also of the Southwest Regional Laboratory, contributed immeasurably to the development of instructional control and overall management of the experimental field work.

Special acknowledgements go to Professors J. P. Guilford and R. Hoepfner of the University of Southern California for supplying the aptitude tests and approving the reproduction of the tests for the experiments. Dr. Harry Silberman of Systems Development Corporation was most helpful in providing technical documentation related to the original logic instruction program. His permission to modify and peproduce the program is gratefully acknowledged.

SUMMARY

Problem

A critical problem in the development of an educational technology involves identification of the learner abilities that are relevant to any given instructional objective. Since most learning is mediated by words, verbal intelligence is typically the ability that shows the highest correlation with school achievement. However, some studies suggest that verbal intelligence might not be such a critical variable when using a programed instruction format. It appears that learner variables must be treated at a more refined level than "verbal intelligence" if useful specifications are to be derived.

Reacting against the omnibus nature of single score measures of intelligence, J. P. Guilford and associates have elaborated a cubical model of the intellect which reflects the factor interaction of three broad principles by which the factors can be classified: process or operation, kind of material or content involved, and kind of product. Although Guilford's work has successfully challenged the concept of a "one unanalyzed intelligence," the implications of his model for educational practice are yet unclear.

Just as Guilford's model of the intellect provides a strong basis for assessing learner characteristics relevant to a specific learning task, potentially it also provides a basis for direct suggestions for the types of stimulus materials that are consistent with the learner characteristics. To date experimental studies in this area have been inconclusive with respect to the variables that influence the effectiveness of certain kinds of material presentations.

Objectives

If Guilford's model has any potential for providing cues for the preparation of learning materials, identification of the relevant learner characteristics and matching these characteristics with appropriate instructional stimulus materials should optimize the efficiency of self-instructional programing procedures, and thereby permit the generalization of a psychometric model to the solution of specified instructional problems.

Specifically, the objectives of the project were to determine: (1) the comparative effectiveness of symbolic and semantic content-based linear programs for teaching the rules of logic to eighth-grade students, (2) the relationship between intellectual abilities as measured by selected tests available in Guilford's compendium of aptitude tests and achievement in each of the two program variations, and (3) the efficiency of matching pupils with the instructional program variation on which they have the highest predicted success.

The general research strategy followed was to develop two variations of a self-instructional program on the basis of cues provided by the semantic and symbolic aspects of the content dimension of Guilford's model.

Methods and Results

A self-instructional program on logic originally developed by researchers at Systems Development Corporation was revised and modified for use in the project. Two variations of the revised program were developed. The sequences are identical with the exception of stimulus content. The semantic variation of the logic program includes no symbols, and the symbolic variation includes symbols wherever words can be replaced. Two criterion tests were developed, each measuring identical substantive content, differing only with respect to stimulus content used. In addition, 17 mastery unit tests were constructed to conform to a behavioral analysis of the program.

Selection of the ability factor measures was based upon interpretation of program objectives in terms of Guilford's structure of the intellect. Twelve tests were selected that saturated the cognitive dimension as it relates to the product and content dimensions. Additional tests were selected that represented the memory, convergent thinking, and evaluation principles of operation as they relate to the product and content dimensions.

In all, 420 eighth-grade students and 56 ninth-grade students from a large metropolitan school district were used for the four studies in the project.

Study One. The comparative effectiveness of the two logic program variations was determined by randomly assigning 160 eighth-grade students to one of four cells in a 2 x 2 factorial design. Two levels of the first factor relate to the symbolic and semantic instructional program variations. The other factor consists of two levels related to the feedback mechanisms employed. In one case, chemically pre-treated answer sheets were used by the students for the 17 unit mastery tests that were interspersed throughout the program. Students assigned to cells in the other level received no chemical feedback but were allowed to compare their responses to the key following the testing situation. The criterion variable was a 55 item logic test with a Kuder-Richardson Formula 20 reliability of .91. None of the resulting F-values is statistically significant. As a matter of fact, random assignment of the two programs yielded almost identical criterion mean scores; 30.74 and 31.10 for the semantic and symbolic forms respectively.

Study Two. The relationship between intellectual abilities as measured by the 12 Guilford tests selected and achievement in each of the two program variations was based on data obtained from Study One. Regression analyses of the criterion predictors were made for each program variation treatment. The predictors with the highest correlation with the semantic and symbolic program performances are in both cases tests related to semantic content. The best predictors of symbolic program performance are the Vocabulary Completion and Verbal Analogies tests. Both have r-values of .50 with the logic criterion test and both represent the semantic content cell in Guilford's structure of the intellect. The best predictor of semantic program performance is the Verbal Classifications test, r = .63, with the criterion test. It also is from the semantic content cell.

The regression analyses data suggest that differential performance on the two forms of the logic program cannot be explained in terms of the content dimension of Guilford's model since in both cases the semantic tests contribute the overwhelming proportion of the total and explained variances. These data suggest that tests loaded on the factors represented in the "convergent thinking operation-semantic content-relationship product" cell have greater utility for predicting performance on the symbolic logic program. Tests representing the "cognitive operation-semantic content-classes product" cell are most predictive of the performance of those using the semantic instructional form.

Study Three. Data analyzed in the first two studies suggest strongly that assignment to the two program variations on the basis of performance on tests sampling the content dimension of Guilford's compendium might not be as efficient as using other combinations. To empirically justify such a statement matching pupils with the program variation on which they have the highest "predicted" success was accomplished by computing two standard scores each for all the students in this study. From a pool of 144 students, 72 were drawn randomly and assigned to the program variation on which they had the highest standard score. That is, if their highest standard score was on the semantic aptitude test they were assigned to the semantic logic program variation. The remaining 72 were assigned randomly to the program variations, irrespective of their standard score performances. Using Guilford's stimulus content principle as the basis, assigning pupils to a program variation on the basis of highest predicted success has no differential influence on performance. However, there was a statistically significant interaction, F - 4.10, suggesting that those students assigned to the symbolic program variation on the basis of their symbolic aptitude test performance were the students who in general had relatively depressed semantic aptitude test performances by comparison.

A preliminary study of the predictive efficiency of other test combinations utilized two classes of 28 high school freshman English majors. They were administered two tests chosen from the Guilford compendium on the basis of maximum effectiveness in explaining variance associated with the two logic program variations. On the basis of comparing the standard scores for each of the students on the two tests, 28 randomly chosen freshman students were assigned to the logic program variation on the basis of the highest prediction. The remaining 28 students were assigned randomly to the program variations. The statistically significant F-value 2.13 for assignment method suggests that assignment to a particular instructional situation on the basis of predicted success is potentially quite useful.

Study Four. In an attempt to ferret out some interpretable underlying structure, a factor analysis involving 33 variables was completed. The analysis yielded seven interpretable factors. The two dominant factors are labeled achievement and general intelligence. Twelve of the 17 mastery tests from the logic program and the logic criterion test have loadings above .30 on Factor One. Only one Guilford test has a loading on this factor. Surprisingly, ten of the 12 Guilford tests have significant loadings on Factor Two. The logic criterion test and one program mastery test also were loaded on this factor. The remainder of the factors, although interpretable, shed little in the way of immediate light on the potential contribution of Guilford's model to the development of instructional strategies.

Conclusions

The stimulus content dimension as defined by Guilford's tests may not be critical from an instructional point of view. The limitation of the utility of the content dimension is undoubtedly related to the fact that an analysis of almost any instructional objective yields a considerable number of verbal aspects. Related to this point, the data strongly suggest that further efforts at determining the instructional utility of Guilford's model might better be aimed at analyses of objectives and learning tasks in terms of the products demanded and the operations involved rather than the stimulus content of the materials themselves.

Although the data from this project reflects considerable magnitude of intercorrelations among the Guilford tests, the specific variance associated with each test should be quite useful in determining more precise recipes of abilities related to various types of tasks. They should also be useful for identifying differential recipes for varying stages of learning.

While use of Guilford's model to aid in the prediction of differential performance on instructional tasks has considerable potential, use of his model to suggest design aspects of the alternatives themselves, either the description of instructional objectives or the specifications of instruction, is not supported by these data.

AN APPLICATION OF GUILFORD'S STRUCTURE OF INTELLECT
TO SELF INSTRUCTIONAL PROGRAMMING

I INTRODUCTION

A. Problem

A critical problem in the development of an educational technology involves identification of the learner abilities that are relevant to any given instructional objective. When the relationship between the relevant learner variables and achievement is known, a knowledge of the individual learner's status with respect to the variables can be used to predict and hopefully to control his achievement of the instructional objective.

Since most learning is mediated by words (Bloom, 1963), verbal intelligence is typically the ability that shows the highest correlation with school achievement. However, initial studies (Schutz and Baker, 1963; Getzels and Jackson, 1958) suggest that verbal intelligence might not be such a critical variable in programed instruction. It appears that learner variables must be treated at a more refined level than "verbal intelligence" if useful specifications are to be derived.

The most significant breakthrough in the identification of discrete mental abilities has been made by Guilford (1956). Employing the mathematical model of factor analysis, he and his associates have attempted to analyze the nature of man's intellect. Reacting against the omnibus nature of single score measures of intelligence Guilford has elaborated a cubical model of the intellect which reflects the factoral interaction of the three broad bases by which the factors can be classified (Guilford, 1959, 1967). The first basis for classification is according to the kind of process or operation, e.g., cognition, memory, thinking, or evaluation. The second is according to the kind of material or content involved, e.g., figural, symbolic, or semantic. The third basis concerns the product; that is, when a certain kind of operation is applied to a certain kind of content, as many as six kinds of products may be involved--units, elements, etc. Representation by means of a cube simply reflects that each specific factor or ability can be described in terms of operation, content, and product.

The fact that Guilford's work has successfully challenged the concept of a "one unanalyzed intelligence" is well accepted (Jensen, 1963; Torrance, 1962; Getzels and Jackson, 1962). The implications of his model for educational practice are yet unclear. The educational application of the model awaits the empirical specification of the factoral abilities that play a significant role in each type of pupil behavior. This specification must go beyond simple correlational studies dealing with gross educational outcomes. What is required is the precise identification of the unique learner characteristics and their interaction with practice and task variables im common learnings (Stolurow, 1961). Gross correlational studies have actually served to obscure the functional relationships involved. For example, as Bloom (1963) points out, the student who is especially good in visualization may respond well to learning procedures which give him an opportunity to use his spatial talent. However, the low correlation between spatial talent and verbal product has provided a misguided rationale for eliminating figural-spatial stimulus materials altogether.

The fact that non-verbal tests have relatively low r's with verbal performance should not deter efforts to determine the role that specific non-verbal abilities might play as vehicles for later verbal performance. Supportive of this challenge is the interesting hypothesis (Ferguson, 1956) that the factors derived from Guilford's model are a consequence of the principles of transfer. This implies that past experience has much to do not only with achievement, but with the development of the abilities themselves (Piaget, 1964). It further suggests that presently developed abilities might be used to develop other abilities and serve as vehicles for shaping more advanced classes of behavior.

Just as Guilford's model of the intellect provides a strong basis for assessing learner characteristics relevant to a specific learning task, it also provides a basis for direct suggestions for the types of stimulus materials which are consistent with the learner characteristics. Experimental studies have been inconclusive with respect to the variables that influence the effectiveness of visual presentation. These studies (Vernon, 1954; Swanson, 1954; Swanson, Lumsdaine, and Aukes, 1956; Sheffield, 1957, 1961; Sheffield, Margolius, and Hoehn, 1961) have been limited to the presence or absence of certain kinds of stimulus material, and have not attempted to control, isolate, or manipulate the influencing variables. The findings do, however, indicate that certain general aspects may have important implications when preparing stimulus materials.

B. Objectives

Identifying the relevant learner characteristics and matching these characteristics with appropriate instructional stimulus materials could or should optimize the efficiency of self-instructional programming procedures and permit the generalization of a psychometric model to the solution of specified instructional problems.

Specifically, the objectives of the project were to determine

1. the comparative effectiveness of symbolic and semantic content-based linear programs for teaching the rules of logic to eighth-grade students.

2. the relationship between intellectual abilities as measured by

selected tests available in Guilford's compendium of aptitude tests and achievement in each of the two program variations.

3. the efficiency of matching pupils with the instructional program variation on which they have the highest predicted success using ability factor raw scores to generate average z-score performances for the two Guilford content areas--symbolic and semantic.

II METHODS

A. Preparation of Instructional Materials

The general research strategy followed was to develop two variations of a self-instructional program on the basis of cues provided by the content dimension of Guilford's model. Therefore, two versions of a previously prepared basic logic program were developed, each differing with respect to type of stimulus content, but identical with respect to the development of logic concepts. The decision to use logic as the subject area was based on three considerations:

1. it provides an excellent set of terminal behaviors that are highly amenable to the development of semantic and symbolic program variations.

2. it can be introduced into all schools at any time during the year without difficulty.

3. the background necessary for programmed entry is of a more general nature and can be assumed to be a part of most student repertoires as a function of a general development of learning skills.

A self-instructional program (1961) on logic originally developed and used by researchers at Systems Development Corporation was selected for modification. The base program was first revised and tried out prior to completing the experimental modifications. Two variations of the 404 frame logic program were developed, field tested, and revised for use in the study. The programs are identical with the exception of stimulus content. The semantic variation includes no symbols and the symbolic variation includes symbols wherever words can be replaced. Appendix A contains samples from the two program variations. Criterion tests for the two variations sample identical substantive content and differ only with respect to the stimulus content used. Appendix B contains the two forms of the logic criterion test. In addition, 17 mastery, or what might be called unit review tests, were constructed to conform to a behavioral analysis of the program. Two variations were developed, one set of semantic mastery tests and one set of symbolic tests. Appendix C contains descriptions of the 17 units defined, and Appendix D contains the 17 unit mastery or review tests. To aid in analyzing the effects of certain feedback strategies, two types of answer sheets were developed. One type of answer sheet was chemically pretreated so that the subject would receive immediate knowledge of the correctness of his test response. The other answer sheet made no provision for immediate feedback.

B. Preparation of the Guilford Aptitude Tests

The ability factor measures used are adaptations of tests from Guilford's compendium of aptitude tests (1959, p. 47 and 1967). Selection was based upon an interpretation of program objectives in terms of Guilford's structure of the intellect. To avoid tampering with the factoral purity of the various tests, modifications were restricted to rewriting the directions and adjusting test length.

Twelve tests were selected that saturated the cognitive dimension as it relates to the product and content dimensions. In addition, tests were selected that represented the memory, convergent thinking, and evaluation dimensions as they relate to the product and content dimensions.

The tests were made available to the Classroom Learning Laboratory by Professors J. P. Guilford and R. Hoepfner of the University of Southern California. The list of tests and their trigram definitions are shown in Table I. Appendix E contains a listing of the tests and their description.

TABLE I

Aptitude Tests Employed, by Dimension and Trigram Symbols

Operation (Product)	Content Dimension	
	S-Symbolic	M-Semantic
C-Cognitive		
U-(Units)	Omelet	Wide Range Vocabulary
C-(Classes)	Number Relations	Verbal Classification
R-(Relationships)	Word Relations	Verbal Analogies
S-(Systems)	Circle Reasoning	Math Aptitude
N-Convergent Thinking		
R-(Relationships)	Object Number	Sentence Completion
E-Evaluation		
U-(Units)	Finding A's	Sentensense

C. Sample

420 eighth-grade students from a large metropolitan elementary school district were made available for the project. The several studies covered a period of three semesters and two calendar years. Over 30 classes have been involved in the design since its beginning.

D. Experiments

Four studies have been completed to date. They are described in the order in which they were conducted.

1. Study One. The comparative effectiveness of two logic program variations was determined by randomly assigning 160 eighth-grade students to one of four cells in a 2 x 2 factorial design. The two levels of the first factor relate to the symbolic and semantic instructional program variations. The other factor consists of two levels related to the feedback mechanisms employed. In one case chemically pretreated answer sheets were used by the student for the 17 unit mastery tests that were interspersed throughout the program. Students assigned to cells in the other level received no chemical feedback, but were able to compare their responses to the key following the testing situation. The criterion variable was a 55 item logic test. Those students working with the symbolic program took the test using symbols, while those working through the semantic variation of the logic program were administered the test that used words. The logic criterion test was given immediately following the program and readministered two weeks later.

2. Study Two. The relationship between intellectual abilities as measured by the 12 Guilford tests selected and achievement in each of the two program variations was based on data obtained from Study One. Regression analyses of the criterion predictors were made for each program variation treatment.

The compendium of 12 tests was administered to the Study One experimental groups prior to the time that they worked through the logic program. Data obtained from these tests were entered in a regression analysis that used the 55 item logic criterion test as the dependent variable.

3. Study Three. Based on the results of the regression analyses students were matched with the program variation on which they would have the highest predicted success. That is, if a student's performance on the Guilford tests representing the semantic dimension was superior to

his performance on the symbolic tests it was hypothesized that he would be better assigned to the semantic based program variation. The actual assignment of a student to either the symbolic or semantic variation of the program was based on his average standard score on the six symbolic referenced aptitude tests as compared to his average standard score on the six semantic referenced tests. If, for example, the student showed a standard score of -1.00 on his performance to the six symbolic tests and +1.00 on the semantic tests, he was assigned to receive the semantic program variation.

The 12 Guilford tests were administered to 180 eighth-grade students. Four weeks later, they were assigned on the basis of their test performances. Ninety students were drawn randomly from the pool of 180 and were assigned randomly to the symbolic and semantic treatment groups. The remaining ninety students were assigned on the basis of predicted success. The results were analyzed in a 2 x 2 factorial analysis of variance.

4. Study Four. Data representing measures of 33 variables were collected for each student participating in Study Three and punched into IBM cards. A product moment intercorrelation matrix was prepared and a principle components analysis was performed. Components with eigenvalues greater than unity were rotated to simple structure using normalized varimax procedures. All statistical computations were performed using a CDC 3400 computer.

The 33 variables identified for inclusion in the factor analysis were the logic program criterion test, 17 *en route* unit mastery tests, 12 Guilford aptitude tests, sex, and instructional program variation form. The analysis was completed to determine the contribution, if any, of Guilford's tests to those factors with primary loadings represented by achievement variables.

III RESULTS

A. Study One. The Differential Effectiveness of Symbolic and Semantic-Based Linear Programs for Teaching the Rules of Logic to Eighth-Grade Students.

To avoid logistical problems ten eighth-grade classes were assigned randomly as intact units to the chemical feedback and delayed feedback groups. The two program variations were then assigned randomly within each class. The results of the analysis indicate no differences in treatment effects and no interaction. As a matter of fact random assignment of the two programs yielded almost identical criterion mean scores, 30.74 and 31.10 for the semantic and symbolic forms respectively. Table II shows the descriptive statistics and resulting F-values. Based on Study One data, KR-20 reliability coefficients of .91 and .90 were computed for the semantic and symbolic forms of the logic criterion test respectively.

TABLE II

Descriptive Statistics and F-Values for Logic Criterion Test Mean Scores, by Program Variation and Feedback Method

	Program Variation					
	Semantic			Symbolic		
Feedback	N	Mn.	S.D.	N	Mn.	S.D.
Chemical	40	29.35	10.16	40	31.55	10.29
Delay	40	32.13	11.42	40	30.75	10.19

F_{1-156} (Program Variation) = .06 ns

F_{1-156} (Feedback Method) = .32 ns

F_{1-156} (Program x Feedback) = 1.41 ns

B. Study Two. Relationship Between Intellectual Ability and Achievement in Each of the Two Logic Program Variations.

Two regression analyses using the 12 Guilford tests as predictors and the two 55 item logic criterion tests as the criterion variables yielded two distinct patterns. The predictors with the highest correlation with the semantic and symbolic program performances are in both cases tests related to semantic content. The best predictors of symbolic program performance are the Vocabulary Completion and Verbal Analogies tests. Both have r values of .50 with the logic criterion test and both represent the semantic content dimension in Guilford's structure of intellect.

The best predictor of semantic program performance is the Verbal Classifications test, showing r = .63 with the criterion test. Table III shows the product moment correlation coefficients between the Guilford tests and the logic criterion test score by instructional program content form. Also shown in the Table are the proportions of total variance contributed to the regression by the Guilford Tests and the proportion of explained variance contributed by each. Further inspection of Table III yields a point of interest. That is, once the variance contributed by the primary variable has been extracted, the proportion of unique variance explained by the remaining tests does not conform to the reported zero order correlation coefficient between the tests and program performance. For example, the Verbal Classifications test contributes 68 percent of the total variance explained by all of the tests, while the Vocabulary Completion test, with an r of .60, contributes only 2 percent unique variance to the total explained variance. The same two tests reverse their order of contribution to performance on the symbolic form of the instructional materials.

TABLE III

Correlation Coefficients Between Guilford Tests
and Program Variation Criterion Scores, and
Proportion of Unique Variance Contributed to the Regression by the Tests

Test	Trigram Code	Semantic Program r	Semantic Program Total	Semantic Program Explained	Symbolic Program r	Symbolic Program Total	Symbolic Program Explained
			Proportion of Variance Contributed				
Semantic (M)							
1. Vocabulary Completion	(MNR)	60	01	02	50	25	58
2. Wide Range Vocabulary	(MCU)	34	00	00	38	00	00
3. Math Aptitude Test	(MCS)	44	00	00	39	00	00
4. Sentensense	(MEU)	50	00	00	42	00	00
5. Verbal Analogies	(MCR)	59	09	16	50	09	21
6. Verbal Classification	(MCC)	63	40	68	38	01	02
Symbolic (S)							
7. Finding A's	(SEU)	26	00	00	16	00	00
8. Letter Series	(SNR)	44	01	02	39	00	00
9. Circle Reasoning	(SCS)	42	04	07	37	02	05
10. Omelet	(SCU)	51	00	00	38	01	02
11. Number Relations	(SCC)	59	02	03	35	00	00
12. Word Relations	(SCR)	57	01	02	45	05	12
Total Battery		R = 76	58	100	R = 66	43	100

The correlation between the two factor tests is .69, which demonstrates that they share a great deal of common variance. Multiple correlation coefficients between the predictors and logic performance are .76 and .66 for the semantic and symbolic instructional forms respectively.

The differential pattern of contributed variance by the tests is best seen in Table IV. Table IV shows the proportion of variance contributed by the tests as they are organized into various combinations representing the several homogeneous functions. Note that two proportions for each entry are entered in the table, one relating to the percentage of <u>total</u> variance and the other related to the percentage of total <u>explained</u> variance. The data suggest that differential performance on the two forms of the logic program cannot be explained in terms of the content dimension of Guilford's model. Since, in both cases, the semantic tests contribute the overwhelming proportion to the total <u>and</u> explained variances. Further inspection suggests that the performance differential may be explained in terms of an interaction between the <u>operations</u> and <u>product</u> dimensions. Tests representing the <u>cognition operation</u> and <u>classes product</u> contribute heavily to the variance related to the semantic form of the instructional program; whereas tests from the <u>convergent thinking</u> operations and <u>relationship</u> product contributed most heavily to the symbolic form of the logic program. It should be noted that the contribution of the various tests to the symbolic form are somewhat more complex. Dotted lines have been drawn around those proportions that are not primary but do have significance in terms of the overall interpretations. These data suggest that tests loaded on the factors represented in the "convergent thinking <u>operation</u> - semantic <u>content</u> - relationship <u>product</u>" cell have greater utility for predicting performance on the symbolic logic program.

TABLE IV

Proportion of Variance Contributed to the Regression by Guilford's Tests, by Ability Categories

	Proportion of Variance			
	Semantic Variation		Symbolic Variation	
Aptitude Dimensions	% of Total	% of Explained	% of Total	% of Explained
Operation				
Cognition	56	96	18	42
Convergent Thinking	02	04	25	58
Evaluation	00	00	00	00
Content				
Semantic	50	86	35	81
Symbolic	08	14	08	19
Product				
Units	00	00	01	02
Classes	42	71	01	02
Relationships	12	22	39	91
Systems	04	07	02	05
Operation x Content				
Cognition - Semantic	49	84	10	23
Cognition - Symbolic	07	12	08	19
Convergent - Semantic	01	02	25	58
Convergent - Symbolic	01	02	00	00
Operation x Product				
Cognition - Units	00	00	01	02
Cognition - Classes	42	71	01	02
Cognition - Relationship	10	18	14	33
Cognition - Systems	04	07	02	05
Convergent - Units	---	---	---	---
Convergent - Classes	---	---	---	---
Convergent - Relationship	01	02	25	58
Convergent - Systems	---	---	---	---

Tests representing the "cognitive operation-semantic content-classes product" cell are most predictive of the performance of those using the semantic instructional form.

C. Study Three. Matching Pupils with the Logic Program Variation on Which They Have the Highest Predicted Success.

Data analyzed in the first two studies suggest strongly that assignment to the two program variations on the basis of performance on tests sampling the content dimension of Guilford's compendium might not be as efficient as other combinations. At this stage of the project it was decided to complete Study Three as outlined in the original proposal. Matching pupils with the program variation on which they have the highest "predicted" success was accomplished by computing two standard scores each for all of the students in this part of the study. One standard score relates to the combination of semantic content aptitude tests, the other relates to the combination of symbolic content tests. On the basis of comparing each individual's two standard scores, assignments were made to the program variation that conformed to their highest standard score. From a pool of 144 students, 72 were drawn randomly and assigned to the program variation on which they had the highest standard score. The remaining 72 were assigned randomly to the two program variations.

Table V shows the results of this analysis. The F-value 1.74 for assignment method was not statistically significant. Thus, assigning pupils to a program variation on the basis of highest "predicted" success has no differential influence on performance. The program variation F-value .26 was again indication of the equivalence of the two program forms.

TABLE V

Descriptive Statistics and F-Values for Comparison of Logic Criterion Test Mean Scores for Assignment Method (Content) and Program Variation

	Program Variation					
Assignment Method	Semantic			Symbolic		
	N	Mn.	S.D.	N	Mn.	S.D.
Predicted	36	30.17	10.59	36	27.32	9.89
Random	36	31.05	11.46	36	32.38	10.14

F_{1-143} (Assignment Method) = 1.74 ns

F_{1-143} (Program Variation) = .26 ns

F_{1-143} (Assignment x Program) = 4.10 $P < .05$

The statistically significant interaction may be explained by two related points. First, there is a high correlation between the semantic aptitude test scores and performance on both logic program variations. Second, the system used to determine "predicted" success was based upon the relationship between each student's two standard scores. Thus, those assigned to the symbolic program variation were the students who in general had relatively depressed semantic aptitude test performance by comparison.

Based on the several analyses completed to date, and subsequent to the first part of Study Three, two classes of 28 high school freshman English majors were used for a preliminary study of the predictive efficiency of other test combinations. They were administered two tests chosen from the Guilford compendium on the basis of maximum effectiveness in explaining variance associated with the two logic program variations.

As pointed out previously, the "convergent thinking operation-semantic content-relationship product" cell seems to have the highest degree of relevancy to performance on the symbolic program variation. The aptitude test with the highest factor loading and highest correlation with success ($r = .50$) on the symbolic program variation is Vocabulary Completion. For the semantic program variation, the "cognitive operation-semantic content-class product" cell has the greatest relevance. The Verbal Classification test is representative of this factor ($r = .63$). Note that in both cases the content dimension is semantic. Since all of the data point to the fact that symbolic ability is overshadowed by semantic ability as a predictor of success irrespective of the stimulus content of the instructional materials, this new assignment strategy seems to hold greater promise.

On the basis of comparing the standard scores of the two tests for each of the students, 28 randomly chosen freshman students were assigned to the logic program variation on the basis of the highest prediction. The remaining 28 students were assigned randomly to the program variations. The results of this analysis are shown in Table VI.

TABLE VI

Descriptive Statistics and Resulting F-Values for the Comparison of Logic Criterion Test Mean Scores for Assignment Method (Operation x Product) and Program Variation

Assignment Method	Program Variation					
	Semantic			Symbolic		
	N	Mn.	S.D.	N	Mn.	S.D.
Predicted	14	36.25	10.69	14	37.16	11.04
Random	14	32.10	11.15	14	33.20	11.64

F_{1-55} (Program Variation) = 1.25 ns

F_{1-55} (Assignment Method) = 2.13. P $< .05$

F_{1-55} (Program and Assignment) = .27 ns

The F-value 2.13 is significant beyond the .05 level of confidence. It is obvious that assignment on the basis of predicted success is potentially quite useful. The fact that the mean difference between these two groups is not dramatic, although statistically significant, is undoubtedly a function of the high intercorrelation between the Vocabulary Completion and Verbal Classification tests. Although they are reported to have reasonable factoral purity, the data obtained in this project recorded zero-order correlation coefficients of .69 and .43 between the two tests on the semantic and symbolic analyses respectively. This is evidence that they are tapping quite a bit of common variance. Table VII shows the correlations between all variables for both the semantic and symbolic program analyses.

TABLE VII

Correlation Matrix for Guilford's Aptitude Tests and the Logic Instructional Program Criterion Tests

Top Half - Semantic Criterion Test Plus Predictors N=110

	1	2*	3*	4*	5	6	7*	8	9	10*	11*	12	13	
1	—	31	53	39	60	48	62	63	56	54	57	69	60	1
2	16	—	30	24	27	30	46	22	19	21	35	31	26	2
3	27	12	—	43	39	54	48	60	47	61	54	60	44	3
4	32	03	48	—	19	33	45	38	22	43	43	39	43	4
5	58	37	17	08	—	30	43	41	44	33	46	42	34	5
6	39	18	35	39	35	—	46	49	45	61	49	55	44	6
7	40	28	34	28	41	35	—	38	41	49	62	52	51	7
8	58	09	45	35	30	42	41	—	58	58	48	64	50	8
9	52	17	31	22	51	37	29	38	—	54	53	52	59	9
10	44	13	45	30	39	64	32	47	41	—	59	56	59	10
11	42	22	46	42	26	44	43	37	36	45	—	55	57	11
12	43	27	32	17	38	38	28	35	30	36	39	—	63	12
13	50	16	39	37	38	39	38	42	50	35	45	38	—	13
	1	2	3	4	5	6	7	8	9	10	11	12	13	

N = 110 Bottom Half - Symbolic Criterion Test Plus Predictors

Tests

1. Voc. Compl.
2. Finding A's
3. Letter Series
4. Circle Reas.
5. Wide Range Voc.
6. Math. Apt.
7. Omelet
8. Sentensense
9. Verb. Anal.
10. Number Rel.
11. Word Rel.
12. Verb. Classif.
13. Logic Criterion

* Tests from the symbolic content structure

D. Study Four. Factor Analysis of Aptitude Test Scores, Logic Criterion Test Scores, and Related Variables.

In an attempt to ferret out some interpretable underlying structure the factor analysis described as Study Four in the previous section was completed. Although the analysis of data related to this study is not complete, there are several points that can be made. First of all, the analysis yielded seven interpretable factors with eigenvalues greater than unity. Interestingly, there is very little factoral complexity amongst the variables included in the analysis.

Table VIII shows the factors and variable loadings of .30 and greater. The two dominant factors are labeled achievement and general intelligence. Twelve of the 17 mastery tests from the logic program and the logic criterion test have loading above .30 on Factor 1. Sentensense is the only Guilford test to have a loading on the factor. Surprisingly, ten of the 12 Guilford tests have significant loadings on Factor 2. Along with the ten tests were the criterion tests and one of the logic program mastery tests. The remainder of the factors, although interpretable, shed little in the way of immediate light on the potential contribution of Guilford's model to the development of instructional strategies.

TABLE VIII

Factors and Principal Loadings

Factor I Achievement

Test O	.84
Test N	.84
Test P	.83
Test M	.82
Test L	.79
Logic Criterion	.69
Test I	.64
Test J	.60
Test Q	.58
Test K	.57
Test H	.54
Test F	.46
Test D	.40
Sentensense (MEU)	.35
Test C	.34

Factor II General Intelligence

Voc. Completion (MNR)	.79
Wide Range Vo. (MCU)	.70
No. Relations (SCC)	.66
Verbal Classif. (MCC)	.66
Sentensense (MEU)	.66
Verbal Analogies (MCR)	.64
Math. Aptitude (MCS)	.60
Omelet (SCU)	.54
Letter Series (SNR)	.52
Logic Criterion	.42
Test F	.37
Circle Reasoning (SCS)	.37

Factor III Exemplar Discrimination

Test B	.74
Test A	.57
Test C	.46
Sex	-.45

Factor IV Clerical

Finding A's	.73
Sex	-.67
Omelet	.44

Factor V (?)

Semantic Form	.89
Test D	-.42
Circle Reason	-.31

Factor VI (?)

Immediate Feedback	.82
Circle Reasoning (SCS)	.46

Factor VII Symbolic Representation

Test G	.68
Test E	.64
Test C	.51
Letter Series (SNR)	.48
Word Relation (SCR)	.39
Test J	.34
Math. Aptitude (MCS)	.34
Test I	.32
Test B	.30

Factor VIII Practical Judgement

Test Q	.57
Test H	.51
Test K	.41

IV CONCLUSIONS

This document actually constitutes a progress report, since the studies done to date are highly suggestive of other directions that might profitably be taken. Too, the kinds of statements that can be made now must be considered tentative, since the instructional situations employed in this project do not represent the whole spectrum of instructional situations to which Guilford's model might be applicable. Certainly from the data gathered and analyzed to date, there are a few points that should be made.

1. The stimulus content dimension as defined by Guilford's tests may not be critical from an instructional point of view. Although the general factor has validity in a psychometric context, its value in offering procedural cues for developing teaching strategies may be limited.
2. The limitation of the utility of the content dimension is undoubtedly related to the fact that an analysis of most any instructional objective yields a considerable number of verbal aspects. For example, the terminal objectives of both variations of the logic program suggest a set of verbal skills. Since the symbols in the symbolic variation of the program are still related to specified verbal manipulations, a great deal of verbal mediation is necessary to handle efficiently the symbols in the logic program.
3. Related to the point above, the data strongly suggest that further efforts at determining the instructional utility of Guilford's model might better be aimed at analyses of objectives and learning tasks in terms of the products demanded and the

operations involved.

4. The data from this project reflect considerable magnitude of intercorrelations among the Guilford tests. This may be a function of the high degree of verbal skill (reading or texting) necessary to respond to the tests. But the specific variance associated with each test should be quite useful in determining more precise recipes of abilities related to various types of tasks. They should also be useful for identifying differential recipes for varying stages of learning.

5. Use of Guilford's model to aid in the prediction of differential performance on instructional tasks has considerable potential. That is, given certain specified instructional alternatives, the model should have utility in helping to make decisions as to which alternative is the most effective.

6. Use of Guilford's model to suggest design aspects of the alternatives themselves, either the description of instructional objectives or the specifications of instruction, is not supported by these data. Literal translation of the dimensions related to his broad principles into instructional language and strategies is not warranted.

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APPENDIX A

Logic Program Variation Samples

1. Page 7, Items 7, 142, 277 Semantic

2. Page 7, Items 7, 142, 277 Symbolic

Semantic

Look at these two sentences:

Why are you running?
Phooey!

Neither of these two sentences is a statement. The first sentence is a question and the second is an exclamation.

Turn the page.

7

Wrong. The name for the connective "If - - - then - - -" is the conditional.

Write the following five times:

"If statement one then statement two" = "statement one conditional statement two" = conditional

Go on to page 144.

142

Answer 276 is 3

Here is another conditional argument:

statement one conditional statement two
statement two

- -
therefore, statement one

Look at the second premise. It is the same as the consequent of the first premise. That is, it AFFIRMS the CONSEQUENT of the first premise. What is such an argument called?

1. Affirming the Antecedent
2. Affirming the Consequent
3. Denying the Antecedent
4. Denying the Consequent

Turn the page for the answer.

277

Look at these two sentences:

"Why are you running?"
"Phooey!"

Neither of these two sentences is a statement. The first sentence asks a question, and the second is an exclamation, but neither gives you information.

Turn the page.

7

Wrong. The name for the connective "——— " is the conditional.

Write the following five terms:

"If p then q" = "p ——— q" = Conditional

Go on to page 144.

142

Here is another conditional argument:

Answer 276 is 3.

p ——— q
q
∴ p

Look at the second premise. It is the same as the consequent of the first premise. That is, it AFFIRMS the CINSEQUENT of the first premise. What is such an argument called?

1. Affirming the Antecedent
2. Affirming the Consequent
3. Denying the Antecedent
4. Denying the Consequent

Turn the page for the answer.

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APPENDIX B

Logic Criterion Tests

1. Semantic

2. Symbolic

Semantic

Logic Test

A. Mark your answer sheet to indicate the class in which each of the sentences below belongs.

space 1 = simple statement
space 2 = conjunction
space 3 = disjunction
space 4 = conditional
space 5 = not a statement

1. The cup broke into a thousand pieces.
2. The tie was red but the suit was black.
3. Provided it snows, then school will close.
4. She wondered if there were more.
5. Hurry, or stay home from the game.
6. It is going to rain, or I don't know weather.
7. He's German, but he's not Jewish.
8. Are you leaving, or do you know what time it is?
9. If I stand up to speak, I get frightened.
10. Either I enjoy a program or I don't watch it.

B. Mark your answer sheet to indicate whether the statements below are negations or are <u>not</u> negations.

space 1 = negation statement
space 2 = <u>not</u> a negation statement

11. He isn't going this afternoon.
12. The cat had four kittens.
13. I would like three dozen.

C. Mark your answer sheet to show whether the underlined parts of the statements below are antecedents or consequents.

space 1 = antecedent
space 2 = consequent

14. If there is no sound, the <u>audio portion is broken</u>.
15. If <u>it has legs</u>, it is a chair.
16. Provided the dog is found, <u>the boy may not need shots</u>.

D. Mark your answer sheet to indicate which of the sentences below might serve as first premises, second premises, or conclusions of arguments.

space 1 = first premise
space 2 = second premise
space 3 = conclusion

17. Either I eat at eleven or I am hungry.
18. If he goes now, he will hear the speech.
19. Therefore, I am hungry.
20. He goes now.
21. Therefore she likes pink hats.
22. statement one connective or statement two
23. therefore, statement two

E. Mark your answer sheet to indicate what the second premise does in each of the following partial arguments.

space 1 = restates part of the first premise
space 2 = denies part of the first premise

24. If it was written in 1877, then it won't be in this book.
25. It won't be in this book.
25. If you call the exterminator, he will spray.
He will not spray.
26. He is in the first room or the second.
He is in the second.
27. statement three connective or statement four
statement three
28. statement one conditional negation statement two
statement two

F. Mark your answer sheet to indicate the names of the arguments below.

space 1 = denying the antecedent
space 2 = affirming the antecedent
space 3 = denying the consequent
space 4 = affirming the consequent
space 5 = disjunction

29. If he has 20-20 vision, he doesn't wear glasses.
He doesn't wear glasses; therefore, he has 20-20 vision.
30. It is in the first group or the second.
It isn't in the first group; therefore, it is in the second.
31. If he dropped the chisel, he cut the tiles.
He dropped the chisel; therefore, he cut the tiles.
32. If the book is red, it is the one I lost.
The book is not red; therefore, it is not the one I lost.
33. If he doesn't arrive by two, he won't come today.
He will come today; therefore, he will arrive by two.
34. If she seals the letter, it must go first class.
She seals the letter; therefore, it must go first class.

35. negation statement five conditional negation statement six
statement six

- -
therefore, statement five

36. statement five conditional negation statement six
statement six

- -
therefore, negation statement five

37. statement one conditional statement two
statement one

- -
therefore, statement two

38. statement one connective or statement two
statement one

- -
therefore, negation statement two

39. negation statement one conditional statement two
statement one

- -
therefore, negation statement two

40. statement three conditional negation statement four

- -
therefore, statement three

G. Indicate which of the following argument forms are valid and which are fallacies.

space 1 = valid
space 2 = fallacy

41. affirming the antecedent
42. denying the antecedent
43. affirming the consequent
44. denying the consequent

H. Indicate which of the following arguments are valid and which are fallacies.

space 1 = valid
space 2 = fallacy

45. statement five conditional negation statement six
negation statement five

- -
therefore, statement six

46. statement one conditional statement two
statement one

- -
therefore, statement two

47. negation statement five conditional statement six

- -
therefore, negation statement six

48. negation statement three conditional statement four
negation statement four

- -
therefore, statement three

49. statement one connective or statement two
negation statement one

- -
therefore, statement two

50. Provided the boat arrives, the island gets mail.
The island gets mail; therefore, the boat arrives.

51. If he calls early, he will get tickets.
He calls early; therefore, he gets tickets.

52. He will wear boots or his feet will get wet.
He will wear boots; therefore, his feet won't get wet.

53. If the fuse is blown, the lights are out.
The fuse isn't blown; therefore, the lights aren't out.

54. If Tom sat in the chair, it broke.
It didn't break; therefore, Tom didn't sit in the chair.

55. Either the mail is in the box or there was none.
The mail isn't in the box; therefore there was none.

Symbolic

Logic Test

A. Mark your answer sheet to indicate the class in which each of the sentences below belongs.

space 1 = simple statement
space 2 = conjunction
space 3 = disjunction
space 4 = conditional
space 5 = not a statement

1. The cup broke into a thousand pieces.
2. The tie was red but the suit was black.
3. Provided it snows, then school will close.
4. She wondered if there were more.
5. Hurry, or stay home from the game.
6. It is going to rain, or I don't know weather.
7. He's German, but he's not Jewish.
8. Are you leaving, or do you know what time it is?
9. If I stand up to speak, I get frightened.
10. Either I enjoy a program or I don't watch it.

B. Mark your answer sheet to indicate whether the statements below are negations or are <u>not</u> negations.

space 1 = negation statement
space 2 = <u>not</u> a negation statement

11. He isn't going this afternoon.
12. The cat had four kittens.
13. I would like three dozen.

C. Mark your answer sheet to show whether the underlined parts of the statements below are antecedents or consequents.

space 1 = antecedent
space 2 = consequent

14. If there is no sound, the <u>audio portion is broken</u>.
15. <u>If it has legs</u>, it is a chair.
16. Provided the dog is found, <u>the boy may not need shots</u>.

D. Mark your answer sheet to indicate which of the sentences below might serve as first premises, second premises, or conclusions of arguments.

space 1 = first premise
space 2 = second premise
space 3 = conclusion

17. Either I eat at eleven or I am hungry.
18. If he goes now, he will hear the speech.
19. Therefore, I am hungry.
20. He goes now.
21. Therefore she likes pink hats.
22. $p \vee q$
23. $\therefore q$

E. Mark your answer sheet to indicate what the second premise does in each of the following partial arguments.

space 1 = restates part of the first premise
space 2 = denies part of the first premise

24. If it was written in 1877, then it won't be in this book.
It won't be in this book.

25. If you call the exterminator, he will spray.
He will not spray.

26. He is in the first room or the second.
He is in the second.

27. $m \vee n$
m

28. $s \rightarrow \sim t$
t

F. Mark your answer sheet to indicate the names of the arguments below.

space 1 = denying the antecedent
space 2 = affirming the antecedent
space 3 = denying the consequent
space 4 = affirming the consequent
space 5 = disjunction

29. If he has 20-20 vision, he doesn't wear glasses.
He doesn't wear glasses; therefore, he has 20-20 vision.

30. It is in the first group or the second.
It isn't in the first group; therefore, it is in the second.

31. If he dropped the chisel, he cut the tiles.
He dropped the chisel; therefore, he cut the tiles.

32. If the book is red, it is the one I lost.
The book is not red; therefore, it is not the one I lost.

33. If he doesn't arrive by two, he won't come today.
He will come today; therefore, he will arrive by two,

34. If she seals the letter, it must go first class.
She seals the letter; therefore, it must go first class.

35. $\sim m \rightarrow \sim n$
n
$\therefore m$

36. $r \rightarrow \sim s$
s
$\therefore \sim r$

37. $p \rightarrow q$
p
q

38. $p \vee q$
p
q

39. $\sim m \rightarrow n$
m
$\therefore \sim n$

40. $c \rightarrow \sim d$
$\sim d$
$\therefore c$

G. Indicate which of the following argument forms are valid and which are fallacies.

space 1 = valid
space 2 = fallacy

41. affirming the antecedent
42. denying the antecedent
43. affirming the consequent
44. denying the consequent

H. Indicate which of the following arguments are valid and which are fallacies.

space 1 = valid
space 2 = fallacy

45. r —— s
r
______
s

46. p —— q
p
______
q

47. r —— s
r
______
s

48. m —— n
n
______
m

49. p q
p
______
q

50. Provided the boat arrives, the island gets mail.
The island gets mail; therefore, the boat arrives.
51. If he calls early, he will get tickets.
He calls early; therefore, he gets tickets.
52. He will wear boots or his feed will get wet.
He will wear boots; therefore, his feet won't get wet.
53. If the fuse is blown, the lights are out.
The fuse isn't blown; therefore, the lights aren't out.
54. If Tom sat in the chair, it broke.
It didn't break; therefore, Tom didn't sit in the chair.
55. Either the mail is in the box or there was none.
The mail isn't in the box; therefore there was none.

APPENDIX C

Descriptions of Logic Program Units

Descriptions of Logic Program Units

A. Decide if an item is a simple statement, an incomplete sentence, a question, a command or an exclamation.

B. Decide if an item is a simple statement, a compound statement, or not a statement at all.

C. Decide if the given logic symbols/words represent a given statement.

D. Part I. Decide whether a given statement is a conjunction of more than one statement.
Part II. Decide whether given logic symbols/words correctly express different conjunctive situations.

E. Decide whether given logic symbols/words correctly represent different disjunctive situations.

F. Part I. Decide whether a given item is a statement or the negation of a statement.
Part II. Decide whether items given are statements or the negation of a statement.

G. Decide whether the sentences given can be represented by various combinations of logic symbols/words given.

H. Part I. Decide whether given statements are conditional statements.
Part II. Decide whether a given statement is a correct translation of given logic symbols/words.

I. Part I. Tests knowledge about parts of an argument.
Part II. Decide whether given items are parts of an argument.

J. Part I. Decide whether a given second premise affirms or denies the first.
Part II. Decide whether a given partial argument is conditional or disjunctive.

K. Decide whether a given partial argument is valid or fallacious..

L. Part I. Decide whether a given word argument is valid or a fallacy. Also decide whether the correct symbolic/word translation is given.
Part II. Decide whether a given argument is a valid disjunctive or an invalid disjunctive.

M. Part I. Decide whether a given second premise affirms/denies the antecedent/consequent.
Part II. Recognize correct representations of various parts of the conditional statement.

N. Decide whether a given argument is valid or a fallacy.

O. Decide whether given stated conclusions of an argument are correct or incorrect.

P. Decide whether a given second premise is correct or incorrect.

Q. Decide whether a given second premise correctly or incorrectly denies the antecedent.

APPENDIX D

Sample Unit Mastery Tests

1. Unit F, Part II, Semantic

2. Unit F, Part II, Symbolic

SEMANTIC

TEST F

Part II.

1. Mark yes beside the logic words which are the negation of statement one and no beside those which are not.

	yes	no
1. statement two	____	____
2. negation statement two	____	____
3. statement one negation	____	____
4. not statement one	____	____
5. negation statement one	____	____

2. Mark yes beside the logic words which are the negation of negation statement one and no beside those which are not.

	yes	no
1. statement two	____	____
2. statement one	____	____
3. statement one negation	____	____
4. not statement one negation	____	____

3. Mark yes beside the English words which are the negation of "The children chased the dogs" and no beside those which are not.

	yes	no
1. The dogs did not chase the children.	____	____
2. The children weren't chased by the dogs.	____	____
3. The children didn't chase the dogs.	____	____
4. The dogs didn't chase the children.	____	____

Go on to the next page.

4. Mark yes beside the English words which are the negation of "There is no center aisle in continental seating" and no beside those which are not.

	yes	no
1. There is a center aisle in continental seating.	____	____
2. There is continental seating without center aisles.	____	____
3. There is no continental seating without center aisles.	____	____
4. There is a center aisle in non-continental seating.	____	____

Symbolic

Test F

Part II.

1. Mark yes beside the symbol which is the negation of p and no beside those which are not.

	yes	no
1. q	___	___
2. ~ q	___	___
3. p ~	___	___
4. not p	___	___
5. ~ p		

2. Mark yes beside the symbol which is the negation of ~ p and no beside those which are not.

	yes	no
1. q	___	___
2. p	___	___
3. p ~	___	___
4. not p ~	___	___

3. Mark yes beside the English words which are the negation of "The children chased the dogs" and no beside those which are not.

	yes	no
1. The dogs did not chase the children.	___	___
2. The children weren't chased by the dogs.	___	___
3. The children didn't chase the dogs.	___	___
4. The dogs didn't chase the children.	___	___

Go to next page

TEST F - Part II. (Con't.)

4. Mark yes beside the English words which are the negation of "There is no center aisle in continental seating" and no beside those which are not.

	yes	no
1. There is a center aisle in continental seating.	___	___
2. There is continental seating without center aisles.	___	___
3. There is no continental seating without center aisles.	___	___
4. There is a center aisle in non-continental seating.	___	___

APPENDIX E

Descriptions of Guilford Aptitude Tests

Descriptions of Guilford Aptitude Tests

Semantic

1. Vocabulary Completion (NMR) Convergent thinking about semantic material resulting in a relationship. Learner produces a word that fits a given definition and begins with a given letter.

2. Wide Range Vocabulary (CMU) Cognitive thinking about semantic material resulting in a unit. Learner answers five - choice synonym items.

3. Mathematics Aptitude (CMS) Cognitive thinking about semantic material resulting in systems. Learner solves five - choice word problems requiring arithmetic only.

4. Sentensense (EMU) Evaluative thinking about semantic material resulting in a unit. Learner decides whether a given sentence is sensible or foolish.

5. Verbal Analogies (CMR) Cognitive thinking about semantic material resulting in a relationship. Learner selects the word to complete the analogy. Finding the relation in the first pair is difficult.

6. Verbal Classification (CMC) Cognitive thinking about semantic material resulting in a relationship. Learner applies a rule discovered from the relations of two given pairs of words to select the second member of a third pair.

Symbolic

7. Finding A's (ESU) Evaluative thinking about symbolic material resulting in a unit. Learner checks the four words having the letter "a" in columns of 40 words each.

8. Letter Series (NSR) Convergent thinking about symbolic material resulting in a relationship. Learner indicates which letter properly continues the sequence of a series of letters.

9. Circle Reasoning (CSS) Cognitive thinking about symbolic material resulting in a system. Learner discovers rules for marking circles in patterns.

10. Omelet (CSU) Cognitive thinking about symbolic material resulting in units. Learner makes a word from a given set of letters.

11. Number Relations (CSC) Cognitive thinking about symbolic material resulting in classes. Learner recognizes a pair of numbers that does not belong in a set of four pairs for lack of a common feature.

12. Word Relations (CSR) Cognitive thinking about symbolic material resulting in a relationship. Learner applies a rule discovered from the relations of two given pairs of words to select the second member of a third pair.