CALIFORNIA STATE UNIVERSITY, NORTHRIDGE

THE STRUCTURE OF INTELLECT MODEL: AN INVESTIGATION
OF ITS USEFULNESS IN LANGUAGE INSTRUCTION

A project submitted in partial satisfaction of the
requirements for the degree of Master of Arts in
Educational Psychology

by

Gwendolyn Young Parker

January, 1975
The project of Gwendolyn Young Parker is approved:

California State University, Northridge
January, 1975
# Table of Contents

**Approval**  
11

**Table of Contents**  
111

**List of Figures**  
iv

**Abstract**  
v

## CHAPTER

**I**  
Introduction and Statement of the Problem  
1

**II**  
Review of the Literature  
8

- Background on the Structure of Intellect Model  
8
- Use of SOI in Diagnosis and Prescriptive Teaching  
11

**III**  
Design of the Study  
16

- Hypothesis  
16
- Subjects  
17
- Materials  
17
- Procedure  
17

**IV**  
The Pilot Study  
19

- Constructing the Lessons  
30
- Discussion of Results  
38

**V**  
Recommendations for Further Research  
41

**References**  
44
## List of Figures

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The Structure of Intellect Model</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>Decision Flow Chart for OPERATIONS</td>
<td>21</td>
</tr>
<tr>
<td>3</td>
<td>Decision Flow Chart for CONTENTS</td>
<td>22</td>
</tr>
<tr>
<td>4</td>
<td>Decision Flow Chart for PRODUCTS</td>
<td>23</td>
</tr>
<tr>
<td>5</td>
<td>Symbolic Slab of SOI model with cells identified by CTBS labeled</td>
<td>28</td>
</tr>
<tr>
<td>6</td>
<td>Semantic Slab of SOI model with cells identified by CTBS labeled</td>
<td>29</td>
</tr>
<tr>
<td>7</td>
<td>Sample flashcard for exercise to strengthen ESU</td>
<td>31</td>
</tr>
<tr>
<td>8</td>
<td>Sample board or seatwork exercise to strengthen ESU</td>
<td>32</td>
</tr>
<tr>
<td>9</td>
<td>Sample exercise to strengthen ESU</td>
<td>33</td>
</tr>
<tr>
<td>10</td>
<td>Sample exercise for ESS</td>
<td>33</td>
</tr>
<tr>
<td>11</td>
<td>Sample exercise for NSS</td>
<td>34</td>
</tr>
<tr>
<td>12</td>
<td>Sample exercise for NSS</td>
<td>34</td>
</tr>
</tbody>
</table>
ABSTRACT

THE STRUCTURE OF INTELLECT MODEL: AN INVESTIGATION OF ITS USEFULNESS IN LANGUAGE INSTRUCTION

by

Gwendolyn Young Parker

Master of Arts in Educational Psychology

January, 1975

The Structure of Intellect model, developed by J. P. Guilford and enhanced by the work of M. N. Meeker, presents a new concept of intelligence. Through Meeker's work with the Structure of Intellect (SOI) model there exists the potential for employing the model in the schools as an aid in classroom instruction: for diagnosis, for the basis of structuring individual lessons, and for remediation. This paper is a preliminary investigation of the diagnostic and prescriptive potential of the SOI model.

Two classes of eighth grade students were used as subjects. One class, randomly selected, received supplemental exercises based on SOI abilities. It was hypothesized that this class, the experimental group, would achieve higher in language areas as measured by the Comprehensive Test of Basic Skills subtests in Reading Vocabulary, Spelling, and Language Mechanics than the
group whose language instruction did not include exercises designed to strengthen SOI abilities.

At the end of a 12-week period, a post-test was administered and scores for the two groups were compared using independent \( t \). No significant difference was found between scores for the two groups at the .05 level.
CHAPTER I
INTRODUCTION AND STATEMENT OF THE PROBLEM

The practice of trying to assign a quantitative value to the individual's intellectual ability through the administration of tests has its deepest roots in the diagnosis of the "feebleminded." During the nineteenth century there was great interest in the diagnosis of mental deficiency using psychological methods, with the aim of discovering the nature of the deficiency and treating it.

The more recent strategies in individual measurement might be traced to the work of Sir Francis Galton. His idea of intelligence being largely a matter of "natural abilities" has had a tremendous influence upon the popular concept of intelligence as a measure of general ability. Galton-inspired tests suggested that intellectual aspects of the individual were largely determined by physical ones. "It was Galton's belief that tests of sensory discrimination could serve as a means of gauging a person's intellect. (Anastasi, 1956, p. 8)" As a result, these tests were largely sensorimotor measuring devices.

It was not until late in the nineteenth century and the early 1900's that tests of intelligence became truly "mental" tests. These introduced computation and reading, and investigated memory span, recognition of forms, following instructions, and "thinking." It was during
this era that Alfred Binet, working with Theodore Simon, produced the first Binet-Simon Scale, known as the 1905 Scale. Its purpose was the identification of children with subnormal mental abilities so that some attention might be given to the education of these children in the Paris schools. The 1905, and later revisions of the Binet-type tests, filled a practical need.

It was such a need that resulted in the widespread use of testing. With the United States' entry into World War I, there was a pressing need for rapid classification of the many recruits. The information made available through group testing could provide the basis for many administrative decisions: assignment to certain service, suitability for officer training, and rejection or dismissal from service. Army psychologists drew upon available tests and prepared the Alpha and Beta tests for use with large groups.

At the close of the war these tests were made available for civilian use, and ambitious testing programs were begun. So popular were group intelligence tests for differentiating between individuals that their use was common for all ages and levels of instruction. The sudden large-scale use of tests was such that their use far outpaced advances in their quality and skill in their interpretation.

It is against this incongruous background that intelligence testing came into the schools. Tests were
used in determining special placement for students. A numerical cutoff point determined whether the child was EMR (Educable Mentally Retarded), TMR (Trainable Mentally Retarded), or MGM (a Mentally Gifted Minor). Scores on tests played a large role in placement of students when homogeneous grouping came into the schools as an obvious carry over of the Army's use of tests. In each example given here it is important to note that once categorized according to test results, the child was likely to remain in the same program throughout his school years. Indeed, as Sharp (1972) suggests, it appears educators embraced tests and Galton's belief, that "intelligence is fixed and immutable" and largely a single over-all quantity within the same individual, simultaneously.

Among those who worked with Binet's tests was Lewis Terman. It was Terman who introduced the concept of the "intelligence quotient" as a ratio of chronological age to mental age. He put great emphasis on the numerical score obtained through testing and believed this ratio, and therefore intelligence, remained fairly constant throughout life.

This notion persisted as the basis of intelligence test construction and interpretation for many years; however, professionals in education and psychology have long assailed the concept of general intelligence. An early study by Kagan, Sontag, Baker, and Nelson (1958) cited environment and motivation as well as abilities as
having great influence on IQ scores. The same children make markedly different IQ scores during school years. It appears that these scores are effected by the child's degree of motivation to acquire the skills being measured by the test and the desire to perform well in the testing situation. McNemar (1964) listed several reasons psychologists and educators may well question the value of assessing general intelligence: IQ has often failed as a predictor of success in individual cases, lack of constancy in IQ as measured by general intelligence tests, the inability to separate cultural factors from tests, and the possibly undesirable effects of expectations created by IQ scores. Other data (Yourman, 1964) deal with the propriety of using general IQ scores in relation to racial minority groups. There as consistent differences in IQ scores of black and white students, though there is no real evidence to support the existence of inherent racial differences. At the same time, dissimilarities in culture and personality obviously effect group intelligence scores. In short, various measures of general intelligence suggest learning ability or all-round knowledge is a single factor and is distributed evenly regardless of the task being learned. There is much cause to doubt the wisdom of using such a measure in dealing with children in school.

Thurstone (1938) was among the earliest advocates of the multiple factor theory of intelligence. Thurstone's work, along with that of Guilford during the 1940's, has
contributed a great deal to the concept of factor analysis and the trend toward the possible abandonment of the unitary measure for intelligence. The introduction of the Wechsler-Bellevue Intelligence Scale in 1939, with two categories of tests scored separately, further marked the movement away from the idea of general intelligence. The Wechsler scales of today have gone far beyond the two scores by way of recognizing that intelligence might well involve multiple aspects greater than verbal and performance abilities alone.

It is to this idea of multiplicity of intellectual abilities that Guilford (1967) addressed his efforts. The Structure of Intellect model, created by Guilford and discussed below, presents a three-dimensional conceptualization of intelligence. As enhanced by the work of Meeker (1969), the Structure of Intellect model could serve as a useful teaching tool. It is the aim of this pilot study to investigate the diagnostic and prescriptive potential of the SOI model. The study will attempt to determine whether instruction directed at specific SOI cells, as identified by standardized test, will result in greater achievement for randomly selected students.

It is hypothesized that language lessons can be constructed to strengthen SOI component skills, and that students whose language instruction is supplemented by lessons designed to strengthen Structure of Intellect component skills will show greater achievement on tests
in language that those students whose language instruction is not supplemented by SOI-based exercises.

No attempt will be made, on the basis of the pilot study, to draw conclusions regarding any population. Instead, it is the intent of this preliminary investigation to raise questions for further research.
Figure 1. The Structure of Intellect cube as modified by Meeker. Randomly labeled cells illustrate the process of pinpointing an ability.
Background on the Structure of Intellect Model

There exists, according to Guilford, relative independence of intellectual abilities. An artist may excell in spatial ability, but fall far short of the same level in the area of practical problem-solving. Yet, in terms of his chosen field, he is creative, though lacking the creativity demanded in problem-solving. In interpreting earlier research by others, Russell (1956) suggests that "problem solving is not a unitary factor, but rather a complex of a number of abilities (p. 268)" and that these abilities may exist somewhat independently from general IQ. In accordance with this view of intelligence as a combination of relatively independent abilities, Guilford presented a unique three-dimensional model of intelligence.

The Structure of Intellect, shortened SOI, cube shown in Figure 1 is a visual conceptualization of the facets of intelligence Guilford proposed exist. The 120 separate sections of the cube each represent a component of intellectual ability. These abilities are characterized according to three dimensions: OPERATION, CONTENT, and PRODUCT. (To facilitate recognition, major dimensions will appear printed entirely in capital letters whenever mentioned throughout this paper, while subclass names will
appear with only the first letter of the word capitalized.) OPERATION is defined as "major kinds of intellectual activities or processes; things the organism does with the raw materials of information." CONTENT, "broad classes or types of information discriminable by the organism," is the second large division. The third major division of the SOI, PRODUCT, is defined as "the organization that information takes in the organism's processing of it."

Russell lends support to the idea of analyzing intellectual activity in terms of CONTENT and OPERATION in writing that problem-solving tends to vary more because of the nature of the problem and the solver's set than because of his age or general intellectual ability.

The problem solving process varies with the nature of the task, with the methods of attack known by the solver, with the personal characteristics of the solver, and with the total situation in which the problem is presented. These are interacting factors. (Russell, 1956, p. 270)

Each of the three major division of the SOI model is further divided into varying numbers of subclasses: OPERATIONS into five, CONTENTS into four, and PRODUCTS into six. OPERATIONS has as its subclasses Cognition (C), Memory (M), Divergent Production (D), Convergent Production (N), and Evaluation (E). CONTENT subclasses include Figural (F), Symbolic (S), Semantic (M), and Behavioral(B) areas. The six subclasses of the PRODUCT dimension are Units (U), Classes (C), Relations (R), Systems (S),
Transformations (T), and Implications (I). The first letter of the same of the subclass, shown in parentheses, is taken as its shortened form, except in the cases of Convergent Production and Semantic subclasses, where other letters are used in order to avoid confusion between Cognition and Convergent Production in the OPERATIONS dimension and Symbolic and Semantic subclasses of CONTENT. The intersections of subclasses resulting from naming the OPERATION, CONTENT, AND PRODUCT respectively, make up the 120 or more components of intellect. For instance, CFU would be translated into Cognition of Figural Units, while Memory of Symbolic Relations would be translated into the trigram MSR.

Tests measuring the varied factors of intelligence could well be used to provide a more comprehensive view of intellectual ability. In re-evaluating the use of intelligence testing, Meeker (1969) determined that if standard intelligence tests were found to sample any of the 120 SOI components, the tests' value would be increased beyond any level previously believed, while at the same time boosting the credibility of Guilford's Structure of Intellect concept. Through the SOI there is the potential for improved interpretation of intelligence tests. The SOI provides a schematic design in which individual intelligence may be examined as more than a single general ability, or verbal and mathematical abilities combined.
Using SOI definitions as guides, Meeker assigned items on the Stanford-Binet and Wechsler Intelligence Scale for Children to specific SOI ability cells. Some items involved more than one SOI factor. It was necessary to determine whether, on the basis of its being weighted toward one factor, the item would be confined to one cell or included in two or more cells. Tests and retests of the items substantiated their appropriateness as measures of various SOI abilities. The product of Meeker's work with the test items was a series of templates for transferring results on the Binet and WISC to SOI components.

Meeker gave further specific steps in analyzing and interpreting Binet and WISC results in terms of SOI by constructing the format for establishing an individual profile in terms of SOI components for both tests. These profiles provide a framework for examining test results in terms of cells indicating deficiency or cells in which the individual excels, as well as looking for indications of intellectual patterns. Going beyond measurement and interpretation, Meeker suggests exercises for use in teaching specific SOI abilities to students who showed deficiency in a cell. What resulted from Meeker's work is a package from diagnosis through remediation.

Use of SOI in Diagnosis and Prescriptive Teaching

As mentioned above, using tests in classifying school children, as the Army Alpha and Beta had done recruits,
came into use after World War I. These tests made it possible to group children into classes according to their measured intellectual ability. Since the introduction of ability grouping in 1920, there has been much discussion of its role in meeting diverse needs in education. Though ability grouping is widely used, it has not been proved superior to heterogeneous grouping. Rinehart (1970) reports that research done toward then end has so far been inconclusive.

Research evidence (Kelly, 1969) tends to show that ability grouping offers differing amounts of gain to students according to their ability level, with greatest amount of gain in a three track system shown by low children, second greatest to average children, and least to bright students. There are many, therefore, who doubt the benefit of using homogeneous grouping.

A major reason for all of the disagreement on the worth of grouping seems to stem from problems in determining just what factors are indicators of differing ability and should therefore be considered in placement. Classroom performance, general intelligence, reading level, and social maturity are all factors that might be weighed.

A survey taken during 1965 and 1966 showed that most schools used a combination of techniques in determining groups. Most often mentioned were reading level, test scores, and teacher recommendation. Yet consideration of factors such as the child's motivation, physical and
mental health, and relationship to classmates and teacher serves to point out that even the most homogeneous of groups by certain standards remains a heterogeneous group.

It appears here then that what is at issue may well be the criteria for establishing groups. It is because of this that the diagnostic potential of the SOI comes into play. The Structure of Intellect model, with its potential to pinpoint intellectual talents and deficits, carries tremendous implications for the field of education. The SOI could be used in placement of students in classes that best meet their needs and abilities. Using SOI and the materials developed by Meeker, testing and assessment of intellectual ability can have increased meaning and usefulness in the school situation. Curriculum could be constructed to more closely fit the needs and abilities of the individual student. This could facilitate increased competence in working with all students. Specifically, the SOI could serve as a diagnostic tool and an aid in prescriptive teaching, and use of the SOI model could facilitate increased efficiency and effectiveness in teaching/learning for students of all abilities.

In writing on remedial teaching, Peter (1965) described prescriptive teaching as a method of employing diagnostic information in modifying educational programs. Prescriptive teaching, based on evaluation of the child, emphasizes strengthening areas of weakness found in the child's diagnostic profile. Through diagnosis and
prescriptive teaching, it is possible to make a more significant contribution to the education of the child.

Testing followed by analysis of SOI cell weaknesses and strengths, using the materials made available by Meeker, could permit placement of students in classes with others with similar SOI profiles. In this way, the student's placement would be determined more by how he can best be helped to learn, rather than being based on the fact that he has not yet learned.

In addition to the obvious benefits in terms of more accurate placement, the use of SOI in designing instructional programs would enable the teacher and student alike to focus on specific learning tasks. Rather than being charged with the awesome and nebulous responsibility of teaching the heretofore nonreader to read, the teacher's task would be more simply to provide exercises to raise abilities judged by specific SOI cells.

The greatest apparent deterrent to instituting a program of diagnosis and instruction based on SOI cells is the growing reluctance of many school districts to administer intelligence tests. Much of this reluctance appears to be strongly related to the misuses of IQ testing and weaknesses in test interpretation cited in Chapter I of this paper. Achievement tests are now in far greater use than intelligence tests. This might suggest the need to analyze achievement tests which are currently in widespread use in terms of Structure of Intellect components.
Indeed, Meeker has made an item analysis of the primary level Comprehensive Test of Basic Skills, a CTB/McGraw-Hill achievement battery. With enough experience, teachers might construct tests for use with their classes which could serve to analyze students' strengths and weaknesses according to SOI. Meeker's work in combination with that of Guilford and Hoepfner (1971) would provide guides for analysis of present tests or construction of teacher-made tests. These may also give examples of the types of exercises which might be employed in an instructional program.
CHAPTER III
DESIGN OF THE STUDY

The Structure of Intellect model, through its potential for more exact diagnosis followed by more specific instruction, makes available an invaluable teaching tool. Testing, followed by interpretation in terms of SOI abilities, could provide the basis of instructional programs designed either to teach to the students' strengths or to teach to compensate for students' weaknesses. The procedure which follows employs the SOI model in the later fram and might best be viewed as an initial investigation of the model's usefulness in remediation in the area of the language arts. The research will attempt to ascertain whether it is possible, using the SOI model and the curriculum suggestions made by Meeker, to strengthen specific SOI cells and thereby raise students' level of achievement in language.

Hypothesis

It is hypothesized that language lessons can be constructed to strengthen SOI component skills, and that students whose language instruction is supplemented by lessons designed to strengthen SOI component skills will show greater achievement on tests in language than those students whose language instruction is not supplemented by SOI-based lessons.
Subjects

Subjects will be students enrolled in two classes of eighth grade English fundamentals at Haydock Junior High School in Oxnard, California. The school employs homogeneous grouping using two tracks in English: the higher track is composition, and fundamentals is the lower. The student's placement in a track is determined on the basis of reading level, previous test scores, and teacher recommendation, with reading level and test scores being primary considerations. Students in English fundamentals are those who are judged to be reading well below grade level and at the same time scoring a total markedly below the fiftieth percentile total on all language subtests of an achievement battery. After determination of the track, the students are randomly assigned to classroom groups without further consideration of individual differences. Both classes are afternoon groups, meeting the final periods of the day, sixth and seventh periods.

Materials

Three subtests of the Comprehensive Test of Basic Skills (CTBS) will be administered to the students: Reading Vocabulary (Test 1), Language Mechanics (Test 3), and Language Spelling (Test 5). Alternate forms of the test will be used for pre- and post-tests: Form Q-Level 3 and Form S-Level 3.

Procedure

Following administration of the CTBS subtests, the
toss of a coin will be used to determine which of the two classes will receive the experimental treatment. Tests will be analyzed in terms of the SOI component cell being measured. SOI definitions, along with Meeker's curriculum suggestions will be used as guidelines for construction of lessons. These lessons will be incorporated into the language instruction of the experimental group, while the control group will be instructed using the standard techniques and exercises for the fundamentals track. Following the experimental treatment, the post-test will be administered and the achievement of the two groups will be compared using the independent t.
CHAPTER IV
THE PILOT STUDY

At the start of the fall semester, two classes of English fundamentals eight were tested using three subtests of the Comprehensive Test of Basic Skills, Form Q-Level 3. The subtests administered were Reading Vocabulary, Language Mechanics, and Language Spelling. The tests were given to both classes in two sessions. Completed answer sheets were hand-scored using the key provided in the examiner's manual. Invalid tests, as defined by the examiner's manual, were eliminated from the tallying of responses. With these tests and items out of consideration, the incorrect responses for each item were tallied for each of the two classes.

Following the administration of the pretest, the toss of a coin determined that the seventh period class would be the experimental group, and receive instruction which incorporated supplemental SOI-based exercises.

The tally of incorrect responses per item revealed a great variation in the number of errors on separate items within the same subtest. Item 1 in the Reading Vocabulary subtest was marked incorrectly only once, while items 20 and 32 were incorrectly marked 15 times each. Similar instances of wide variation in the number of errors per item were apparent in each of the subtests. Since the SOI provides for examination of the intellectual
process, it would seem then that each item, with parallel
collection, within each subtest measured the same SOI
ability cell because each called upon the subject to
perform the same task. Why then, did the number of errors
on items within each subtest vary so greatly? It appeared
that a closer examination of the items was called for.

Using the Decision Flow Charts illustrated in
Figures 2, 3, and 4, items 1 and 20 of the Reading
Vocabulary subtest were examined. Items of the Spelling
and Mechanics subtests for which the number of incorrect
responses varied greatly were also examined more closely
using the Flow Charts. No difference in the task was
discovered. In each instance, the subject was to select
the "best" response from four or five alternatives.
For every item of each of the three subtests, the student
was involved in the OPERATION subclass Convergent Produc-
tion.

Convergent Production: Generation of infor-
mation from given information, where the
emphasis is upon achieving unique or conven-
tionally accepted best outcomes. It is
likely the given information (cue) fully
determines the response.

Convergent production is 'rigorous thinking' --
the process of finding the answer where
'finding' is something more than mere
retrieval and 'the answer' suggests that
the domain is so systematic, ordered, and
determinant that there are rules or
principles for converging on the solution.
(Meeker, 1969, p. 19)

The quotation above, from Meeker, serves to point out
Is item simply a repetition of presented material?  

No

Does item involve more than routinized (well practiced) skills?  

Yes

Does item require retention of presented material (no review permitted)?  

No

Does item require a determinant answer (a single, correct answer)?  

No

Does item require reorganization or redefinition of function?  

Yes

Is examinee required to classify or order presented content?  

No

Is this primarily to test comprehension?  

No

Is examinee required to trace implications of meanings or courses of action?  

Yes

Does item require comparisons with rules or standards (appropriateness)?  

Yes

Figure 2. Decision Flow Chart for OPERATIONS from Meeker, 1969
Is information presented in concrete form (pictures, mazes objects, figures)?

Yes

No

Is picture primarily used to represent a meaning rather than a form?

Yes

No

Does information deal with interpersonal perception?

Yes

No

Behavioral

Figural

Could essential content be recalled in concrete form?

Yes

No

Would this give evidence for the answer?

Yes

No

Symbolic

Semantic

Does essential content of the item involve letters or symbols?

Yes

No

Figure 3. Decision Flow Chart for CONTENTS from Meeker, 1969
Does item present a process (as actually performed or by serial presentation)?

No

Does item present item just one element? Yes → Produce an equivalent? Yes → Units

No No

Does item ask examinee to produce more than one element? Yes → Enumerate only? Yes

No No No

Is examinee asked to identify likenesses and differences? Yes → Classes

No

Is examinee asked to identify connections between elements (causal, spatial)? Yes → Relations

No

Are connections merely enumerated or recounted? Yes

No

Are the relations those that any (item age) child would know? Yes → Systems

Implications

No

Is examinee asked to judge material as to expectations, consequences, etc? Yes

No

Is examinee expected to convert material into any other form or order? Yes → Transformations

Figure 4. Decision Flow Chart for PRODUCTS from Meeker, 1969
that by definition any achievement test item would involve Convergent Production (N), and that this is the OPERATION most often demanded of students in school.

In terms of CONTENT, items from the Vocabulary subtest were predominantly Semantic (M) in that they would demand that the student have attached and internalized meaning to the words, which would be called up from his store of information on viewing the items. The words themselves are Symbolic (S) in the absence of abstract meaning. It is necessary here to emphasize the word predominantly preceding the subclass name or trigram. Few items can be confined to any single SOI component cell, and must be categorized according to the ability of which they are primary or predominant indicators. As Rose (1974) points, there may be more than one correct interpretation of the factors involved in any task. This is worthy of note throughout the subclasses of each of the three SOI dimensions. Marked delineation in terms of the SOI cell or cells involved in a task is improbable, if not impossible, because a task is seldom pure -- confined to a single subclass. A vivid example of the relative impurity of tasks would be the solving of story problems in arithmetic.

In determining the PRODUCT subclass in which the vocabulary items belong, it appeared that the items primarily involved output in Units (U). The "best" response was a single word to be selected from four
alternatives. The task of selecting the appropriate response on the vocabulary items involved Relations (R) as well. To complete each item the student would need to examine connections between meanings of individual words.

In summary, the SOI ability cells measured through the vocabulary subtest would be Convergent Production of Semantic Units (NMU) and Convergent Production of Semantic Relations (NMR), with NMN as the predominant ability. To improve vocabulary it would be necessary to construct exercises to strengthen NMU.

Items of the Language Spelling subtest were examined through use of the Decision Flow Charts. These were found to be indicators of the SOI ability Convergent Production of Symbolic Units (NSU). To respond appropriately to the spelling subtest items, it was necessary for the student to determine whether any one word in a group of four alternatives per item was incorrectly spelled. This task also involved Evaluation of Symbolic Units (ESU), as each alternative in each item was judged on the basis of correctness. If the student judged each of the four words to be correct, he could mark a fifth alternative -- none -- to indicate that all of the words in the item satisfied the criterion of correctness.

The SOI ability cells measured through items of the Language Spelling subtest then were Convergent Production of Symbolic Units (NSU) and Evaluation of Symbolic Units, with ESU -- judgment of the individual words as to
correctness in spelling -- being the primary ability involved. To improve students' spelling it would be necessary to construct exercises to strengthen ESU and NSU.

Items of the Language Mechanics subtest were examined. Again the students were to "converge" on the "best" response from alternatives given for the punctuation of a business letter and a paragraph, and for capitalization of sentences. Though punctuation seems obviously to involve Symbolic CONTENT, it is also Semantic in that placement of punctuation marks influences meaning in written communication. In terms of OPERATION and PRODUCT, items of the mechanics subtest involved Evaluation of Units and Systems. Judgment of the appropriateness of a comma, colon, dash, or capital letter in a specific location would represent Evaluation of Units. At the same time, judgment of the appropriate placement of punctuation marks or capital letters within the context of the letter, story, paragraph, or sentence would involve understanding the System implied in sequencing words and symbols in order to convey meaning.

The SOI ability cells related to punctuation and capitalization items in the mechanics subtest were the most difficult to determine. In referring to the definitions for the subclasses of the three dimensions, it became apparent that the items involved more than one subclass in each of the major dimensions. In the OPERATION dimension, Convergent Production (N) and Evaluation (E)
were involved; in the CONTENT dimension, the Symbolic (S) and Semantic (M) subclasses were involved; and in the dimension of PRODUCTS, Units (U) and Systems (S) were both involved. The result of the intersections of these subclasses -- eight trigrams -- is overwhelming when one considers that each trigram points to a single cell involved in the specific mechanical skills of punctuation and capitalization. Obviously, if interpretation of the test in terms of SOI is to serve its purpose in regard to prescriptive teaching, some limitation on multiplicity of cells must be imposed. Through use of the Decision Flow Charts, the predominant SOI factors involved in learning to punctuate and capitalize appropriately in context, as measured by the mechanics subtest, were found to be Convergent Production of Semantic Systems (NMS) and Evaluation of Semantic Systems (EMS). Strengthening these cells should lead to increase proficiency in use of punctuation and capitalization.

Figures 5 and 6 show the Symbolic and Semantic slabs of the Structure of Intellect model. Here "slabs" refers to a cross section of the model from the CONTENT dimension. Those cells which might be measured by an item of the language subtests of the CTBS are labeled with the appropriate trigrams. Those which were determined to be primary factors in learning a skill, and indicators of abilities to be strengthened, are shaded. These shaded cells were stressed in constructing supplemental exercises.
Figure 5. The Symbolic slab of the Structure of Intellect cube showing cells identified through language subtests of the Comprehensive Test of Basic Skills.

*Convergent production of Symbolic Units was a factor not identified in Meeker's work as of 1969.
Figure 6. The Semantic slab of the Structure of Intellect cube showing cells identified through language subtests of the Comprehensive Test of Basic Skills.
for the experimental group. It is important to note that Convergent Production of Symbolic Units (NSU), a cell which, by definition as well as use of the Flow Chart, was related to spelling and mechanical items, had not been identified and validated in Meeker's item analysis of tests as of 1969, and was not used in construction of exercises. **Constructing the Lessons**

To trace devising of supplemental exercises for each of the cells measured by the CTBS subtests would be an exhaustive task. The paragraphs immediately below relate in depth how lessons were constructed for a single cell -- ESU -- using the definitions of the SOI component abilities along with curriculum suggestions from Meeker, test descriptions for component abilities, and examples from Guilford and Hoepfner (1971). Suitable exercises were constructed for each of the remaining cells, with emphasis on those cells which are shaded in Figures 5 and 6, using the same approach outlined below. Brief descriptions of suggested exercises for other cells follow the more detailed account of the processes of designing exercises for Evaluation of Symbolic Units.

In designing the lessons to strengthen the cell ESU, the ability's definition from Meeker (1969) was the primary guide. It states that "ESU is the ability to make rapid decisions regarding the identification of letter or number sets." Lessons to strengthen ESU would involve judgment of letter combinations or
single words.

One exercise developed toward this end involved flashcards for studying spelling words. A card such as the one below, identified as Figure 7, would be used. The card could be used in game-like competitions between individuals or with the entire class. The exercise could be entirely visual, with the students being instructed to write the one word from the card that was a correctly written spelling word, or the exercise could involve auditory and visual judgment, with the students being asked "Which word says crumble?" as the card is shown.

![crumbel crumble](image)

Figure 7. A sample flashcard for strengthening ESU.

In using the exercise to incorporate auditory/visual judgment, students could be instructed to write the word is the entire class was involved in the exercise, or to call out the word's position, if the group was small.

Because the cell ESU, by definition, requires rapid judgment, cards would be exposed for a matter of seconds, with less time being given when the word was spoken for the students, than when they were required to read each of the choices. More time would be allowed also when there was a greater number of choices. Some exercises
involve deciding between two items, while other cards were made with three items.

A similar exercise for strengthening ESU involves letter combinations and a phonetic approach to spelling. In this exercise, students would be asked which combination of letters (either in isolation or in the context of words) represented a specific sound. Figure 8 is an example of this type of exercise.

```
elephant
hippopotamus
rhinoceros
```

Figure 8.

In the example shown in Figure 8, the students would be asked to indicate, through underlining or circling, which letter or letters represent the schwa /ə/ sound in elephant, hippopotamus, and rhinoceros. The exercise could be done at the board, with each word being on the until students had come forward to mark the appropriate letters or the exercise might be done as seatwork, with each student being given a duplicated list of words to examine for the sound-symbol relationship and mark.

For strengthening ESU involving letter combinations appropriate to any given word, cards similar to that shown in Figure 7 might be used. The students would be
asked to judge which item correctly showed the /ɔ/ sound in couple. Figure 9 illustrates this approach.

![c u p l e)

c o u p l e]

Figure 9.

Evaluation of Symbolic Systems (ESS) -- another component ability measured by the CTBS -- is defined as "the ability to estimate appropriateness of aspects of a symbolic system. (p. 66)" Language lessons directed toward this SOI component would require students to make judgments regarding series of letters or punctuation marks. Figure 10 illustrates an exercise in ESS. In this exercise students would be asked to explain which symbols go together, and why.

![. ? ! ,]

Figure 10.

The Symbolic System (_SS) is one of punctuation. All except the comma are end marks for sentences. The period, question mark, and exclamation mark are appropriate to a symbolic system of end punctuation marks.

An example exercise for teaching Convergent Production of a Symbolic System (NSS), "the ability to produce a fully
determined order or sequence of symbols. (p. 79)" is illustrated in Figure 11.

\[ \text{team} \rightarrow \text{trim} \]
\[ \text{team} \rightarrow \text{tram} \rightarrow \text{trim} \]

Figure 11.

The students' instructions for completing an exercise such as the one shown in Figure 11 would involve producing a specific word — in this case, trim — by changing only one letter at a time. Any number of intermediate changes could be built into the exercise, thus calling upon the student to produce a more elaborate system of symbols such as that illustrated by Figure 12.

\[ \text{train} \rightarrow \text{trace} \]
\[ \text{train} \rightarrow \text{trait} \rightarrow \text{tract} \rightarrow \text{trace} \]

Figure 12.

A number of exercises can be developed to strengthen Evaluation of Semantic Units (EMU), "the ability to make judgments about the suitability or adequacy of ideas and word meanings in terms of meeting certain given criteria." (p. 69) One exercise which could be used requires students to select the one word from several alternatives which best meets the specific described criteria. Given the choices egg, watermelon, and peach, the students would be asked,
"Which one is smooth and firm?" To increase the complexity of the Evaluation, a third criterion for selecting the best of the alternatives could be given.

Exercises similar to the one suggested above could be used in teaching for Convergent Production of Semantic Units (NMU), "the ability to converge on an appropriate name (or summarizing word) for any given information."(p.81)

Given the choices egg, watermelon, and peach, the students would be asked to supply a single word that described all three. Finer, more explicit, summarizing words could be called for by narrowing the scope of the choices: orange, watermelon, and peach; or cantaloupe, watermelon, and casaba.

"Convergent Production of Semantic Relations (NMR) is the ability to produce a word or idea that conforms to specific relationship requirements. (p. 83)" An exercise to strengthen this SOI ability might require students to provide a word similar in meaning to some given words. For example, given chalk and pencil, the student might supply the word pen.

To teach for Convergent Production of Semantic Systems (NMS) requires exercises designed to strengthen "the ability to order information into a verbally meaningful sequence. (p. 83)" Exercises to teach NMS include scrambled sentences and scrambled stories. Presented with the word arrangement which follows, students would rearrange the words so as to communicate an idea.
"Up the dog barked and sat" would become "The dog sat up and barked."

"Evaluation of Semantic Systems (EMS) is the ability to judge the internal consistency of a complex of meaningful information. (p. 71)" A sample exercise to strengthen EMS could be having students judge the accuracy of a statement such as this one: "Last December it was so warm that we wore coats to school each morning." A second type of exercise to teach for EMS would involve the students in judging whether all elements of a list of words such as the one which follows are compatible in meaning: hurt, injure, mar, damage, harm.

These are only a few of the many exercises that could be developed to strengthen SOI cells, and thereby raise students' achievement in the language arts. Lessons such as these were incorporated into the instructional program for the experimental group, while the control group received more traditional instruction.

Use of the lessons was supplemental to other instruction. Before the exercises illustrated in Figures 7 through 12 and described above could be used, it was necessary to present to the students some information on the relationship of the letters of the alphabet and the sounds of speech, what characteristics of a group of words constituted its being considered a sentence, and so on. This would be done in a lecture or teacher presentation, because underlining the abilities to evaluate and converge
there seemed to be the need for Cognition.

Cognition: Immediate discovery, awareness, rediscovery, or recognition of information in various forms; comprehension or understanding.

Cognition is perhaps the most obvious of all the OPERATIONS. It is certainly an essential in the education process even from the earliest stages. In terms of the dynamics of learning it seems to be the primary process since every other activity presupposes perception and awareness of stimuli with the associated ability to discriminate or attend. Without registration there would seem to be no CONTENT for further processing. (Meeker, 1969, p. 14)

The same would be true in introducing punctuation and capitalization rules before exercises designed to strengthen Evaluation of Semantic Systems (EMS) or Convergent Production of Semantic Systems (NMS) were used.

The difference in procedure with the two groups then was the inclusion of the SOI-based exercises with the experimental group. Both classes would receive the same presentation of rules. With the control group the presentation would be followed by assignments which required application of the rules. The experimental group would have exercises constructed according to SOI definitions and Meeker's curriculum suggestions to supplement the teacher's presentation before being asked to apply the information presented.

The SOI exercises were incorporated into the assignments for the experimental group's instruction as
seatwork whenever possible and relevant to the language skills measured and identified by the CTBS items. In addition to use of SOI exercises as seatwork, at least once each week the 45-minute class period was devoted to practice in using a specific SOI cell by working through exercises similar to those described above.

After twelve weeks, both classes were given a post-test using Form S-Level 3 subtests from the CTBS. The test scores for the two groups were compared using t-independent. Table 1 shows the numerical data for the post-test. Analysis of these data revealed no significant difference between scores for the sixth period control group and the seventh period experimental group at the .05 level. The study had failed to show that lessons designed to strengthen specific SOI component abilities could boost the achievement of students in language, and the null hypothesis was confirmed.

Discussion of Results

There is much room for speculation here is to why the hypothesis of the study was not proved. The primary factor which is worthy of question is whether the exercises which were constructed were valid techniques to strengthen Structure of Intellect abilities.

Examination of Table 1 further reveals a much higher degree of variability in test scores for the experimental group than for the control group. The high score for the experimental group was 69, while the lowest
Table 1
Post-test scores of experimental and control groups

<table>
<thead>
<tr>
<th>Experimental Group</th>
<th>Control Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>69</td>
<td>54</td>
</tr>
<tr>
<td>59</td>
<td>52</td>
</tr>
<tr>
<td>53</td>
<td>51</td>
</tr>
<tr>
<td>53</td>
<td>51</td>
</tr>
<tr>
<td>51</td>
<td>49</td>
</tr>
<tr>
<td>45</td>
<td>47</td>
</tr>
<tr>
<td>45</td>
<td>46</td>
</tr>
<tr>
<td>43</td>
<td>44</td>
</tr>
<tr>
<td>40</td>
<td>42</td>
</tr>
<tr>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>39</td>
<td>39</td>
</tr>
<tr>
<td>38</td>
<td>38</td>
</tr>
<tr>
<td>38</td>
<td>38</td>
</tr>
<tr>
<td>33</td>
<td>37</td>
</tr>
<tr>
<td>32</td>
<td>37</td>
</tr>
<tr>
<td>27</td>
<td>35</td>
</tr>
<tr>
<td>24</td>
<td>35</td>
</tr>
<tr>
<td>22</td>
<td>33</td>
</tr>
</tbody>
</table>

N = 17
X = 41.88
SD = 12.20

N = 20
X = 41.35
SD = 7.38
score was 22, producing a range of 48; while the range for the control group was 28. The means for the two groups were very nearly the same, yet the standard deviation for the control group was 7.38, while the experimental group standard deviation was 12.20. These differing measures of variability might serve to point out that in spite of the fact that both classes were presumed to be homogeneously grouped, the seventh period experimental group may have been less so, to the point that the lessons designed met the needs of fewer students within the wide range.

A third possible area of question is the time lapse between the pretest and post-test. During this relatively brief period, the students in the experimental group were exposed to new methods of learning which varied greatly, in many instances, from the techniques to which they had previously been exposed. The twelve-week period may not have been long enough, especially with the proportion of class time devoted to SOI exercises, for the students to become adjusted to these new methods and receive the maximum benefit from them.
CHAPTER V

RECOMMENDATIONS FOR FURTHER RESEARCH

Though the data resulting from this pilot study do not substantiate the usefulness of the Structure of Intellect model as a tool in diagnosis and prescriptive teaching, some suggestion of the potential benefit of this concept of intelligence to the field of education does remain. Rose (1974) reports noticeable academic improvement for students given SOI instruction. Though these data are not conclusive, they do suggest the need for further exploration.

I have hundreds of lessons developed by teachers in my SI seminars. Unfortunately, they suffer from the same lack of validity and reliability as the others because they weren't facto-analyzed nor were they properly tested in any fashion beyond that they seemed effective and were logical models, that is transformations of the exercises and tests that Guilford has in his books. Collectively they indicate, because of the significant test scores and the academic improvement of the children exposed to them that they are PROBABLY effective. The proof of their effectiveness and the magnitude of their worth have yet to be established and is one of the reasons for this article. (Rose, 1974, p. 15)

There are a number of questions raised by this pilot study to which further research might attempt to ascertain answers:

1. How can assignment of specific tasks to SOI cells be validated?

2. How can specific techniques to teach SOI cells --
individual exercises -- be validated?

3. Are exercises based on tests of SOI abilities valid for teaching the SOI ability?

4. Are instructional programs based exclusively on SOI abilities possible?

5. Can long-term instruction in a specific SOI area increase an individual's ability in that cell?

6. If Cognition is antecedent to all other OPERATIONS what valid methods to insure Cognition might be used?

Further research might attempt to determine whether of not it is possible to construct daily exercises which strengthen specific SOI cells; whether using SOI-based exercises as the sole method of instruction, rather than as supplementary to other instruction, could strengthen SOI component abilities; whether there is a difference in the direction and degree of growth of two groups, even though significant differences in final achievement scores may not be apparent.

Finally, it is acknowledge that the sample size in the pilot study is undesirably small, and the amount of time during which the students in the experimental group were exposed to the Structure of Intellect exercises was brief. A replication of the study using larger samples in both groups and exposing the experimental group to the exercises for a greater amount of time seems worthwhile.

While research toward answering questions regarding
the potential usefulness of the SOI in boosting achievement test scores remains inconclusive or pending, the SOI and knowledge of it may prove to be useful in helping classroom teachers design instructional programs that are more task-specific and realizable. Instruction designed to strengthen Cognition of Semantic Units (CMU), Convergent Production of Semantic Units (NMU), or Cognition of Symbolic Relations (CSR) is far more specific for teacher and learner alike than being charged with teaching/learning to read, spell, or expand the vocabulary. This same task-specificity might enable teachers to cope more readily with the individual differences of students in any classroom group.
References


Meeker, M. N. The structure of intellect its interpretation and uses. Columbus, Ohio: Merrill, 1969.


Rose, R. What Guilford's structure-of-the-intellect model can do for education. unpublished manuscript, 1974.


Thurstone, L. L. Primary mental abilities. Psychometr. Monogr., 1938, 1, 121.