CHAPTER-I
CHAPTER -I

THE PROBLEM

1.1 INTRODUCTION

The Almighty, the creator of the universe, has the supreme-mind who possesses the finest creative abilities. He has created all of us and all that is revealed in nature.

Every one of us ought to have unique creation, but does not possess the same creative ability. Some of us are endowed with high creative talents and contribute to advancement in the fields of art, literature, science, business, teaching and other spheres of human activities and are responsible for propounding new ideas and bringing about social and cultural changes. Mahatma Gandhi, Abraham Lincoln, Homi Bhaba, Newton, Shakespeare, Leonardo Da Vinci were some of the exceptionally creative individuals who left their mark in their chosen fields.

Though they were undoubtedly gifted with creative abilities the role of environment in terms of education, training and opportunities in their development cannot be ignored.

Good education, proper care and provision of opportunities for creative expression, inspire, stimulate and sharpen the creative mind and it is in this sphere that parents, society and teachers make a significant
contribution. They are required to help the children in nourishing and utilizing their utmost creative abilities.

The educational process has to be aimed at developing creative abilities among children. This can be achieved by acquainting among students by teachers and parents real meaning of the creative process and the ways and means of developing and nurturing creative thinking abilities.

1.2 CONCEPT OF THINKING

Cognitive ability like thinking may be considered as one of the chief characteristic which distinguishes human beings from other species.

Good poetry, a highly developed computer or a robot, a beautiful painting or a magnificent building are all products of the thinking abilities of their creators or inventors.

1.2.1 MEANING OF THINKING

Thinking is a pattern of behavior in which the use of internal representations (symbols, signs etc) of things and events for the solution of some specific and purposeful problem is made.
1.2.2 DEFINITIONS OF THINKING

Ross – 1951 : ‘Thinking is mental activities in its cognitive aspect or mental activity with regard to Psychological objects’.

Moshin (1967) : ‘Thinking is an implicit problem solving behavior’.

Garett (1968) : ‘Thinking is behavior which is often implicit and hidden and in which symbols (images, ideas, and concepts) are ordinarily employed’.

Gilmer (1970) : ‘Thinking is a problem solving process in which we use ideas or symbols in place of overt activity’.

1.2.3 NATURE OF THINKING

Thinking is essentially a cognitive ability. It is always directed towards achieving some purpose. It is described as a problem solving behavior. In thinking, there is mental exploration rather than motor exploration. It is a symbolic activity and it can shift instantaneously over a span of time and space.

1.2.4 TOOLS OF THINKING

Various elements involved in the thinking process may be as follows.

1. Images

Images are mental pictures consists of personal experiences of objects, persons of scenes actually seen, heard and felt.
2. Concepts
A concept is a general idea that stands for a general class and represents the common characteristic of all objects or events of this general class.

3. Symbols and Signs
Symbols and signs represent and stand for substitutes for the actual objects, experiences and activities.

4. Language
Language is the most efficient and developed vehicle used for carrying out the process of thinking.

5. Muscle Activities
Thinking in one way or the other shows evidence of the involvement of some incipient movements of group of our muscle.

6. Brain Function
Thinking is primary a function of the brain, our mind or brain is said to be chief instrument or seat for carrying out the process of thinking.

1.2.5 TYPES OF THINKING
Thinking as a mental process, this is usually classified into the following categories.

1.2.5.1 CONCRETE THINKING
This is the simplest form of thinking. The basis of this type of thinking is perception, i.e. interpretation of sensation according to one's
experience. It is called concrete thinking as it is carried out on the perception of actual or concrete objects or events.

1.2.5.2 CONCEPTUAL OR ABSTRACT THINKING

It is thinking where one makes use of concepts, the generalized ideas and language. It is regarded as superior to perceptual thinking, because it economizes efforts in understanding and problem solving.

1.2.5.3 REFLECTIVE THINKING

This is higher form of thinking. It can be distinguished from simple thinking in the following ways. It aims at solving complete rather than simple problems. It requires reorganization of all the relevant experience and new ways. It does not involve the mechanical trial and error type of efforts. It takes all the relevant facts arranged in a logical order in order to arrive at a solution of the problem on hand.

1.2.5.4 CRITICAL THINKING

It is a type of thinking that helps a person in stepping aside. From his own personal beliefs, prejudices and opinions to sort out the facts and discover the truth, even at the expense of his basic belief system.
1.2.5.5 ASSOCIATIVE THINKING

Some times we find ourselves engaged in unique type of thinking which is non-directed and without goal. It is reflected through dreaming, free associations, fantasy delusions and uncontrolled activities.

1.2.5.6 CREATIVE THINKING

This type of thinking as the name suggests is associated with one’s ability to create or construct some thing new, novel or unusual. It looks for new relationships and associations to describe and interpret the nature of things, events and situations. It is not restricted by any pre-established rules. The individual himself/herself usually formulates the problem and is also free to collect the evidences and to fashion the tools for its solution. The thinking of scientists, artists or inventors provides ideal examples for such type of thinking.

1.3 CREATIVITY

1.3.1 AN ABILITY

A simple definition is that creativity is the ability to imagine or invent something new. As we will see below, creativity is not the ability to create out of nothing (only God can do that) but the ability to generate new ideas by combining, changing or replying existing ideas. Some
creative ideas are astonishing and brilliant, while others are just simple, 
good, practical ideas that no one seems to have thought of yet.

Believe it or not, everyone has substantial creative ability. Just 
look at how creative children are. In adults, creativity has too often been 
suppressed through education, but it is still there and can be reawakened. 
Often all that's needed to be creative is to make a commitment to 
creativity and to take the time for it.

1.3.2 AN ATTITUDE

Creativity is also an attitude: The ability to accept change and 
newness. A willingness to play with ideas and possibilities, a flexibility 
of outlook, the habit of enjoying the good and looking for ways to 
 improve it. We are socialized into accepting only a small number of 
permitted or normal things, like chocolate-covered strawberries, for 
example. The creative person realizes that there are other possibilities, 
like peanut, butter and banana sandwiches or chocolate-covered prunes.

1.3.3 A PROCESS

Creative people work hard and continually to improve ideas and 
solutions, by making gradual alterations and refinements to their works. 
Contrary to the mythology surrounding creativity, a very few works of 
creative excellence are produced with a single stroke of brilliance or in a 
frenzy of rapid activity. Much closer to the real truth are the stories of
companies who had to take the invention away from the inventor in order to market it because the inventor would have kept on tweaking it and fiddling with it, always trying to make it a little better. The creative person knows that there is always room for improvement.

1.3.4 CREATIVE METHODS

Several methods have been identified for producing creative results. Here are five classic ones

1.3.4.1 EVOLUTION

This is the method of incremental improvement. New ideas stem from other ideas, new solutions from previous ones, the new ones slightly improved over the old ones. Many of the very sophisticated things people enjoy today, have been developed through a long period of constant incrimination. Making something a little better here, a little there gradually makes it something a lot better—even entirely different from the original.

For example, look at the history of the automobile or any product or technological progress. With each new model, improvements have been made. Each new model builds upon the collective creativity of previous models, so that over the time, improvements in economy, comfort and durability take place. Here the creativity lies in the refinement, the step-by-step improvement, rather than in something
completely new. Another example would be the improvement of the common wood screw by what are now commonly called drywall screws. They have sharper threads which are angled more steeply for faster penetration and better holding. The points are self tapping. The shanks are now threaded all the way up on lengths up to two inches. The screws are so much better that they can often be driven in without pilot holes, using a power drill.

The evolutionary method of creativity also reminds us that critical principle: Every problem that has been solved can be solved again in a better way. Creative thinkers do not subscribe to the idea that once a problem has been solved, it be forgotten or to the notion that ‘if it aims to broke, don’t fix it’. A creative thinker’s philosophy is that ‘there are no such things as an insignificant improvement’.

1.3.4.2 SYNTHESIS

With this method, two or more existing ideas are combined into a third, new idea. Combining the ideas of a magazine and an audio tape gives the idea of a magazine you can listen to, one useful for blind people or freeway commuters.

1.3.4.3 REVOLUTION

Sometimes the best new idea is completely different one, a marked change from the previous one. While an evolutionary
improvement philosophy might cause a professor to ask, 'How can I make my lectures better and better?' a revolutionary idea might be, ‘why not stop lecturing and have the students teach each other, working as teams or presenting reports?’

1.3.4.4 RE-APPLICATION

Look at something old in a new way. Go beyond labels. Unfixate, remove prejudices, expectations and assumptions and discover how something can be re-applied. One creative person might go to the junkyard and see art in an old model T transmission. It is painted up and put it in living room. Another creative person might see in the same transmission the necessary gears for a multi-speed hot walker for the horse. Who hooks it to some poles and a motor and puts it in the corral. The key is to see beyond the previous or stated applications for some idea, solution or thing and to see what other application is possible.

1.3.4.5 CHANGING DIRECTION

Many creative breakthroughs occur when attention is shifted from one angle of a problem to another. This is sometimes called creative insight.

A classic example is that of the highway department trying to keep kids from skateboarding in a concrete-lined drainage ditch. The highway department put up a fence to keep the kids out; the kids went
around it. The department then put up a longer fence; the kids cut a hole in it. The department then put up a stronger fence; it, too, was cut. The department then put a threatening sign on the fence; it was ignored. Finally, someone decided to change direction, and asked, ‘What really is the problem here? It’s not that the kids keep getting through the barrier, but that they want to skateboard in the ditch. So how can we keep them from skateboarding in the ditch?’ The solution was to remove their desire by pouring some concrete in the bottom of the ditch to remove the smooth curve. The sharp angle created by the concrete made skateboarding impossible and the activity stopped. No more skateboarding problems, no more fence problems.

This example reveals a critical truth in problem solving: the goal is to solve the problem, not to implement a particular solution. When one solution path is not working, shift to another. There is no commitment to a particular path, only to a particular goal. Path fixation can sometimes be a problem for those who do not understand this; they become overcommitted to a path that does not work and only frustration results.

1.4 INTELLIGENCE AND ITS THEORIES

It is acknowledged by all teachers that one of the single variable which effects schooling is the quality of behavior called intelligence. The term intelligence is vague and ambiguous in its meaning.
Psychologists have been interpreting the term in different ways and are in disagreement on the meaning of the term intelligence. During the last fifty years, much research has been done on the nature of intelligence and its measurement. Vast literature is available on this topic. In psychological literature, intelligence has been treated as a construct; no one knows what intelligence is. Due to the vagueness, in recent years concept of intelligence has become less acceptable and more exposed to criticism by Psychologists.

1.4.1 DEFINITIONS OF INTELLIGENCE

Intelligence, the dictionary says, is ‘The capacity to acquire and apply knowledge’. A number of definitions have been evolved by Psychologists according to their own concept of the term intelligence. Being dissatisfied by the number of definitions and their interpretation, Boring defined ‘Intelligence is what intelligence tests test’. All the definitions have been systematized by Vernon and Freeman. Let us examine the classification of the definitions of intelligence done by this Psychologist.

Vernon

Vernon classified all the definitions under three broad categories, such as Biological, Psychological and Operational. Freeman, though classified all definitions of intelligence into three categories but his approach differs from Vernon.
1. Biological Approach

This category of definitions emphasizes the adaptive nature of human beings. Man is one kind of organism.

According to this approach, is the capacity to adapt relatively in new situations of life? But if critically examined the biological concept of intelligence one finds that many great men to whom could hardly deny an assessment of exceptional intelligence (Pascal, Kafka and numerous academic experts) have been spectacularly ill-adapted in their social and physical environment. The biological concept of intelligence is not of great use from practical point of view in the study of individual differences within a culture.

2. Psychological Approach

The second category of definitions according to Vernon, are Psychological. Few of the definitions advanced by experts contained a clear commitment about the relative effects of hereditary and environmental influences in the development of intelligence. Burt, C. an English Psychologist, defined intelligence as innate general cognitive ability. Since scores on existing intelligence tests have often been shown to be susceptible to environmental influences, a consequence of this definition is that intelligence as defined differs from intelligence as measured by tests.

Psychologists have attempted to escape from this dilemma in two ways: Hebb and Cattell have distinguished two kinds of intelligence,
calling then intelligence ‘A’ and intelligence ‘B’ or fluid and crystallized intelligence. The distinctions are made by Hebb and Cattell are more or less the same. In each case fluid intelligence or ‘A’ is thought of as genetic potentiality or the basic innate qualities of the individuals’ nervous system and the crystallized intelligence or ‘B’ is mainly the result of experience, learning and environmental factors. Psychologists have specified two types of intelligence which will, in normal circumstances, overlap so much as to be in practice indistinguishable. Further, it is impossible to assess genetic potential uncontaminated by the effects of training and experience and other environmental influences.

3. Operational approach

The third category of definitions of intelligence is operational. Operational definitions are important to understand the concept of intelligence in clear and definite terms. Scientific terms are defined not in isolation, as in a dictionary but by stating the observable conditions under which a sentence containing the term is true or false. Instead of defining the word by itself if it is defined by giving the conditions for the truth of a sentence in which the term occurs. Such definitions are called operational, for they frequently state what must be done in order to make certain observations. For instance, in order to determine a child’s I.Q., we must first administer a test of specific kind, then observe
his performance on the test and finally make certain calculations and decisions. All of these conditions define the meaning of I.Q.

It would certainly be of great advantage to have an operational definition of intelligence that every one would accept for scientific work and would distinguish it from vague popular conceptions of the term.

Freeman: Classified all the definitions under three abilities. Such as

1. Adjustment or Adaptation Ability: The definitions of this category lay emphasis on the adjustment ability of an individual to his environment. The individual is thought intelligent in proportion to his ability to adjust to new situations and problems of life. The person who is intelligent has no difficulty in the adjustment. He adjusts in an effective way and can vary his behavior according to the situation. A person who is less intelligent is rigid and has less response to make in the process of social interaction.

2. Ability to Learn: The definitions of this category emphasize the importance of an individual's ability to learn. Learning ability is an index of one's intelligence. Backingham says, 'Intelligence is the learning ability'.

3. Ability to carry on Abstract Thinking: This category of definitions lays more emphasis on the effective use of concepts and symbols in dealing with situations, especially, presenting a problem to be solved through the use of verbal and numerical symbols. Terman,
defining intelligence, says, 'An individual is intelligent in proportion as he is able to carry on abstract thinking'.

**Binet (1905):** Regarded intelligence as a collection of faculties: judgment, practical sense, initiative and the ability to adapt one to circumstances. However, his selection of tests was based on an empirical criterion, namely, those tests which differentiated older from younger children. What he thought that the tests were measuring was based only upon his opinion; the tests were not originally selected on the bases of factor analysis.

**Wechsler (1958):** Defined intelligence as 'the aggregate or global capacity of the individual to act purposefully, to think rationally and to deal effectively with his environment'. This definition implies that intelligence is composed of qualitatively different elements or abilities. However, it is not the mere sum of abilities that defines intelligence, because intelligent behavior is also affected by the way in which the abilities are combined and by the individual's drive and incentive. Wechsler recognized that while it is possible to measure various aspects of intellectual ability, the obtained scores are not identical with what is meant by intelligence. Wechsler has taken a pragmatic view of intelligence, stating that intelligence is known by what it enables us to do. However, as Guilford (1967) noted, Wechsler failed to supply empirical reference for such terms 'aggregate', 'global', 'purposefully' and 'rationally'.
Piaget (Elkind, 1969): Intelligence is an extension of biological adaptation, consisting of the processes of assimilation (processes responsive to inner promptings) and of accommodation (processes responsive to environmental intrusions). Assimilative processes permit intelligence to go beyond a passive coping with reality, while accommodative processes operate to prevent intelligence from constructing representations of reality which have no correspondence with the real world. Intelligence represents the rational processes, the processes which show the greatest independence of environmental and internal regulation.

Stoddard (1943): Presented comprehensive description 'Intelligence is the ability to undertake activities that are characterized by 1) difficulty, 2) complexity, 3) abstraction, 4) economy, 5) adaptiveness to a goal, 6) social value and 7) the emergence of originals and to maintain such activities under conditions that demand a concentration of energy and a resistance to emotional forces'.

1.4.2 THE NATURE OF INTELLIGENCE

Many different theories have been advantaged over the years to explain the nature of intelligence. We shall discuss major theories/views briefly.
Spearman’s View (1904): The two factor theory proposed by Spearman postulated that intelligence is composed of a general factor ‘g’ underlying all mental functions and a multitude of ‘s’ factors dealing with tasks of the same general nature into a group factor. According to this theory, a child’s ability to do a problem in arithmetic depends on the quality of his ‘g’ factor and of his ‘s’ factors dealing with that particular problem. People differ in the amount of ‘g’ as well as in the quality of the specific or the group factors involved in the given task so that it is possible for a person who is relatively more intelligent than another by reason of a superior ‘g’ to be less capable in a given area. On the other hand, Spearman postulated ‘g’ as a form of mental energy permeating all mental operations; it would be unlikely for a person who is grossly lacking in general intelligence to be particularly capable in a specific.

Binet’s View (1911): According to Binet conceiving of intelligence not as a unitary trait but rather as a composite of many abilities, he set up a number of questions dealing with areas with which every child while lacking in knowledge of the specific questions, would nonetheless be somewhat aquatinted, this sampling of many different types of performance in which intelligent behavior or might be displayed proved sufficiently successful that in 1905 be devised the first intelligence test.

Thorndike’s View (1927): The theory of specific intelligence proposed by Thorndike conceived intelligence as a multitude of specific and independent neural connection; intelligence was simply the
summation of all the abilities involved in mental acts, each separate and independent of the others. According to Thorndike, a bright person simply has more neural connections of an adequate nature than a dull person, a view consistent with his S-R Bond theory of learning.

**Kelly’s View (1934)**: Emphasized that psychological ‘g’ factor is heterogeneity of the population of individuals sampled for an analysis. He pointed out that a ‘g’ might simply represent variations in age, sex, education and so on. If two tests are both correlated with age, they will correlate with one another because of this fact.

The needs for structural models of intelligence arose only after common factors in addition to ‘g’ were found. Results of factor analysis over the years have contributed a steadily growing list of common factors in the domain of intelligence. Two types of models have emerged – (i) Hierarchical model, and (ii) Morphological type of model.

The Hierarchical type of model is proposed by Burt (1950) and morphological type of model proposed by Guilford, (1959b).

Burt conceives the hierarchical model as an inverted tree pattern, which has two wings to every branch. From ‘g’ the first dichotomy is between verbal and nonverbal or intellectual and practical that he calls the ‘relational’ level and lower levels and called ‘association’, ‘perception’ and ‘sensation’. But he applies his model to the known group factors; he has to depart from the strict dichotomization design. He insists on a small ‘g’ factor at each level except that of sensation.
Thurstone's View (1935): He proposed a theory of primary mental abilities, which conceives of intelligence as made up of a number of mental abilities in the relative amount of any one of which people differ not only from one to another but also differ within themselves. A person may, for example, have relatively less of most of mental abilities than another person and so be generally less 'bright' but he may have considerably of more of one ability which makes it possible for him to excel in the task where this ability is important. Of course, to the extent that many tasks involve a combination of these abilities, a person would be restricted in intelligence by a particular weakness in any one area.

Garrett's View (1946): According to him, intelligence is the comprehension and use of symbols in the solution of problems, proposes a development theory of intelligence. He includes that intellectual ability tends to be unified and general during the early school years, but as age increases this generalized ability become recognized and differentiates itself into a number of fairly distinct and independent abilities.

Vernon's View (1950): Make a beginning similar to that of Burt. From 'g' there is branching into a verbal-educational (V:Ed) factor and practical–mechanical spatial (K:M), factor (V:Ed) subdivided into verbal and numerical abilities and factor (K:M) into space and psychomotor abilities. From there on Vernon relates subdivided factors
rather directly to formal educational areas of instruction, reflecting his educational interests rather than interest in basic psychology.

**Guilford’s View (1956, 1959, 1967):** The most comprehensive conceptualization of the complex structure of the human intellect is presented by Guilford. In which he classifies the intellect according to three dimensions.

**a.** The process or operation performed: cognition, memory, convergent thinking, divergent thinking and evaluation.

**b.** The kind of material or content: figural (i.e., concrete intelligence), symbolic, semantic (abstract intelligence) and behavioral (social intelligence).

**c.** The kind of product resulting from the application of certain operations on certain kinds of content:

- Unit, classes, relations, systems, transformations and implications.

These three components of the intellect can be represented by a 5X4X6 three-dimensional solid mode, each of the 120 cells of which can be constructed as a factor.

The interesting aspect is in the distinction between convergent and divergent thinking. The convergent thinking oriented towards solving a problem to which there is a known answers; this is generally known as logical thinking or simply reasoning.
Divergent thinking seeks a new and different solution and might be considered imaginative thinking or creativity. The divergent thinking abilities have word fluency at the semantic level. The divergent production of class ideas may be considered a factor of spontaneous flexibility.

These theories of intelligence are not conflicting; they merely represent different emphasis and different levels of comprehensiveness.

The Guilford's model is presumably and extension of the Thurstone approach to the identification of mental components. Spearman's group factors might well be the counterpart of Thurstone's primary mental abilities. Thurstone primary mental abilities do not account for the total variance in the mental performance of different individuals; there is room for a general factor. The difference reflects difference in purpose. Spearman's emphasis on a general factor leads to the calculation of a single measure of general intelligence which may satisfy the needs of the elementary school.

Guilford's model is of complex and even thought it structures the various aspects of the intellect into a logical system, it does complicate the task of measuring 'intelligence'.

Special significance is the recent shift from intelligence as something one has or perhaps is born with-to intelligence as something one develops. Substantial scientific evidence has converged from varied sources to focus on the need for educators to abandon their previous
emphasis on the immutability of development as essentially a maturational process in favor of a more positive view of development as amenable to systematic environmental influences.

1.4.3 TYPES OF INTELLIGENCE

B.L. Thorndike

Classified intelligence into three categories which are as follows:

a) Concrete intelligence.

b) Abstract intelligence

c) Social intelligence.

a) Concrete Intelligence: Concrete intelligence means intelligence in relation to concrete materials. It is the ability of an individual to comprehend actual situations and react to them adequately. The concrete intelligence is evident from various activities of daily life. This kind of intelligence is measured by performance tests and pictures tests in which the individual has to manipulate concrete materials.

b) Abstract Intelligence: It is the ability to respond to words, numbers and letters etc. All tests of intelligence which require manipulation of symbols are tests of abstract intelligence. Abstract intelligence is required in the ordinary academic subjects in schools, such as reading, writing and history and so on. The highest level of abstract intelligence is manifested in the thought of philosophers and in the use of mathematical formula.
c) **Social Intelligence**: Social intelligence means ability of an individual to react to social situations of daily life. Social intelligence would not include the feelings or emotions aroused in us by other people, but merely our ability to understand others and to react in such a way towards them that the end desired should be attained. High social intelligence is possessed by those who are able to handle people well. Adequate adjustment in social situations is the index of social intelligence.

### 1.4.4 THEORIES OF INTELLIGENCE

Philosophers and Psychologists developed various theories as regards the nature of intelligence. Philosophers developed the concept of single factor or monarchical theory of intelligence which believes that intelligence consists of a single factor which equally works in all situations of life. The representative theories of intelligence are given as follows:

**Faculty Theory**

Faculty theory is the oldest theory regarding the nature of intelligence. This theory flourished during 18th and 19th century. According to this theory mind is made up of different faculties like reasoning, memory, discrimination and imagination etc. These faculties are independent of each other and can be developed by vigorous exercise of the difficult subject matter. This theory of the nature of
intelligence gave birth to a new theory of education, popularly known as mental discipline theory. Faculty theory had been under criticism by experimental psychologists who disproved the existence of independent faculties in the brain.

**Two-Factor Theory**

Two-factor theory was developed by an English Psychologist, Charles Spearman in 1904. He proposed that intellectual abilities were comprised of two factors, General ability or Common ability known as ‘G’ factor and group of Specific abilities known as ‘S’ factor.

Characteristics of ‘G’ (a) It is universal inborn ability. (b) It is general mental energy. (c) It is constant in the sense that for any individual in respect of all the correlated abilities, it remains the same. (d) The amount of ‘G’ differs from individual to individual. (e) It is used in every life activity. (f) Greater the ‘G’ individual is the greater in the success of life.

Characteristics of ‘S’ (a) It is learned and acquired in the environment. (b) It varies from activity to activity in the same individual (c) Individuals differ in the amount of ‘S’ ability.

**Multifactor Theory:** Multifactor theory of intelligence was developed by Thorndike, an American Psychologist. Thorndike was associationists who opposed the theory of general intelligence. He proposed that there are specific stimuli and specific mental responses. Intelligence to him is nothing more than a convenient name for an almost infinite number of
actual or potential specific connections between these stimuli and responses. Differences of intelligence among people are due to the number of connections in the neurological system. According to this theory, there is no general intelligence. Thorndike’s theory is atomistic theory of intelligence. He distinguished four attributes of intelligence.

a) **Level**: This attribute refers to the difficulty of a task that can be solved. If thoughts of all tasks or test items are arranged in sequential order of increasing difficulty, the height that can attain on this ladder of difficulty determines the level of intelligence. Level is the important factor of intelligence which cannot be measured alone.

b) **Range**: Range or width refers to the number of tasks at any given degree of difficulty that it can be solved. Theoretically an individual, possessing a given level of intelligence, should be able to solve the whole range of tasks at that level. Range of intellectual growth is determined not only by level but also by breadth of experience and by opportunity to learn. In intelligence tests, range is represented by items of equal difficulty that cannot measure altitude without range or width.

c) **Area**: Area in a test means the total number of situations at each level to which the individual is able to respond. Area is summation of all the ranges at each level of intelligence processed by an individual. It is in general highly correlated with altitude level.
d) **Speed:** This is the rapidity with which one can respond to test items. Speed and altitude are positively correlated. The co-efficient comes to 50. Speed is much less closely bound up with altitude than the other attributes. Therefore, one should not emphasize speed too much in the intelligence tests.

### 1.4.5 FACTOR ANALYTIC THEORIES OF INTELLIGENCE

**Spearman**

Spearman (1927) was one of the early proponents of a factor analytic approach to intelligence. Spearman proposed a two-factor theory of intelligence to account for the patterns of correlations which he observed among group tests of intelligence. The theory stated that a general factor \( g \) plus one specific factor per test can account for performance on intelligence tests. Any intellectual activity involves both a general factor, which it shares with all other intellectual activities, and a specific factor which it shares with none.

**Thorndike**

Thorndike’s (1927) mentioned his approach to intelligence based on the premise that intelligence is comprised of a multitude of separate elements, each representing a distinct ability. He believed that certain mental activities have elements in common and combine to form clusters. Three such clusters were identified, namely, social intelligence (or dealing with people), concrete intelligence (or dealing with things),
and abstract intelligence (or dealing with verbal and mathematical symbols). However, factor analytic methods were not used to obtain these clusters.

**Thurstone**

The factor analytic theorist who was most divergent from Spearman was Thurstone (1938), who used the centric method of factor analysis. In the centric method, factors are extracted from a correlation matrix in which the first axis passes through the center of gravity of the system. Thurstone extracted the following seven important group factors or as he labeled them, 'Primary mental abilities': verbal meaning, number facility, inductive reasoning, perceptual speed, spatial relations, memory, and verbal fluency. Tests were developed to measure these factors (Primary Mental Abilities Tests). While Thurstone's multidimensional theory at first eliminated g as a significant component of mental functioning, the primary factors were found to correlate moderately among themselves, leading Thurstone to postulate the existence of a second-order factor which may be related to 'g'.

**Guilford**

The most prominent multifactor theorist in the United States is Guilford's (1967). He developed the Structure of Intellect Model as a way of organizing intellectual factors into a system. The model is three dimensional, with one dimension representing Operation categories, a second dimension representing Content categories, and a third
dimension representing Product categories. Thus, intellective tasks can be understood by the kind of mental operation performed and the type of content on which the mental operation is performed and the resulting product. The model proposes five different kinds of operations (Cognition, Memory, Divergent thinking, Convergent thinking, and Evaluation), four types of content (Figural, Symbolic, Semantic, and Behavioral), and six products (Units, Classes, Relations, Systems, Transformations, and Implications). Thus, 120 possible factors (5 x 4 x 6) are postulated in accordance with the model. (The Structure of Intellect Model also is described in Chapters 10, 13, and 16 for the Stanford-Binet, WISC, and WPPSI, respectively).

Guilford’s model has been criticized by Eysenck (1967) for failing to reproduce the essentially hierarchical nature of intelligence test data. Eysenck, following McNemar (1964), noted that the one outstanding fact which recurs in most studies of intelligence tests is the universality of positive correlations among all relevant tests, and the positive correlations between different factors. The failure to mention any central feature in the model thus reduces its value.

Vernon (1961) also had reservations about Guilford’s model. He noted that proof is lacking for the existence of the large number of factors in the model. The model, too, has not been frequently used in other laboratories. Finally, validity evidence is lacking to demonstrate
that the new factors give additional information about thinking in everyday life.

Vernon

A hierarchical theory of intelligence has been developed by Vernon (1950). The highest level is a general intellective factor (g), followed by two major group factors—Verbal-Educational (V:ED) and Practical-Mechanical-Spatial (K:M). Each of these group factors is further broken down into minor group factors. Specific factors, peculiar to certain tests, form the last level. The theory synthesizes the work of Spearman and Thurstone, but gives central importance to g.

Cattell

Cattell (1963) proposed that general intelligence is composed of two factors—fluid intelligence and crystallized intelligence. These factors are viewed as distinct but correlated. Fluid intelligence is a basic capacity for learning and problem solving, independent of education and experience. Fluid intelligence is general to many different fields, and is used in tasks requiring adaptation to new situations. Crystallized intelligence is the result of the interaction of the individual's fluid intelligence and his culture: it consists of learned knowledge and skills.
1.5 THEORETICAL FOUNDATION OF STRUCTURE OF INTELLECT MODEL

Guilford wrote during the past twenty years numerous investigation by the method of factor analysis have brought to light some sixty different abilities having to do with intellectual activities.

Guilford (1967) has proposed a three dimensional model of intelligence. Structure of intelligence model is not hierarchical in nature. Instead it comes in the category of ‘morphological’ models. In more common terminology it is a cross-classification of the abilities.

The cube represents the 3 dimensional factor-analytic matrix of Guilford’s structure of intellect. As shown in Figure 1.1 The model is a structural one, which is used in multivariate analysis, and also serves a taxonomic purpose and indicated how information may interact and be interrelated to give rise to unique kind of intellectual skills of which 120 are hypothesized by the theory.

The three dimension of the model specifies first, the Operation; second, the Content; and third, the Product of a given kind of intellectual act.

There are three ways of classification. The first way of classification is in terms of the kind of mental operation involved in the abilities. Each ability involved simply cognition, memory, divergent production, convergent production and evaluation. Each operation
category of the model gives us twenty four different abilities, parallel to those in every other operations category.

The second way of classification is in terms of area information within which the operations are performed figural, symbolic, semantic and behavioral. Each set of abilities distinguished as to content includes thirty abilities that are parallel to those in every other content category.

The third way of classification is in terms of product. It describes the formal kinds of information. Information takes the form of units, classes, relations, systems, transformations and implications. Any area of information takes different abilities in the form of the various products. There is a set of twenty abilities in each product category which are parallel with those in each of the five other product categories.

It is by putting all three classification together in one cross-classification that we obtain the three dimensional model. Altogether there are 120 cells of cubes in the model, each representing a unique kind of ability. All the mental abilities are factors of S.I. model.

Guilford (1968) wrote ‘when the three cross classifications are combines in the three dimensional model, the interaction of a certain kind of operation, a certain kind of content and a certain kind of product, is represented by a single cell. Each cell is represented its own kind of ability. Ability in any cell is unique by its own through combination of one kind of operation, one kind of content and one kind of product. Theoretically, there are 120 unique abilities, but it should not be
supposed that 120 abilities cover the whole range of intellectual traits because there are reasons of expecting more than this number."
Figure No 1.2: The Cubic Cross-matrix of Factors
1.6 REVISED STRUCTURE OF INTELLECT MODEL

The revised structure of intellect model (SOI model) contains five content properties termed visual auditory, symbolic, semantic and behavioral; six operation entitled cognition, memory recording, memory retention, divergent production and convergent production and evaluation; and the same six products as named units, classes, relations, systems, transformation and implication. Figure No.1.3 shows the changes in the S.I. Model.

The present change has been reported in a 1977 book by Guilford entitled 'Way beyond the IQ: Guide to Improving Intelligence and Creativity'. It involved a separation of figural-content column into 'visual and auditory' categories. These two categories have been originally combined because of the very limited number of auditory factorial abilities that had been reported. The label of 'figural' for the column was assigned in view of the property that two kinds of sensory information have in common. Since that time more auditory abilities have been reported by Feldman (1969) and Horn (1973). These abilities could be filled into the model.

The abilities formerly listed in the 'memory' column had been demonstrated by tests that call for evidence of retention immediately after the exercise of memorizing a set of items. The Kamastra (1971) finding is in line with the distinction that experimental psychologist for some time have made between long-term and short-term memories,
although in their conception, short-term retention lasts only a matter of seconds. In the SOI model, the new column has been called 'memory-retention'. In group testing there seems to be no way of applying the experimental controls that would distinguish the operation of recording and short term retention.

Traditional views of memory have included not only recording and retention but also retrieval of items of information from memory storage. Divergent and Convergent production depend heavily on the retrieval of information from storage, something more seemed to be involved. Now realized that the 'something more' can be accounted for by other SOI features and that one may regard the two SOI functions as operations of retrieval broad search in the one case and focused search in the other.

The same type of model was found to apply to psychomotor abilities (Guilford, 1958). One dimension pertains to categories of types of movement and the other to parts of the body involved. It would seem logical to hypothesize that the SOI operation and product categories might also apply. Elsewhere Guilford (1985) has pointed out how the SOI categories can account for the phenomena of learning, including reinforcement, problem solving, creative thinking, decision making and speech.
Figure 1.2: The Revised Structure of Intellect Model

Visual
Auditory
Symbolic
Semantic
Behavioural

PRODUCTS
Units
Classes
Relations
Systems
Transformations
Implications

OPERATIONS
Evaluation
Convergent Production
Divergent Production
Memory Retention
Memory Recording
Cognition

Figure 1.3: Structure of Intellect - A Flow Diagram of the Processes

Memory

<table>
<thead>
<tr>
<th>U</th>
<th>MFU</th>
<th>MSU</th>
<th>MMU</th>
<th>MBU</th>
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<td>MBC</td>
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<td>MSR</td>
<td>MMF</td>
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<td>MBU</td>
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<td>MSI</td>
<td>MMI</td>
<td>MBI</td>
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Cognition

<table>
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Evaluation

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<td>ESS</td>
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<td>EMT</td>
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Divergent Production

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<th>DBU</th>
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<td>DSC</td>
<td>DMC</td>
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<tr>
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<td>DSR</td>
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Convergent Production

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<th>NBU</th>
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<td>NSC</td>
<td>NMC</td>
<td>NBC</td>
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<td>R</td>
<td>NFR</td>
<td>NSR</td>
<td>NMR</td>
<td>NBR</td>
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<td>S</td>
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<td>NSS</td>
<td>NMS</td>
<td>NBS</td>
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<tr>
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<td>NFT</td>
<td>NSI</td>
<td>NMT</td>
<td>NBT</td>
</tr>
<tr>
<td>I</td>
<td>NFI</td>
<td>NSI</td>
<td>NMI</td>
<td>NBI</td>
</tr>
</tbody>
</table>
1.6.1. PARAMETERS OF THE SI MODEL AND THEIR CATEGORIES

The structure-of-intelligence model is not hierarchical in nature. Instead, it comes in the category of 'morphological' models. In more common terminology, it is a cross-classification of the abilities. That is to say, it classifies the abilities in three different ways, and the categories of one way intersect with those of the other ways of classification. As the graphic representation of the SI model in Figure No1.4 Shows, one way of classification is in terms of the kind of mental operation involved in the abilities. Each ability involves simply cognition (knowing), memory (or learning 'that sticks'), divergent production (generation of logical alternatives), convergent production (generation of logic-tight conclusions), and evaluation (judging goodness of what is known or produced). Each operation category of the model is shown as including 24 different abilities, parallel to those in every other operation category.

The second way of classification is in terms of content or areas of information within which the operations are performed-figural (concrete, perceived), symbolic (signs, code elements such as numbers or letters), semantic (thoughts, conceptions, or constructs) and behavioral (psychological). Each set of abilities distinguished as to

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The content categories describe the basic substantive kinds of information from the Psychological point of view; the product categories describe the formal kinds of information. Information takes the form of units (seggregated chunks), classes (common properties within sets), relations (meaningful connections), systems (organized patterns), transformations (changes, transitions), and implications (information suggested by other information).

1.6.2 DEFINITIONS OF THE PARAMETERS AND THEIR CATEGORIES

Formal definitions of the parameters and their categories are given below, with examples of abilities representing them and with other elaborations to follow. Letter symbols applied to various categories are also given here.

**Operations:** Major kinds of intellectual activities or processes; things that the organism does in the processing of information. Information is being defined as ‘the organism discriminates’.

**Cognition(C):** Immediate discovery, awareness, rediscovery, or recognition of information in its various forms, comprehension or understanding.
Memory(M): Fixation of newly gained information in storage. The operation of memory is to be distinguished from the memory store.

Divergent Production(D): Generation of logical alternatives from given information, where the emphasis is upon variety, quantity and relevance of output from the same source. Likely to involve transfer recall (instigated by new cues).

Convergent Production(N): Generation of logical conclusions from given information, where emphasis is upon achieving unique or conventionally best outcomes. It is likely that the given (cue) information fully determines the outcome as in mathematics and logic.

Evaluation(E): Comparison of items of information in terms of variables and making judgments concerning criterion satisfaction (correctness, identity, consistency, etc).

Contents: Broad, substantive basic kinds or areas of information.

Figural(F): Pertaining to information in concrete form, as perceived or as recalled in the form of images. The term 'figural' minimally implies figure ground perceptual organization. Different sense modalities may be involved-visual, auditory, kinetic and perhaps others.

Symbolic(S): Pertaining to information in the form of denotative signs having no significance in and of themselves, such as letters, numbers, musical notations, codes, and words (as ordered letter combinations).

Semantic(M): Pertaining to information in the form of conceptions or mental constructs to which words are often applied, hence most notable
in verbal thinking and verbal communication, but not necessarily dependent upon words. Meaningful pictures also convey semantic information.

**Behavioral (B):** Pertaining to information, essentially non figural and nonverbal, involved in human interactions, where the attitudes, needs, desires, moods, intentions, perceptions, thoughts, etc. of others and of ourselves are involved.

**Products:** Basic forms that information takes in the organism’s processing of it.

**Units (U):** Relatively segregated or circumscribed items or ‘chunks’ of information having ‘thing’ character. May be close to Gestalt Psychology’s ‘figure on a ground’.

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

**Relations (R):** Connections between items of information based upon variable or points of contact that apply to them. Relational connections are more definable than implicational connections.

**Systems (S):** Organized or structured aggregates of items of information. Complexes of interrelated or interacting parts.

**Transformations (T):** Changes of various kinds (redefinitions, shifts, transitions, or modifications) in existing information.
Implications(I): Circumstantial connections between items of information, as by virtue of contiguity, or any condition that promotes 'belongingness'.

1.6.3 THE SI CODE SYSTEM

Each SI ability is often designated in terms of its special trigram composed of a letter for each of its parameters-its operation, content, and product, in that order. For example, CMS is a shorthand expression for 'Cognition of Semantic Systems,' and EFT is the label for 'Evaluation of Figural Transformations'. Some letters happen to be used twice, but never for categories of the same parameter-for example, MMR means 'Memory for Semantic Relations'. And NSS means 'Convergent Production of Symbolic Systems'. Keeping in mind the order of the three parameters in a trigram should help the reader avoid confusions. The code system is summarized in Table No 1.1.

**TABLE NO 1.1: Trigram Convention of Representing Convergent Ability Factors**

<table>
<thead>
<tr>
<th>Operation</th>
<th>Content</th>
<th>Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>C - Cognition</td>
<td>F - Figural</td>
<td>U - Unit</td>
</tr>
<tr>
<td>M - Memory</td>
<td>S - Symbolic</td>
<td>C - Class</td>
</tr>
<tr>
<td>D - Divergent production</td>
<td>M - Semantic</td>
<td>R - Relation</td>
</tr>
<tr>
<td>N - Convergent production</td>
<td>B - Behavioral</td>
<td>S - System</td>
</tr>
<tr>
<td>E - Evolution</td>
<td></td>
<td>T - Transformation</td>
</tr>
</tbody>
</table>

| I - Implication            |               | I - Implication |

42
1.6.4 TRIGRAM CONVENTION OF REPRESENTING FACTORS

As it appears that the three dimensions model having 4 contents 5 processes and 6 products can suggest of 4x5x6=120, mental abilities which can be found through the model. Each process in the model, for example, convergent will act upon each content say Symbolic to produce each type of product, for example, Implications that is convergent production of symbolic Implications.

Thus, each quality drawn through the model will represent the three characteristics of these facets. Guilford has used various single letters to represent these three characteristics of the faces.

The abilities drew through combination of operation- convergent four types of contents-figural, symbolic, semantic and behavioral to give rise to twenty four products. These Products are clearly shown in the partial representation of S.I. Model in figure No 1.3.

1.7 THE NATURE OF CONVERGENT THINKING

Generating new information from given information is the characteristic of convergent thinking. The problem focuses on the production of an answer that is determinate or is desired by another as in the instance of making the correct choice on a multiple choice test. In a social behavior a conforming response to social expectations represents
convergent thinking. A large part of the creative production in science, mathematics and engineering is 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 (Guilford, Fruchter, and Kelley, 1959).

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. Convergent components are apparent in creative thinking, if some criterion of success other than number and diversity of response is applied. A component of creative thinking includes abilities in the convergent production category (Guilford, 1959; Guilford and Merrifield, 1960).

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 relationship for examples, are generally measured as an aspect of the education of correlates through the usual analogies test (Guilford, 1956).
1.8 ANALYSES OF CONVERGENT PRODUCTION ABILITIES

Convergent production is the less explored regions of intelligence. Table No1.2 shows 24 hypothesized abilities, 13 have not been investigated. The symbol’s in the table usually means only three or four investigations in which signs of the factors have been revealed. In 5 instance, Convergent Production have been suggested as an age of fourteen (EI-Add.1963), and an in 2 instances at an age as young as six (McCartin & Myers, 1965) Scott and Ball (1964) were able to interpret a few factors found in infant and pre-school test as convergent abilities.

TABLE NO 1.2: Matrix of the Convergent Production factors
(N) represented in the structure of intellect

<table>
<thead>
<tr>
<th></th>
<th>Figural (F)</th>
<th>Symbolic (S)</th>
<th>Semantic (M)</th>
<th>Behavioral (B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>U</td>
<td>NFU</td>
<td>NSU</td>
<td>NMU</td>
<td>NBU</td>
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<tr>
<td>C</td>
<td>NFC</td>
<td>NSC</td>
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<td>R</td>
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<tr>
<td>I</td>
<td>NFI</td>
<td>NSI</td>
<td>NMI</td>
<td>NBI</td>
</tr>
</tbody>
</table>

Convergent production is in the area of logical deduction convergent production rather than divergent production is the prevailing...
function when the input information is sufficient to determine a unique answer.

1.9 MEASUREMENT OF CONVERGENT PRODUCTION ABILITIES

i) Convergent Production of Figural Classification (NFC)

David Rapport, M. Gill, and R. Schafe (1945) drew a shape distinction between ‘active’ and ‘passive’ concept formation. The Rapport modification of the Goldstein-Scheerer object sorting test has two parts for active sorting, requires ‘E’ to sort objects into classes, and the second part of passive concept formation, requires ‘E’ to watch a sorting being done and then to define the class the examiner has produced. The active-sorting score on part I involves factor NFC.

ii) Convergent Production of Figural Transformation (NFT)

The first hint of a factor NFC came in Thurston’s analysis (1944) of what he called perceptual abilities. One of his factors called ‘Gestalt flexibility’ was characterized by Hidden Picture test and two forms of Gottschaldt-figures tests.

Thurston’s experience with his Gestalt – flexibility factors, when a Gottschaldt-figures test has appeared in analysis without support from other test of NFC. Like Thurston’s Hidden Pictures of Hidden faces task, it has gone in different directions, none of them recognizable as NFC. Whenever a Gottschaldt figures test and a hidden-pictures test
have appeared together in an analysis, a factor that can called NFT emerges. It fits cell NFT because it is convergent a transformation does occur, in the form of revision of the interpretation or use of lines.

iii) **Convergent Production of Symbolic Implication (NSI)**

The factor NSI involve drawing logic-light deductions from given information. In psychology, such deductions exist only in the convergent production area of abilities and functions.

The first trace of factor NSI appeared in the first exploratory analysis of reasoning abilities in the Aptitudes Research Project. The factor was marked, by Form Reasoning test. In this test ‘E’ is presented with a set of simple equations based on the combinations of figures, two at a time, to give other single figures. Using this information ‘E’ is to solve problems that consist of combinations of three figures, each in a multiple choice type of item. The first two of these figures imply another figures, and this other figure combined with the third implies still another.

A second test of factor NSI is sign changes test. E is to solve simple arithmetical equations under the special instruction that be is to replace one of the operation signs with another.

iv) **Convergent Production of Semantic Unit (NMU)**

Much earlier, Carroll (1941) had found a factor common to two tests, Color Naming and Form Naming. The Guilford considered this factor to be NFU, in the SI system, but they suggest that this factor
might be treated as NSU, DSU and NMU. One reason is that in the color Naming and Form Naming test it is not actually figural units that are being produced; It could be either symbolic or semantic units, third test was Giving first Naming test which should emphasize factor DSU. A forth test was phrase completion, in which E gives a word to complete a phrase, suggest, factor NMU.

Since no study has been aimed significantly to investigate factor NMU and no test have been developed. It has happened for certain cognitive abilities have contributed to the findings of this factor. Tests for factor NMU have been picture Group Naming and Word Group Naming test.

v) Convergent Production of Symbolic Relations (NSR)

The most consistent test for factor NSR has been correlate completion II. In an early analysis of reasoning abilities in the Aptitudes Research Project, a test Correlation completion was employed. It was designed after the abstraction test in the Shipley-Hartford scale for the assessment of intellectual deterioration with curiosity as to what type of reasoning might be involved in the test. The test helped to determine a factor that was described as ‘education of correlate’. When the distinction between symbolic and semantic abilities became apparent, it was realized that correlate completion contained items of both kinds of information. Correlate completion II designed with symbolic information only.
Canisia (1962) found two kinds of tests for fit the definition of NSR. First test was Algebraic Inequalities which require deduction of an inequality from two given algebraic statements and the second test was Formulas and Figures test which requires association of algebraic statement with a given figure. These tests require productive thinking.

vi) Convergent Production of Symbolic System (NSS)

Factor NSS has been demonstrated in four analyses, with a specifically designed test named as word changes test. In this test E asks to go from a given word to another given word by changing just one letter at a time. This test has not always been free from secondary factor variances, which have not been consistent, except that they have always been symbolic.

vii) Convergent Production of Semantic Transformation (NST)

The first thinking of factor NST was seen in analytical study of flexibility. A test called Camouflaged words designed by analogy to the NFT. The factor was probably a confounding of NET and NST, but it was promise of the possibility of demonstrating NST. Camouflaged Words and word Transformation test have together marked a factor NST. In camouflaged Word test E is to find out and circle the concealed of sport of games in the given sentence. Where as in Word transformation test only phrases or parts of sentences are given and ‘E’ is to make complete regrouping to form new words.
viii) Convergent Production of Semantic Class (NMC)

Factor NMC was found but represented poorly, in only one analysis (Merrifield et al., 1962). Tests were designed for an ability hypothesized as the production of classes, in connection with an analysis of abilities believed to be pertinent to problem solving. The successful test was Word Grouping. In this test 12 common words to be presented and E classify them in a specified number of classes. The words were so chosen that there is only one reasonable set of class and no word is to appear in more than one class.

Another test called Figure Concept was helped to determine the factor NMC. This test presented a relatively large number of pictured familiar objects, with E to form as many classes composed of two or three members each.

ix) Convergent Production of Semantic Relation (NMR)

As stated in NSR, the first form of correlate completion was instrumental in bringing out a factor of education of correlates, which may have been a confounding of NSR and NMR. After the semantic items had been eliminated to produce correlate completion II, the letter continued as a marker for NSR but had no further apparent relationship with NMR. No semantic-correlate completion test was constructed. Instead of this test Verbal Analogies Completion test was constructed. In this E has to supply his won answers. There is still no univocal test
for NMR, but there seems little doubt about the repair ability of this factor.

**x) Convergent Production of Semantic System (NMS)**

The leading ordering test on the factor NMS was picture arrangement, a test borrowed from Abkins and Lyerly (1951). Picture arrangement presents problems of putting the parts of a cartoon strip are presented in randomized order, with E to indicate what the correct should be.

Another test was Sentence order test. It gives three sentences each of which is a natural step in some series of events. E indicates the correct order of events by writing 1, 2 and 3 in appropriate blanks. This has been a fair test for NMS.

Temporal ordering was next best test for NMS. This test presents a problem that takes a number of successive steps in a logical or practical order.

**xi) Convergent Production of Semantic Transformation (NMT)**

In the investigation of abilities entering into creative production, a hypothesized factor was termed redefinition, a concept borrowed from Gestalt Psychology. The test for this factor was Gestalt transformation in which 6 is asked to select one of the five objects that could be used in whole or in part to accomplish some unusual purpose for that object.
The second test for this factor was object synthesis, in which E is given two common objects with which, he is to make something else that is useful.

The third test was Picture Gestalt, shows photograph of an ordinary room, and E is told to suggest what object he would use for accomplishing each of several purposes.

These three tests performed as expected, and in later analysis one or more of them have helped to mark the recognized factor NMT. Evidently the best test for this factor has not yet been written.

xii) Convergent Production of Semantic Implication (NMI)

There are only slender threads of evidence for factor NMI. The first test for this factor was Sequential Associations, which as designed for a study of problem solving abilities.

A second test very weakly determines this factor. This was Attribute Listing II, in which E is to list the essential attributes of an object that is needed to achieve a stated purpose.

1.10 THE NATURE OF DIVERGENT THINKING

Guilford's with the help of his intellect model differentiated intelligence and creativity and substituted them by the terms convergent and divergent thinking abilities respectively. Convergent thinking is characterized by rigidity, conformity and unquestioning acceptance of authority. It is a stereotyped behavior.
On the other hand, divergent thinking is a kind of healthy departure from the beaten track. It stimulates a questioning frame of mind and discourages blind acceptance. One does not take things for granted. It is a goal-directed activity aimed at a destination one is only dimly aware of. One becomes venture some and exploratory rather than being a slave to conventional mode of thinking.

In other words convergent thinking is 'Closed system thinking' while divergent thinking is 'Open system thinking'. Each are problem solving. But convergent thinking leads to find only one correct answer from the already given test items. While divergent thinking leads to find new, various answers without already given any answer to test item.

Thus, in convergent thinking the answer is already known to everybody, but in divergent thinking the answers are not known to any body of any test item.

1.11 ANALYSIS OF DIVERGENT PRODUCTION ABILITIES

Divergent–Production tests typically provide E with an item or items of information from which to start and instructions to supply a quantity of different items of information the nature of the information depending on the task some of the tests for example, tests of fluency of production, are highly speeded hence quantity of production is
especially emphasized in other tests criteria of quality are applied in scoring.

TABLE NO 1.3 : Matrix of the factors of Divergent Productions

<table>
<thead>
<tr>
<th></th>
<th>F</th>
<th>S</th>
<th>M</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>U</td>
<td>DFU</td>
<td>DSU</td>
<td>DMU</td>
<td>DBU</td>
</tr>
<tr>
<td>C</td>
<td>DFC</td>
<td>DSC</td>
<td>DMC</td>
<td>DBC</td>
</tr>
<tr>
<td>R</td>
<td>DFR</td>
<td>DSR</td>
<td>DMR</td>
<td>DBR</td>
</tr>
<tr>
<td>S</td>
<td>DFS</td>
<td>DSS</td>
<td>DMS</td>
<td>DBS</td>
</tr>
<tr>
<td>T</td>
<td>DFT</td>
<td>DST</td>
<td>DMT</td>
<td>DBT</td>
</tr>
<tr>
<td>I</td>
<td>DFI</td>
<td>DSI</td>
<td>DMI</td>
<td>DBI</td>
</tr>
</tbody>
</table>

At present parallel steps of factors in three content areas, as shown in Table No 1.3. Factors pertaining to divergent production of figural and symbolic information have been investigated only recently (Gershon et al., 1963).

**DFU—Figural fluency**: The ability to produce figural units rapidly, given a few elements from which to start or to use in composing those units.

**Sketches**: Given a simple figure, such as a circle or an angle, repeated 12 times, E adds a minimum to make each one into different objects.
Making Figures: Given three lines, for example, two short, straight lines and a curved line, E makes as many as different combination as he can in limited time.

Making Marks: E makes simple figures of a specified kind, for example, open figure composed only of curved lines, in limited time.

DSU-Word fluency: The ability to produce rapidly words that conform to some simple literal specification.

Suffixes: E writes words ending with a specified suffix, for example ‘-sion’.

Word Fluency: E writes each containing a specified letter, for example, the letter ‘S’.

First and Last Letters: E writes words beginning and ending with specified letters, for example, ‘r-l’.

Prefixes: E writes words beginning with a specified prefix, for example, ‘sub-;

Tests designed for factor CSU frequently have variances of substantial amounts attributable to factor DSU. In cognizing a word under difficult circumstances, being able to run over a list of similar words fitting the incomplete information given is an aid in recognizing the words.

A broader conception of factor DSU is provided by Majewsla’s (1960) finding that a test requiring a rapid production of number combinations to meet specifications is also loaded strongly on the factor.
indicating that the factor needs a broader connotation than its original one of 'word fluency'.

**DMU-Ideational fluency:** The ability to produce a quantity of ideas, relevant to given information but not necessarily of high quality, in response to a given idea.

**Ideational Fluency:** ‘E’ writes names of things fitting relatively broad classes, for example, things that are white and edible.

**Topics:** E writes ideas about a given topic, for example, working on the railroad.

**Brick Uses (fluency):** E lists uses for a common brick, the total number of responses being the score.

**Plot Tittles (nonclever):** E lists appropriate for a given short story (The number of clever responses is uses in scoring for another factor, DMT.)

**Consequences (obvious):** E lists consequences he can see from a proposed unusual event (The 'remote' consequences are scored for another factor, DMT).

**DFC-Figural spontaneous flexibility:** The ability to shift readily from one class of figural information to another.

**Varied Figural Classes:** Given a collection of three figural objects that can be conceived as representing different classes, E decides which of five single figures can be classified in different ways with the three.
DSC-Symbolic spontaneous flexibility: The ability to shift readily from one class of symbolic information to another.

Number Grouping

Given a set of several number, E groups at least three of them to a class, the same numbers being needed in different classes, for example, the list: 2,3,4,6,17,23,36.

DMC-Semantic ‘spontaneous flexibility’: The ability to shift readily from one class of verbally meaningful information to another. This was the first of the three similar factors to be demonstrated and it is much more firmly established.

Brick uses (shifts): E’s list of uses is scored for the number of items he goes from one class of uses to another in two consecutive uses for example, the uses ‘build a house throw at a cat make a doorstop make a tombstone for a bird’ given consecutively [one after another] represent three shifts a string of uses of bricks in building things would have no shifts.

Alternative uses (a revision of unusual uses): E is to list as many as six uses for an object such as a newspaper other than the common use which is stated with the item.

DSR-Symbolic Relation: The ability to produce a variety of symbolic relations or a variety of symbolic correlates.

Letter Group Relations: Give a set of four letters that are related to one another in several ways selects other sets of four that have the same
relations for example given set C A E F, which of the following groups exhibit any of the same relations? WLSD PIOS ADMU MVBQ answer: all except the last groups qualify.

**Number Rules:** Given a starting number, E relates one of more numbers to it achieve a given result for example, starting with 2 arrive at 6 answer 2+4, 2x3 and 2x2+2.

**DMR Associational Fluency:** The ability to produce a variety of verbally meaningful correlates.

**Associational Fluency:** E writes synonyms for given words for example, for the word ‘hard’. Possible answers difficult tough, heartless, brittle, solid, etc.

**Simple Insertions:** E supplies a variety of appropriate words each to fill blanks in a given simile for example, The ‘fog is as ---as a sponge’ possible answers soft dense opaque full of holes etc.

**DFS–Figural Systems:** The ability to organize figure elements for example, lines into larger wholes.

**Making Objects:** Given a few figures and lines, E is to construct from them with nothing added specified meaningful objects.

**Monograms:** Given three initial letters, e.g., A.V and O, E is to invent a variety of monogram designs.

**Designs:** Given five figure elements for example, a line curve a dot an angle and a circle is to combine them in various ways to produce designs them such as appear on wallpaper linoleum or fabrics. The tests
monograms and designs also have strong secondary loading on factor DFU the making figures test in the DFU list also has significant secondary loading on DFS these result might be interpreted as indicating a substantial correlation between factors DFU and DFS as oblique rotations of these two axes would suggest. The writer’s interpretation however is different in line with a general principle of interpretation in such instances. It is probable that in the overlapping between tests of DFU and DFS there is much uncertainty whether an examinee treats combinations of lines as units or as systems. Complex units may be treated as units or as systems. Complex units may be treated as systems and simple systems may be taken as units. It may be predicted that tests involving more exclusively simplified units on the hand and tests involving more exclusively complex systems on the other word show a wider separation between tests of the two factors DFU and DFS.

**Making Codes:** E invents variety of code systems, using numbers and letters.

**Number combinations:** Given a few simple numbers for example, 2,3,4,5,6, E constructs as many correct equations as he can. An equation is kind of symbolic system.

DSS is one of the most tenuously identified factors. Tests were designed for it with SI specifications in mind but only the two listed here were used to represent it. Although it emerged in 3 populations of
ninth grade students it failed to show up analysis based on result from a sample of girls of only. Better tests and further verification are needed.

**DMS- Expressional Fluency**: The ability to construct meaningful patterns of ideas.

**Expressional Fluency**: E constructs a variety of four word sentence given four initial letters no word to be used more than once, for example, ‘W__f__r__d__’

Possible answer who found rover dead

**Simile interpretation**: E completes a statement involving a simile in a number of ways with explanatory remarks, for example, ‘women’s dress is like the autumn:

It _____’

Possible answer ‘is highly colourful’.

**Word Arrangements**: E writes a number of sentences each containing four specified words.

It should be said that the factor expression fluency has sometimes appeared. Therefore in cell DSS with the idea that the construction of phrases and sentence or organized discourse is a matter of grammar and syntax hence is symbolic in nature. The finding of a factor better qualified for the cell DSS has forced the relocation of expressional fluency in cell DMS. If this is the correct location for the factor tests of expressional fluency for measure an ability that should be of very great importance. Activities such as programming (except for its symbolic
theory aspect), story telling and even scientific theory buildings should depend on ability DMS

**DFT-Figural Adaptive Flexibility:** The ability to redefine or reinterpret figural properties for example, of lines in a number of ways so as to permit new approaches to a problem.

**Match Problems:** Given a set of adjacent squares or triangles of the same size each away a specified number of matches to leave a specified number of squares (triangles) with no matches left over solving each item in as many as four ways, others forms of match problem tests also measure this factor. In one form the number of matches to be removed is specified but number of squares to be left is not. In another form the number of squares to be left is specified but the number of matches to be removed in not still another form emphasizes more drastic insights such as being left with both large and small squares and having squares left inside other squares.

**Planning Air Maneuvers:** E selects the most direct path for an airplane in ‘sky-writing’, two–letters combination (capital letters) considerable trials and errors are required, to arrive at solutions. Each new trial can be assumed to be a varied approach with revision of how things appear.

**DMT-Originality:** The ability to redefine or interpret verbally meaningful information so as to achieve varied results of high quality.
**Plot Titles (Clever):** The score is the number of title the fox and the would be rated as nonclever, but titles such as ‘the fox griped about grapes’ or ‘the outfoxed fox’ would be rated clever. Not that both the clever titles involve this is very common with titles transformations in meaning this is very common with titles rated clever.

**Consequences (remote):** E gives remote consequence (distant in time or in sequence of events or in space) to proposed events. The score measures originality, probably because the task entails some unusual reinterpreations of the event.

**Symbol Production:** E is to given simple symbols to stand for the meaningful of words as for the italicized words in the sentence ‘Issue the order’. It is likely that E has run over different connotations of each concept in order to find one that translates readily into figural form.

**Riddles (Clever):** 'E' has to give a clever answer to riddles. Example: What city is the favorite of actors? To this he might say ‘Hollywood’, which would not be rated clever, or he might say ‘Publicity’, which would be so rated.

**DFI–Figural Elaboration:** The ability to add reasonable continuations or completions to given figural information.

**Decorations:** Given articles of furniture and other objects in outline form, E is to add internal markings to decorate them. The same object, repeated is to be completed in different design.
Production of Figural Effects: Given a very simple line or two, E is to build upon the given to produce a (no meaningful) figure of some degree of complexity. Scoring is in terms of the amount of linear information added.

Figure Production: Some as the previous test, except that E is to end with a meaningful object: scored similarly.

DSI- Symbolic Elaboration: The ability to extend given symbolic information is several ways.

Limited Words: Given two common words, E is to make a number of new word pairs from the letters included, using all the letters, as given, for example, 'shirt, bears, thin,' etc.

Symbol Elaboration: Given two simple equations involving letters E is to deduce a variety of other equations that follow from them, e.g., 

\[ V=R+K \] and \[ T=K\times C \]

DMI-Semantic Elaboration: The ability to produce a variety of ideas implied by a given idea.

Planning Elaboration: E adds detailed operations which are needed to make a briefly outline plan successful. The score is the number of pertinent details suggested.

Possible Jobs: For a symbol that is given, E suggests a number of different occupations or jobs for which it might stand. For example a glowing electric light bulb might symbolize an electrical engineer, a missionary or a night watchman.
1.12. TECHNIQUES TO STIMULATE DIVERGENT THINKING

Brainstorming is a technique which involves generating a list of ideas in a creative, unstructured manner. The goal of brainstorming is to generate as many ideas as possible in a short period of time. The key tool in brainstorming is 'piggybacking,' or using one idea to stimulate other ideas. During the brainstorming process, ALL ideas are recorded, and no idea is disregarded or criticized. After a long list of ideas is generated, one can go back and review the ideas to critique their value or merit.

1. *Keeping a Journal.* Journals are an effective way to record ideas that one thinks of spontaneously. By carrying a journal, one can create a collection of thoughts on various subjects that later become a source book of ideas. People often have insights at unusual times and places. By keeping a journal, one can capture these ideas and use them later when developing and organizing materials in the prewriting stage.

2. *Free writing:* When free-writing, a person will focus on one particular topic and write non-stop about it for a short period of time. The idea is to write down whatever comes to mind about the topic, without stopping to proof read or revise the writing. This can help to generate a variety of thoughts about a topic in a
short period of time, which can later to be restructured or organized following some pattern of arrangement.

3. **Mind or Subject Mapping.** Mind or subject mapping involves putting brainstormed ideas in the form of a visual map or picture that shows the relationships among these ideas. One starts with a central idea or topic, and then draws branches off the main topic which represent different parts or aspects of the main topic. This creates a visual image or ‘map’ of the topic which the writer can use to develop the topic further. For example, a topic may have four different branches (sub-topics), and each of those four branches may have two branches of its own (sub-topics of the sub-topic) ‘Note’ this includes both divergent and convergent thinking.

1.13 **STATEMENT OF THE PROBLEM**

The Problem of the present study entitled as ‘A Comparative study of Guilford’s Convergent and Divergent Abilities among the Students of 9th Standard’

1.14 **OBJECTIVES OF THE STUDY**

1. To compare the Guilford’s convergent production ability factors among the 9th standard students of selected Government and Private schools of Bagalkot and Bijapur districts.
2. To compare the Guilford's convergent production ability factors among the 9th standard students of selected aided and unaided schools of Bagalkot and Bijapur districts.

3. To compare the Guilford's convergent production ability factors among the 9th standard students of selected urban and rural schools of Bagalkot and Bijapur districts.

4. To compare the Guilford's convergent production ability factors among the 9th standard boy and girl students of Bagalkot and Bijapur districts.

5. To compare the Guilford's divergent production ability factors among the 9th standard students of selected Government and Private schools of Bagalkot and Bijapur district.

6. To compare the Guilford's divergent production ability factors among the 9th standard students of selected aided and unaided schools of Bagalkot and Bijapur districts.

7. To compare the Guilford's divergent production ability factors among the 9th standard students of selected urban and rural schools of Bagalkot and Bijapur districts.

8. To compare the Guilford's divergent production ability factors among the 9th standard boy and girl students of Bagalkot and Bijapur districts.
1.15 NEED OF THE STUDY

These abilities are hereditary or genetic which help the individual to learn in the life. The learning is in behaviour, not behaviour. It is a transition from one behavioural status or condition to some other, and it not always improvement. To say that it is improvement of behaviour involves us in volume judgments, which take us beyond basic science into technology.

What is learned is in the form of products of information. Most learning studies that have been emphasized the formation of connections may be interpreted as pertaining to implications. This is true when the connections are either between stimuli or between stimulous and response, particularly, where expectations may be said to be involved. This means that by far the greatest amount of research has been devoted to the formation of implications as the products.

Another kind of product that has received much attention in experimental research is that of classes, as in studies of concept attainment and concept formation. Since concept units of information such learning also applies to the (indirect) formation of units. Particular units are acquired through the process of familiarization. From the fact that almost any kind of product can also become a unit, it is quite common to find that units are formed indirectly through the acquiring of other kinds of product first.
No much effort has been devoted implicitly to investigation of the learning of relations, systems, and transformations, but such learning have not been neglected by any means. Serial learning of almost any kind involves the formation of systems. The discovery of principles involves relations or systems depending upon the complexity of the things learned.

The involvement of transformation in learning is in the Gestalt-favoured types of experiments in which insight is an important feature. The reorganization of a field is a transformations or it involves number of transformations. If we are to go fully along with Gestalt theory of learning, we should see transformation in almost all learning.

It is also possible to see the product of transformation in the Piaget concept of ‘Accommodation’. By the term Piaget that as input information is assimilated, there are readjustments. Readjustments may be kinds of transformation. Since Piaget is not very free with examples of observed events as referents for accommodation, it is difficult to say how much matching there is with the concept of ‘transformation’. One difference between transformation and either reorganization or accommodation is that transformations are also regarded as products of information that can be remembered and utilized later. They are usable later in transformer recall because they are transposable.

The most rudimentary form of classification is seen in the conditioning phenomenon of stimulus generalization, in which the
organism makes the same response to a range of similar stimuli, as if they were equivalent. We define classifying in such a way that similarities are recognized in spite of instance of classification, not even a limiting case. The usual conception of classification does appear to imply differentiated information prior to the classifying act.

Studies aimed specifically the problem of the learning of relation have been rare. The learning of relation came rather suddenly and once it came was not lost. The order of difficulty of learning the various relation concepts, from easiest to hardest was action agent, agent-action, attribute- substance, substance-attribute, genus-species whole part, partwhole and species-genus. The age levels at which 50 percent of the Ss could learn the relations extended over a rather narrow range of one year and three months, around the age of six.

Piaget has great deal to say about the development of class ideas at different stages of childhood but relatively little to say about development of relations, as such. According to him, relations come mostly under the heading of 'seriation' which is concerned with quantitative relation only. Since most of what he has to say on these subjects pertains to genetic development and not specifically to learning.

Reviving items of information from memory storage in order to meet certain objectives is the basis for psychological production, either divergent or convergent. Divergent production is the concept defined in accordance with a set of factors of intellectual ability that pertain
primarily to information retrieval and with their tests, which call for a number of varied responses to each test items. Certain hypothesis about abilities that should be of special relevance for creative thinking (Guilford, 1950) led to the search for abilities having to do with fluency of thinking and flexibility of thinking abilities concerned with the ready flow of ideas and with readiness to change direction or to modify information. The first large factor analysis that was aimed at the investigation of those hypotheses (Wilson et. Al 1954) and others that have followed, have found not one kind of fluency factor but three, not one kind of flexibility factor but two, besides a factor that was called by the term originality. It was recognized that the three fluency factors were probably the same as had been found before; word fluency (Thurstone, 1938a), ideational fluency (Calvin.W. Taylor 1947) and associational fluency (Fructure, 1948 in a reanalysis of Thurstone’s 1938 data)

Garnett (1919) found originality factor and called it as ‘cleverness’ in a study of ratings of many personality traits. The full identification of this factor with one found only in aptitude tests cannot be effected on the basis of evidence. Hargreaves (1927) found that creative imaginations are by no means an undifferentiated ability.

In a study of planning abilities (Berger, et.al, 1957) there was hypothesized an ability to elaborate upon ideas, to fill them out with details. The result added another kind of ability, elaboration, to be
considered along with fluency, flexibility and originality to make up the set that was to become known as divergent production abilities.

The fourth kind of fluency had been added to the list by Taylor (1947). He called it ‘Verbal Versatility’ but it became known later as ‘Expressional fluency’, an ability to produce connected discourse.

Since the divergent production tests require examinees to produce their own answers not to choose them from alternatives given to them, it is not surprising that any such tests would be conspicuous by their absence in modern group tests of intelligence particularly after machine scoring came into the picture. In recent years, it has become known children of high IQ can be either high or low in divergent production tests. Guilford J.P. has developed tests on Divergent production abilities.

Convergent production is 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 task. In divergent production tests there is considerable freedom, but not complete freedom in producing information to serve a purpose. In convergent production there is no freedom if the individual’s productive processes are functioning properly and if he has the information available or can readily construct it.
In view of the apparent importance of convergent production abilities for any activities of life in which rigorous thinking is involved—mathematics, logic, science, engineering and law to name a few. There is a need to push forward in the exploration of this whole area. Guilford, J.P. has developed tests on convergent production abilities.

Guilford SI theory is intended to be a general theory of human intelligence. Its major application has been in personnel selection and placement.

By convergent thinking the students is good at bringing material from a variety of sources of bear on a problem, in such a way as to produce the ‘Correct’ answer. This kind of thinking is particularly appropriate in science, maths and technology.

By Divergent thinking the student’s skill is in broadly creative elaboration of ideas prompted by a stimulus and is more suited to artistic pursuits and study in the humanities.

With the view expressed above, the investigator is strongly motivated to study on convergent and divergent abilities of 13+ age group of students in relation to the major variables, namely, sex, type of management of schools and location of the schools. Mentioned abilities are very important and these abilities can not be neglected as the Economic growth, Technological development and the Psychological well being of a Nation.
In the present study, investigator intends to study, know and compare the divergent and convergent abilities of the 9th standard students of Bagalkot and Bijapur districts. Therefore, investigator has developed the Guilford’s type tests on Convergent abilities and used K.N.Sharm’s divergent production abilities tests to carry out successfully the present study on the 9th standard students of Bagalkot and Bijapur districts.

1.16 CHAPTER SCHEME

The first chapter of the present study deals with the introduction, concept of thinking, nature of thinking, Tools of thinking, types of thinking, creativity and its methods, types of intelligence, theories of intelligence, theoretical foundation of S I Model, the nature of convergent production, analysis of convergent production abilities, measurements of convergent production abilities, divergent production ability factors, techniques to stimulate divergent thinking, title of the study, objectives of the study, operational definitions of key terms, chapter scheme and limitations of the study.

1.17 LIMITATIONS OF THE STUDY

1. The present study is limited to the students of 9th standard who are studying in Bagalkot and Bijapur Districts only.
2. In the present study 9th standard students of some selected schools in Bagalkot and Bijapur districts have been selected as the subjects of the study.

3. The sample is restricted to 1008 boys and girls studying in 9th standard.

4. The present study is restricted to six talukas of Bagalkot district and six talukas of Bijapur district.

5. In the present study, convergent production ability test items developed by the researcher after consulting books, unpublished dissertations, battery of intelligence tests based on Guilford’s structure of intellectual model and personal experiences of the researcher.

6. In the present study investigator used divergent production ability test battery developed and standardized by K.N. Sharma.

1.18 CONCLUSION

In this topic, investigator has discussed in detail about the concept of thinking, nature of thinking, types of thinking, creativity, creative methods, intelligence and its theories, Nature of intelligence, types of intelligence, structure of intellect model, parameters of S.I. model and categories, nature of Convergent thinking and its abilities, nature of
Divergent thinking and its abilities, Statement of the problem, objectives of the study, need of the study and limitations of the study.

The succeeding chapter speaks about the review of previous studies which are closely related to the present study.