3.1 Introduction

Guilford (1967) argued against the concept of a single general intelligence factor proposed by Spearman, Burt, and Vernon. He also disagreed with Cattell and Horn's notion of a small group of general abilities (Guilford 1980). Instead, he posited 120 distinct intellectual abilities representing the structure of intellect. Guilford organized these factors along three dimensions that interact to determine different specific factors. The three dimensions consist of five types of mental operations, four types of content areas in which to perform the mental operations, and six products resulting from the application of different mental operations to different content areas. Each intellectual ability results from a unique combination of some mental operation being applied to some content area and resulting in some product. These dimensions do not represent higher order factors but simply provide an organizational framework for Guilford's structure-of-intellect theory. Guilford has attempted to create individual tests to specifically measure each of his posited 120 factors (Guilford and Hoepfner, 1971). Although it has not been adequately validated empirically, Guilford's structure-of-intellect theory has led to the development of many educationally appropriate measures, particularly in the area of creativity.
3.2 Guilford's Structure of Intellect Model

To organize intellectual factors, identified by factor analysis or simply hypothesized, Guilford (1967) designed a structure of intellect (SI) model. This model was essentially conceived to serve the heuristic function of generating hypotheses regarding new factors of intelligence. The placement of any intellectual factor within this nonhierarchal model is determined by its three unique properties: its operation, its content and its product.
Figure - 3.1: Guilford's Structure of Intellect Model

(6 x 4 x 5 three Dimensional Model)
Figure - 3.2: Cross-sectional Analysis of Guilford’s SI Model

Cognition “C”

Memory “M”

Divergent Production “Dn”

Convergent Production “N”

Expanded Figures

CONTENTS

OPERATIONS

Products

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1. Learning takes place through cognition and evaluation.
2. Storage of learned material is in memory.
3. Production of learned material may be:
   - Unchanged = Convergent
   - Reoriented or invented = divergent

**Contents**: Broad classes or types of information discriminable by the organism.

Four types of contents are:

**Figural (F)**: Information in concrete form, as perceived or as recalled possibly in the form of images. The term “figural” minimally implies figure-ground perceptual organization. Visual spatial information is figural. Different sense modalities may be involved e.g., visual kinesthetic.

**Symbolic (S)**: Information in the form of denotative signs, having no significance of in and of themselves, such as letters, numbers,
musical notations, codes, and words, where meanings and form are not considered.

Semantic (M): Information in the form of meanings to which words commonly become attached, hence most notable in verbal communication but not identical with words. Meaningful pictures also often convey semantic information.

Behavioural (B): Information, essentially nonverbal, involved in human interactions, where awareness or attention, perceptions, thoughts, desires, feelings, moods, emotions, intentions, and actions of other persons and of ourselves are important.

Operation: Major kinds of intellectual activities or processes; things the organism does with the raw materials of information, information being defined as 'that which the organism discriminates'.

Five kinds of operations are:

Cognition (C): Awareness, immediate discovery or rediscovery, or recognition of information in various forms; comprehension or understanding.

Memory (M): Retention or storage, with some degree of availability, of information in the same form in which it was committed to storage, and in connection with the same cues with which it was learned.

Divergent Production (D): Generation of information from given information, where the emphasis is upon variety and quality of output.
from the same source. Likely to involve what has been called transfer. This operation is most clearly involved in aptitudes of creative potential.

**Convergent Production (N)**: Generation of information from given information, where the emphasis is upon achieving unique or conventionally accepted best outcomes. It is likely the given information (cue) fully determines the response.

**Evaluation (E)**: Reaching decisions or making judgements concerning criterion satisfaction (correctness, suitability, adequacy, desirability, etc.,) of information.

**Products**: The organization that information takes in the organism's processing of it.

Six kinds of products are:

**Units (U)**: Relatively segregated or circumscribed items of information having 'thing' character.

**Classes (C)**: Recognized sets of items grouped by virtue of their common properties.

**Relations (R)**: Connections between items of information based on variables or points of contact that apply to them. Relational connections are more meaningful and definable than implications.
**Systems (S)**: Organized or structured aggregates of items of information, a complexes of interrelated or interacting parts.

**Transformations (T)**: Changes of various kinds, of existing or known information in its attributes, meaning, role, or use.

**Implications (I)**: Extrapolations of information, in the form of expectancies, predictions, known or suspected antecedents, concomitants, or consequences. The connection between the given information and that extrapolated is more general and less definable than a relational connection.

### 3.3 Convergent Production

Thinking is convergent when the conclusion or other outcome is unique one, that is, essentially determined by the information given. Convergent thinking converges upon the unique consequences. Generating new information from given information is the characteristic of convergent thinking.

Convergent thinking is using information in a way that leads to one right answer. It involved in situations where the production of the one correct solution or answer is required, as for example, in a multiple-choice test. In a social behaviour a conforming response to social expectations represents convergent thinking.
Table – 3.1: Matrix of the Convergent-production Factors

<table>
<thead>
<tr>
<th>Products</th>
<th>Contents</th>
<th>Figural (F)</th>
<th>Symbolic (S)</th>
<th>Semantic (M)</th>
<th>Behavioural (B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units (U)</td>
<td></td>
<td>NFU</td>
<td>NSU</td>
<td>NMU</td>
<td>NBU</td>
</tr>
<tr>
<td>Classes (C)</td>
<td></td>
<td>NFC</td>
<td>NSC</td>
<td>NMC</td>
<td>NBC</td>
</tr>
<tr>
<td>Relations (R)</td>
<td></td>
<td>NFR</td>
<td>NSR</td>
<td>NMR</td>
<td>NBR</td>
</tr>
<tr>
<td>Systems (S)</td>
<td></td>
<td>NFS</td>
<td>NSS</td>
<td>NMS</td>
<td>NBS</td>
</tr>
<tr>
<td>Transformations (T)</td>
<td></td>
<td>NFT</td>
<td>NST</td>
<td>NMT</td>
<td>NBT</td>
</tr>
<tr>
<td>Implications (I)</td>
<td></td>
<td>NFI</td>
<td>NSI</td>
<td>NMI</td>
<td>NBI</td>
</tr>
</tbody>
</table>

The above table shows the abilities drawn through combination of Operation – convergent on four types of Contents – figural, symbolic, semantic and behavioural to give rise to twenty-four Products. These products are clearly shown in the partial representation of SI Model.

The operation category of convergent production is one of the less explored regions of intelligence. All the 24 hypothesized abilities were considered for the study. Convergent production is in the area of logical deductions or at least the area of compelling inferences. Convergent production rather than divergent production is the prevailing function when the input information is sufficient to determine a unique answer. A large part of the creative production in science, mathematics and engineering is convergent production.
Convergent components are apparent in creative thinking, if some criterion of success other than number and diversity of response is applied. Components of creative thinking includes abilities in the convergent production category (Guilford, 1956).

Convergent thinking is oriented towards solving a problem to which there is a known answer. This is generally known as logical thinking, or simply reasoning. Convergent production dealing with relationships, for example, is generally measured as an aspect of the education of correlates through the usual analogies test (Guilford, 1956).

3.4 Description of the Convergent – Production Tests

Here we shall list factors, define them and give examples of representative tests.

I. Convergent Production: The Figural Dimension

1. Convergent Production of Figural Units (NFU)

   It is the ability to converge on an appropriate name or summarizing word for any given figure information.

   i. Picture group naming: Respondent provides the class name for a group of five pictured objects.

   Example:

   ![Image of five pictured objects]

   Answer: - Domestic Animals
2. Convergent Production of Figural Classes (NFC)

It is defined as the ability to classify uniquely or conventionally items of figural information.

i. Figure grouping: Given eight common figures respondent is to classify them into two classes.

Example:

Answer: Group A) 1, 4, 6, 7 Group B) 2, 3, 5, 8

3. Convergent Production of Figural Relations (NFR)

It is the ability to produce a figural item of information that conforms to specific relationships requirement.

i. Figure Selection: In a given 5 figures respondent selects unmatched picture/figure.

Example:

Answers: 2

4. Convergent Production of Figural Systems (NFS)

It is the ability to organize a set of meaningful units into the most acceptable order.

i. Sequence Completion: Given the 4 pictures in a sequence respondent selects the 5th to complete the sequence.
5. **Convergent Production of Figural Transformations (NFT)**

It is the ability to redefine figural elements of a given object and reuse them in new ways.


ii. *Concealed Figures*: Respondent indicates which one of four complex geometrical figures contains a given simpler geometric figure.

iii. *Hidden Figures*: Respondent indicates which of five simple figures is concealed in more complex figures.

**Basic figures**

![Basic figures](image)

*Sample items*

*Answers*: D, A, and B respectively.

6. **Convergent Production of Figural Implications (NFI)**

It is the ability to draw correct deduction from figural information according to rules.
i. **Figure Compose:** The respondent compose the given picture parts in a order and name the figure.

*Example:*

![Figure Compose Example](image)

*Answers:* Pot

**II. Convergent Production: The Symbolic Dimension**

**1. Convergent Production of Symbolic Units (NSU)**

It is the ability to converge on an appropriate name or summarizing word for any given symbolic information.

i. **Group Naming:** Respondent provides appropriate name for a group of 4 symbols.

*Example:*

![Group Naming Example](image)

*Answers:* Mathematical Symbols

**2. Convergent Production of Symbolic Classes (NSC)**

It is the ability to classify unequal items of symbolic information.

i. **Letter Grouping:** Groups a given list of nonsense words into four classes, using each word only once.


*Classes:* 1, 3, 10; 2, 6, 9; 4, 7, 12; 5, 8, 11.

ii. **Restricted Symbolic Classifications:** Partition a list of nonsense words so that each word is a member of exactly two classes.
3. Convergent Production of Symbolic Relations (NSR)

It is the ability to produce a symbolic item of information that uniquely fits the relationship.

i. Correlate Completion II: Respondent applies a rule, which he discovers from relations of the letters of two pairs of words, to write the second member of a third pair.

*Sample items*: Complete analogies where words are paired as to letter compositions.

*Answers*: bout

ii. Letter Series: Respondent states which letter pair properly continues the sequence of a series of letters.

*Sample items*: Find the rule of order in a series of letters, then continue the series, following the rule.

*Answers*: 1 - F E; 2 - R E.

4. Convergent Production of Symbolic Systems (NSS)

It is the ability to produce a fully determined order or sequence of symbols.

i. Operations Sequence: Respondent states the order in which a sequence of numerical operations should be performed in going from one number to another.
Sample item: Order three specified numerical operations to get from one number to another, starting with 6, obtain 18.

Alternative operations: A + 3  B ÷ 2  C X 3
Correct order: BAC

ii. Word Changes: Respondent states what sequence must be followed to get from a given starting word to a given goal word, e.g., starting with the word 'set', change one letter at a time, to end up with the word 'cry.' The words to be used are: day, sat, dry, and say.
Answer: sat, say, day, dry.

Sample item: Arrange a list of words so that the first word is changed into the last one, one letter changed each time.
End words: Bell _____ _____ _____ Main
Filler words: 1. Bail 2. Ball 3. Mail
Correct order of the fillers: 2, 1, 3.

5. Convergent Production of Symbolic Transformations (NST)

It is the ability to produce new symbolic items of information by revising given items.

i. Camouflaged Words. Respondent will identify the name of a sport or game concealed in a given sentence.

Sample item: Find the name of a sport or game concealed in a sentence, e.g., 'I did not know that he was ailing.'

Camouflaged word: Sailing

ii. Word Transformations: Respondent indicates new divisions between letters in a words to form a new phrase.

Sample phrases: Separate letters of words in a phrase with lines to make a different set of words. THE RED OLIVE

New sets of words: THERE / DO / LIVE
6. **Convergent Production of Symbolic Implications (NSI)**

It is the ability to draw correct deductions from symbolic information, according to rules.

i. **Form Reasoning**: Respondent solves simple equations that are given in terms of combinations of familiar geometric figures.

*Sample item*: Given the equations for combinations of forms below, what is the figure equalled by the combination of three figures, taking the latter by combinations of two?

```
□ □ = □
□ □ = □
□ □ = □
```

*Answer*: A

ii. **Sign Changes**: Given the condition that certain numerical-operation symbols are interchanged, respondent solves simple equations.

*Given rules*: Solve simple equations, in which the operation signs are changed according to rules, e.g., Replace \(-\) with \(x\), Replace \(+\) with \(-\).

*Sample items*: 1. \(3 - 6 = \_\) 2. \(6 + 2 = \_\) 3. \(4 - 3 = \_\)

*Answers*: 1. 18; 2. 4; 3. 12.

III. **Convergent Production: The Semantic Dimension**

1. **Convergent Production of Semantic Units (NMU)**

It is the ability to converge on an appropriate name for any given information.
i. **Word – Group Naming:** Respondent provides class name for a group of five words.

*Sample words:* Give class names to five-word groups, knife, pan, bowl, rolling pin, strainer

*Class name:* Kitchen utensils.

ii. **Seeing Trends:** Respondent names the meaningful trend in a group of words.

*Sample item:* Name or describe the meaningful progression in a group of concepts.

1. mouse, rat, lion, pig, cow, horse, elephant
2. century, year, decade, day, week, second

*Answers:* 1 – animals become larger; 2 – time units became smaller.

2. **Convergent Production of Semantic Classes (NMC)**

It is the ability to produce verbally meaningful classes under specific conditions and restrictions.

i. **Word Grouping:** Given 12 common words, respondent is to classify them into classes.

*Sample item:* Assign 12 words to 4 mutually exclusive classes.


*Classes:* 1, 10, 11; 5, 7, 8, 12; 4, 6; 2, 3, 9.

ii. **Figure Concepts Test (uncommon):** Find characteristics in common to two or more of many pictured objects.

*Sample objects:*

<table>
<thead>
<tr>
<th>1. Arrow (picture)</th>
<th>2. Bee (picture)</th>
<th>3. Crocodile (picture)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. Fish (picture)</td>
<td>5. Kite (picture)</td>
<td>6. Sail boat (picture)</td>
</tr>
<tr>
<td>7. Sparrow (picture)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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**Sample Answers:**

(1, 2, 5, 7) *Found in the Air*

(3, 4, 6) *Found in the Water*

(2, 3, 4, 7) *Living Beings*

(3, 4, 5, 7) *Have Tails*

3. **Convergent Production of Semantic Relations (NMR)**

It is the ability to produce a word or idea that conforms to specific relationship requirement.

i. **Associations** III: Write a word similar in meaning to two given words.

   *Sample item*: Skin ________ conceal.

   *Answer*: hide

ii. **Inventive Opposites**: Write two antonyms for each given word, the first letters of the antonyms being given.

   *Sample item*: NARROW  b ________  w ________

   *Answers*: broad, wide

iii. **Vocabulary Completion**: Write a word that fits a given definition and begins with a given letter.

   *Sample items*:

   1. A contest of speed: r ____
      
   2. The wife of a king; q ____

   *Answers*: 1. race; 2. queen

4. **Convergent Production of Semantic Systems (NMS)**

It is the ability to organize a set of meaningful units into the most acceptable order.

i. **Picture Arrangement**: Given the four pictures of a comic strip, respondent indicates the temporal order needed to make complete sense.
ii. Sentence Order: Respondent indicates the temporal order in which three verbally stated events should be placed to make sense.

Sample sentences: Arrange three statements of events in good order.
A. She bought some food at the market.
B. She cooked some of the food she had bought.
C. She went to the market.
Correct order: CAB

iii. Temporal Ordering: Order temporally disarranged steps in a described project.

Sample project: Changing a tire on a car.

Some steps:
A. Set out flares.
B. Tighten nuts.
C. Block wheels so car won't roll.
D. Raise car with jack.
E. Replace flat with spare.
F. Unlock trunk to get tools.
G. Take jack out of trunk.

Sample items:
1. What steps should precede D? ______
2. The first two steps, in order, are ______
3. The last step should be ______


5. Convergent Production of Semantic Transformations (NMT)

It is the ability to produce new uses for objects by taking them out of their given context and redefining them.

i. Gestalt Transformation: Select one of five objects, a part of which could be adapted for some new and unusual purpose.
Sample purpose: To start a fire.

Alternative objects: A. fountain pen  B. onion  C. pocket watch
D. bottle top  E. bowling ball

Answer: C (crystal used as burning lens)

ii. Object Synthesis: Combine two common objects to make a new one.

Given objects: PLIERS and SHOESTRING

Possible composite: pendulum; weapon.

6. Convergent Production of Semantic Implications (NMI)

It is the ability to deduce meaningful information implicit in the given information.

i. Sequential Association: Respondent indicates the best order for four words to produce a chain of associations, e.g.,

Given words: pen pig read write
Correct sequence: pig pen write read

ii. Attribute Listing II: Respondent states the essential attributes of an object that is to serve a certain purpose, e.g., to drive a long nail into a hard post, no hammer being available.

Sample item: You wish to drive a long nail into a hard post. List the attributes that a usable object should have.

Possible attributes: Harder than the nail; flat striking surface; won't shatter.

IV. Convergent Production: The Behavioural Dimension

1. Convergent Production of Behavioural Units (NBU)

It is the ability to identify units of items of information like attitudes, needs, desires, moods, intentions, perceptions, thoughts of other people and of ourselves.
i. **Figure Selection**: Respondent select closely matching human figure for the given human figure.

*Example*:

```
1 2 3
```

*Answer*:

2

2. **Convergent Production of Behavioural Classes (NBC)**

It is the ability to produce non-verbal information, involved in human interactions into meaningful classes under specific conditions and restrictions.

i. **Human Picture Classification**: Given four common picture, respondent is to classify them into two equal mutually exclusive classes.

*Example*:

```
a b c d
```

*Answer*: i. a & d, ii. b & c

3. **Convergent Production of Behavioural Relations (NBR)**

It is the ability to produce non-verbal information involved in human interactions that uniquely fits the relationships.

i. **Inventive Opposite**: Given human picture, respondent select the more appropriate opposite Behaviour.
4. Convergent Production of Behavioural Systems (NBS)

It is the ability to produce a set of meaningful information pertaining to human interaction into an organized form.

i. Sequential Association: Given four pictures of human interaction respondent indicates the temporal order needed to make a complete sense.

Example:

Answer: 2

5. Convergent Production of Behavioural Transformations (NBT)

It is the ability to modify, or shift items of information in between two or more persons into a new form.

i. Picture Completion: Given incomplete picture, respondent completes the picture by observing non-verbal information involved in human interaction.
6. **Convergent Production of Behavioural Implications (NBI)**

It is the ability to infer meaningful conclusion regarding the information available inbetween the persons.

i. *Sequence Completion*: Respondent applies a rule which he find out from the relations and non-verbal interactions in the given pictures, to select fourth picture of the sequence.

*Example:*

```
Answer: 1
```

```
1 2 3
```

```
```

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