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2.0 INTRODUCTION

Reasoning is the mental activity used in argument, demonstration or proof. It consists in making a new judgement on the basic of judgement or judgements already formed and is commonly defined as "Perceiving relation among judgement or seeing agreement or disagreement among judgements already made. Reasoning is generally associated with formal rules and formulæ of logic, but people even young children, reason without consious realizing that they are doing so, when the child runs towards the door on hearing a hawker, when a dog comes back on seeing the master enter a car, when we put off a engagement or thank a friend for a favour received reasoning is involved.

Reasoning is process or adjustment to a new situation and at a somewhat higher level aims at the solution of problem. Dewen analyses it into five steps: The first step a difficulty is felt or a problem is realized. Unless a problem is felt we do not reason. The second step to examine the object or the situation carefully. Often the problem is stated in the form of a judgement or a series of judgement. Thirdly an attempt is made to solve the problem or to explain the puzzle. Possible causes of difficulty and the several possible solutions are explored and developed. Forthly, one very problem solution is provisionally accepted, and an attempt is made to verify or test it. All implications are examined and compared with facts. In the last step on the basis of proof one solution is finally accepted or rejected. This may be described as thinking a decision or making a judgement.

The decision or final judgement has been reached through a close examination of facts. When a universal judgement is thus arrived at, on the basis of particular facts the method is called inductive and when one start with general truth or statement and proceed to apply it to particular instances the method is
called deductive.

Though, it is possible to analyse reasoning and indicate its most essential steps, people do not analyse their reasoning but also resent other people's effort to do it for them. They reach conclusions by processes which are largely unconscious, or simply jump at conclusions.

Reasoning is a valuable mental activity and in the solution of problems is far superior to the method of trial and error. In the latter the material must be present in the reasoning the material need not be present. The commander plans strategy from the head quarters, hundred of miles behind the front and since the several alternative are mentally tested, it saves great time and energy. The administrator can find out by reasoning the effect of a change in policy before making the change. An Engineer can plan a building less costly and more commodious, the education can choose between policies and methods before putting then into practice by a process of reasoning. Reasoning solves problems and can use the experience of others. Reasoning leads to cultural progress and is an source of individual efficiency and well-beings.

In English the word 'reason' has long head and still has a large number and a wide variety of senses and uses, related to one another in ways that are often complicated and often not clear. However, there is one particular sense of the word in which if, with its synonyms or analogues in other language has figured prominently in philosophical controversy. This is the sense, sometimes distinguished typographically by initial capital, in which the term is taken to designate a mental mental faculty or capacity in which reason might, for example, be regarded as co-ordinate with, but distinguishable from, sensation, emotion or will.

What by means of reasoning, are we in a position to achieve? In this
form it becomes very clear that the question raises at least two highly disputable
issues. First, it is far from immediately clear what reasoning is on what occasion
in what activities or processes, reason is exercised. And second if we determine
- probably with same degree of arbitrariness, what reasoning is, it may very
well remain highly disputable whether this or that can or cannot be achieved
by reasoning presented by Comte in the nineteenth century from the logical
positivism-of recent philosophy.

2.1 THE NATURE AND DEVELOPMENT OF REASONING ABILITY

The most complex form of adjustment of which human beings are capable
is reasoning. Reasoning is productive thinking in which previous experiences
are re-organised, or combined in new ways, to solve a problem. ¹ Reasoning
is then a tool for problem solving and, at the same time, is a form of learning
which involves.

(1) The selection of past experience or the systematic search for
    new information that is relevant to the goal.
(2) The perception of relations, and
(3) The purposeful adaption of means to ends.

It is a process which is characterized by understanding or insight.

The ability to reason is closely related to intelligence. It becomes pertinent,
then to find out how the ability to reason develops and whether it can be
improved by systematic training.

2.1.1 Variation in Reasoning Ability

First, however, it is important to ask whether everyone is capable of
reasoning, in some degree at least or whether some individuals are entirely
incapable of rational behavior. The evidence shows that variation in reasoning
ability is continuous as it has proved to be in other psychological traits. In
other words there is no point that divides the people who can reason from
those who cannot. Differences in reasoning ability are differences in degree. Some individuals can solve more difficult problems than others can manage. Some can solve more problems in a given length of time, some less susceptible to prejudice and emotional impulse, some are more limited in certain fields because they do not possess special aptitudes in sufficient degree, or because their experience in these fields is meagre. Some are less efficient, too because they have not developed a sufficiently flexible method of attack upon problems or because they have not learned how to work effectively. Investigation of all these aspects of problem solving ability shows that human beings very in these characteristics in terms of more or less instead of in terms all or more.

2.1.2 System of Reasoning Ability Improvement

It has sometimes been asserted that problem-solving ability develops instinctively, and that training in reasoning is therefore, either unnecessary or important. In other words, it has been assumed that some individuals grow naturally into good problem solves, while others are not endowed with much capacity for thinking and there is nothing that education can do about it. It is true, of course that problem solving ability is greatly dependent upon native endowment, and that no amount or quality of education could stimulate intellectual attainments beyond a certain limit. But there is good reason to believe that few of us fully utilize our native capacity for learning. The fact that we ordinarily fall short of potential achievement is revealed in many studies of improvement under desirable conditions of practice and motivations. There is good ground for believing that few persons learn to reason most rigorously and effectively without systematic training in the process and a great deal of active experience in solving or attempting to solve problems high proficiency in reflective thinking does not appear by magic not even
the magic of inheritance alone.

2.1.3 Ability to develop Reason Gradually

It was once believed that the reasoning powers develop late and rather suddenly. This concept of mental development was based upon the assumption that the child's capacities to acquire specific skills and to memorize particular items of information develop first, and that only after these powers come to fruition is the child capable of reasoning. This doctrine was much more general a decade or too ago than it is now, although it has not disappeared by any means, and it was probably in considerable part responsible for making the elementary school a "drill school" and for deferring the exercise of higher mental processes until the secondary school period.

The evidence, however, indicates that children pre school, children can reason. Investigations have shown that children as young as three years can discover a principle and apply it to new situations. Five year old children have been able to construct a route to the goal in a maze problem by integrating two isolated experiences. Competence in problem solving increases gradually with age. Older children can solve more complex problems, state their conclusions in better language, and formulate, the reasons for their solutions more cogently. Adults can perform these operations even more effectively. But although young children are limited by immaturity both in inner growth and in experience, they are capable of rational behavior on their own level. In fact, if allowances are made for differences in knowledge, experience and language development, it appears, that children and adults reason in essentially the same fashion. The errors which young subjects make are not different in kind from those which adults exhibit when they meet very unfamiliar situations.

We may conclude, then, that the ability to reason, including the ability to discover relationships and to use previous experience in meeting new situ-
ations, develops gradually. This suggests that there should be no level of education where learning is exclusively devoted to the acquisition of facts or entirely given over to reflective thinking. The two processes should develop together. It is becoming common to see intermediate grade children in the modern elementary school start with a significant question, search for relevant facts in several sources, evaluate the authoritative adequacy of these sources, organize their information and bring the facts to bear upon their problem. This is kind of activity which elementary schools should increase by large amounts, provided the situations can be made meaningful and useful to children at that time.

2.1.4 Difficulties in Improving Reasoning Ability

It is admittedly difficult to learn how to think, the person acquires the ability must do it through hard work. It is true, too, that psychologists have discovered all too little about the higher thought processes and their education. This lack of evidence on the nature of reasoning and improvement of problem solving makes it difficult, for the teacher to guide pupils in the development of critical thinking. But in spite of the lack of scientific data and the difficulty of learning and teaching how to think, there are at least commonsense approaches to the improvement of reasoning which give promise of value. Before discussing these procedures, however we should define problem solving more explicitly, and explore the data on the nature of reasoning which are available in the psychological literature.

2.2 REASONING ABILITY

Reasoning plays a significant role in one's adjustment to one's environment. It controls not only one's cognitive activities but may also influence the total behavior and personality by the proper or improper development of one's reasoning ability. It is essentially a cognitive ability and is like thinking in
many aspects.

* Like genuine thinking, it has a definite purpose or goal.
* It is also an implicit act and involves problem solving behaviour.
* Like thinking, it involves the use of one's previous knowledge and experiences.
* Like thinking, in reasoning also, there is mental exploration instead of motor exploration as it involves mental exploration of the reason or cause of an event or happening.
* Like thinking, reasoning is a highly symbolic function. The ability to interpret various symbols, development of concepts and language aids reasoning.

In view of the foregoing points of similarity, it is not easy to clearly distinguish between thinking and reasoning as separate functions. Reasoning is said to be a productive and advanced stage in the complex process of thinking. In comparison to thinking it may be said to be a more serious and complex mental process which needs a well-organised brain and deliberate effort.

The following definitions given by some eminent scholars can throw more light on the meaning and nature of the process of reasoning.

According to Garrett ⁴, "Reasoning is step-wise thinking with a purpose of goal in mind."

According to Gates ⁵, "Reasoning is the term applied to highly purposeful controlled selective thinking."

According to Woodworth ⁶, "In reasoning, items (facts or principles) finished by recall, present observation or both; are combined and examined to see what conclusion can be drawn from the combination."

According to Skinner ⁷, "Reasoning is the word used to describe the mental recognition of cause-and-effect relationships. It may be prediction of
an event from an observed cause or the inference of a cause from an observed event.

According to Munn, "Reasoning is combining past experiences in order to solve a problem which cannot be solved by mere reproduction of earlier solutions.

A close analysis of the foregoing definitions may reveal that reasoning depicts a higher type of thinking which is a very careful, systematic and organised function.

It may follow some logical systematic steps like:

* Identification of the goal or purpose to which the reasoning is to be directed.
* Mental exploration or search for the various possibilities, cause and effect relationships or solutions for realising the set goal or purposes based on the previous learning or experiences and present observations or attempts.
* Selection of the most appropriate possibility or solution by careful mental analysis of all the available alternatives.
* Testing the validity of the selected possibility or solution, purely through mental exercise and thus finally accepting or rejecting it for the actual solution of the problem.

Reasoning may thus be termed as highly specialized thinking which helps an individual to explore mentally. The cause and effect relationship of an event or solution of a problem by adopting some well-organised systematic steps based on previous experiences combined with present observation.

Reasoning is generally assumed to be the crowning achievement of intelligence and hence reasoning ability occupies an important place amongst all mental abilities. Mental abilities if, broadly interpreted, include awareness of sensory
impulses or sensation, the interpretation of sensation of perception, the power to build upon perceptual material not present to the senses or imagination, the ability to recall those things which have been experienced or memory, and reasoning is the highest form of mental ability which includes the formulatings of generalizations drawn form experiences and the dealing with abstractions. According to Vincent,\(^9\) "Reasoning is the ability to utillize past experiences in the drawing of practical or theoretical conclusions, and to solve problems. Problem solving again requires a wide background of experiences i.e. a background of sensation and sense perception, along with the mastery over language. More recollection of past experiences will not help an individual to solve problem. Problem solving requires something more and that is the ability to utillize past experiences to solve problems.

Buckingham defines intelligence as "the ability of acting effectively under given conditions"\(^{10}\) which is closely related with the definition of reasoning given by Vincent\(^{11}\) Vincent further defines problem solving as the form of thinking, known as reasoning. He adds, any use of past experience, of presently available tools, of skills and habits to solve a problem is the form of thinking, generally agreed upon as reasoning. So, any thinking involved in the solution of a particular problem can be defined as a reasoning and that thinking process may be called reasoning process."

Hazlitt,\(^{12}\) however, define intelligence as the, the problem solving organisation, of the mind, according to him general factor in intelligence is the degree to which experiences influence one another. For the infact the recognition of a simple sensory experience becomes or involves a problem, and therefore, the activity or intelligence.\(^{13}\)

From the above discussions it may be more precise to consider reasoning as a type of thinking which involves something more than the immediate use
of a fact or a principle that has been recalled. In it, one approach everything with a question mark in our mind. As Locke has said, \(^{14}\) "Mathematics is a way to settle in the mind habit of reasoning. "The reasoning in mathematics is of peculiar kind and processes a number of characteristics such as simplicity, accuracy, certainty of results, originality, similarity to the reasoning of life, and varification.

2.2.1 Types of Reasoning Ability

Reasoning Ability in mathematics is of two broad types, viz., (i) Inductive reasoning ability and (ii) Deductive reasoning ability.

In the beginning mathematics arises out of practical applications and it is mostly inductive and intuitive. "Mathematics in the making is not a deductive science, it is an inductive, experimental science and guessing is the experimental too of mathematics." Mathematics, like all other scientists, formulate their theories from bunches, analogies and simple examples.

2.2.2 Inductive Reasoning Ability

When the statements or propositions are based on general observation and experience, reasoning is called inductive reasoning ability. When one can show that a particular property holds good in a sufficient number of class, one conclude that it will also hold good in all similar cases. This type of reasoning ability is known as inductive reasoning ability.

In this type of reasoning we usually follow the process of induction. Induction is a way of proving a statement or generalizing a rule or principle by proving or showing that if a statement or a rule is true in one particular case, it will be true in all cases in the same serial order and it may thus be applied generally to all such cases. Therefore, in inductive reasoning one can formulate generalized principles and conclusions on the basis of certain facts and specific
examples. For instance:

(1) Mohan is mortal, Radha is mortal, Karim is mortal, Edward is mortal. Therefore, all human beings are mortal.

(2) Iron expands when heated, water expands when heated, air expands when heated. Therefore, all matter-solid, liquid and gas-expands when heated.

Inductive reasoning may thus be considered to be a type of specialized thinking aimed at the discovery or construction of a rule or generalized principle by making use of particular cases, special examples and identity of elements or relations.

In Mill's view, induction is clearly of central importance, since it is the only possible source of substantive general positions. While the details of his theory are complicated, its main lines may be concisely indicated. All methodical and critical induction rests on fundamental principle of uniformity of nature, namely, that what has happened once will happen again, if circumstances are sufficiently similar. Mill thought that this is a factual proposition which is self derived by a primitive and natural process of induction. We first note a few limited regularities and predict that they will hold in the future. After our prediction come true, we spontaneously generalize, saying that since some events have been found to occur in repeating patterns, all events will be found to occur in repeating patterns. Belief in the uniformity of nature is true derived from, and resolvable into, belief in the existence of less sweeping patterns of occurrences, or into particular causal laws. Mill defined "cause of a phenomenon" as the antecedent or concurrence of antecedents on which it is invariably and unconditionally consequent. "Like the axiom" of the uniformity of nature, the principle that every occurrence has a cause is confirmed by all our experience. It is in fact, simply a more precise way of stating the
principle of nature. The hope of science is to formulate propositions about specific sequences of phenomena that can be relied on to the same degree as the law of causation. And the problem of methodical induction which is the core of the problem of scientific reasoning-aries when it is discovered that the simplest method of induction, often leads to general propositions which turn to be false. We then seek ways of obtaining better results. The fundamental technique is to obtain evidence which will allow us to argue as follows: either A is the cause of a, or else there are some events which have no cause, and since we are certain that every event has a cause, we may be certain that A cause a.

According to Mill, there are four inductive methods, the method of agreement, the method of difference, the method of residues, and the method of concomitant variations. He also discussed a combination of the first two, calling it the joint method of agreement and difference. We use the first two methods of in this way. If we find that A under circumstances BC is followed by abc, while under circumstances DE it is followed by ade, then A cannot be the cause either of bc or de, since they sometimes do not occur when A occurs (and hence by the definition of 'cause' cannot be caused by it). But a occurs under both sets of conditions, hence it could be effect of A. This illustrates the method of agreement. To ascertain of something other than A might be the cause of a we use the method of differences. Will BC without A be followed by a? If not, we have so far confirmed our view that A causes a, for, in the causes we have examined. A is always followed ba, a and a never occurs without being preceded by A. Hence, by the definition of cause ' A is, so far as our evidence goes, the cause or part of the cause, of a-or else there are events without any regular cause.

Science does not rely upon induction and experiment alone. It is only
infrequently, Mill thought, that we will find genuine causal laws, that is, absolutely invariable sequences. More frequently we will find regularities which hold as far as a limited experience shows but which, we have reason to believe, might well not hold under quite different circumstances. These 'empirical laws' are not to be considered basic laws of nature. Much of the practical application of science depends on them, but we cannot claim to have truly scientific knowledge until we can deduce empirical laws from basic laws of nature, showing why the combination of circumstances and renders inevitable the limitations within which the empirical laws hold. This makes clear the aim of science, to discover law of nature and empirical laws, and do connect them, in a deductive system, in such way as to show how the understricted laws would give rise to the regularities reported by the empirical laws. The various sciences are differentiated by the ways in which these two types of laws must be discovered and connected. In some sciences it is possible to discover laws of nature directly, deduce what the empirical laws must be, and then proceed to verify the deductions by checking against experimental data. In others, empirical laws are discovered first, and laws of nature are presented as hypotheses to explain them. These alleged laws of nature are then and tested by deducting further empirical laws from them and testing these deductions. In any science, Maths, however explanation comes to an end when laws of nature are reached, these are simply ultimate facts are to be accepted.

The period called the Dark Ages was destined to an end when Roger Bacon and, a little later, Galileo began performing numerous experiments and critically observing the results. This kind of attempt to learn about phenomena gave rise to inductive reasoning.

Inductive reasoning consists of considering a group of many distinct facts and drawing therefrom a single conclusion. For example: John throws
a block of Oak wood into lake, it floats. He throws a stick of cherly wood into the lake, it also floats. He notices in the swimming pool that Marry succeeds in keeping a float by clinging to a floating board of maple wood. In the history book he sees a man being rescued from the briny deep because he found and along to a raft of wood. These and many similar experiences cause Johny to conclude, by Inductive reasoning that "all would floats when tussed into water".

Frequently a certain without of inductive reasoning is basic to intuitive concluding but, as a whole, the spirit of intuitive concluding is not to search without for bases upon to reason but rather within. On the other hand the spirit of reasoning used by Bason, Galileo and their countless disciples emphasizes outside observation based on many and varied experiments which, however, containing in so far as is possible a single cause and a single effect.

Literally hundreds of significant contributions have been added to man's store house of knowledge through use of inductive reasoning. Reference will here by made to only one monumental achievement that exemplifies an application of inductive reasoning to the quest of knowledge.

Certainly, Inductive reasoning has accounted for much progress. Nevertheless the conclusions reached by inductive reasoning are only probably true.

To the extent that observed separate facts are numberous and truly representative of the area to be tested and the results are completely observed, inductive reasoning is informative. If can, however, never prove anything with absolute certainty, it allows one to draw conclusions that are only more or less likely to be true.

2.2.3 Deductive Reasoning Ability

Deductive Reasoning Ability is based on self-evident truths, postulates, axioms etc. If proceeds from a premise. Here the statements are the products
of mind. This reasoning consists in comparing the statements and drawing
a conclusion therfrom. Whithead has correctly emphasised the place of deductive
reasoning in mathematics by saying "Mathematics in its widest sense
is the development of all types of deductive reasoning."

Deductive reasoning is the exact opposite of inductive reasoning. It
may be defined as the ability to draw logical conclusions from known statements
or evidences. Here, one starts with some already known or established generalized
statement or principle and applies it to specific cases. The following statements
are examples of deductive reasoning.

(1) All human beings are mortal; you are a human being; therefore, you
are mortal. (2) Matter expands when heated; iron being a form of matter,
will expand when heated.

Mill's argument in book I of the Logic in intended to show the mistake
of those who say that deductive inference (as found, for example, in the
syllogism) is entirely useless because it involves petition principle, but at
the same time to take it clear that deduction in general is never the source
of new knowledge. Mill agreed that the conclusion of a syllogism may not
contain more than contained in the premises and that "no reasoning from
a general to particulars can, as such, prove anything, since from a general
principle we cannot infer any particulars, but those which the principle it
self assumes as known."

It is useless to defend deduction by saying that it shows as what would
be implicitly contained in what we already know. Mill's solution to the problem
and his explanation of the value rules of deduction rest on his view that
"all inference is from particulars to particulars" when we reason. All men
are mortal, Jones (not yet dead) is a man, so Jones is mortal, our real evidences
for the assertion that Jones will die is our knowledge that Smith Peters, Wilkins,
and many other individuals who resemble Jones in many respects die. We infer from their deaths to his. The general premise that all men are mortal is not itself our evidence. It is rather a note, or register, of the particulars evidence on which the conclusion really depends, to gether with the prediction that what we have found in cases which we have already observed will also hold in similar cases not yet observed. The real inference, Mill thought, comes in constructing the general preposition on the basis of observation of particular cases. Deduction is to be understood as a way of interpreting the note that has been made of our previous inference. It is valuable because misinterpretation is very easy, but it no more gives us new information than do proposition that are true by definition. Such propositions, which Mill called "verbal" only pull out of a word what was previously put into it, and in the same way, a syllogism simply retrieves from a general proposition a particular one that was previously assumed to be in it. Since there is no real progress of thought in deduction deductive inference is merely apparent inference. Induction is the only procedure that gives us non-verbal general prepositions that go beyond what has actually been observed. Hence, only in induction do we make real inferences.

Mathematical knowledge is no exception to this taking geometry first, as the deductive science per excellence, Mill argued that its conclusions are necessary only in the sense that they necessarily follow from the premises from which they are deduced. But the premises themselves—ultimately, the axioms—are grounded on observation and are generalizations from what we have always experienced. (The definitions are in a some what different position, although an experiential element is involved in the belief that the entities they define, such as a geometric point or line, really exist.) That two straight lines do not enclose a surface is evident to us every time we look at two
straight lines which intersect. The laws of psychology, operating on such experiential data, are sufficient to explain the production in us of the belief that such lines cannot possibly enclose a surface. Hence we need not appeal to intuition or to some other nonexperiential source to explain the belief. Even the inconceivability of the denial of the axioms of geometry does not show, Mill argued, that thdy are not based on experience. For inconceivability is psychological, and the fact that we cannot think of something does not show that thing cannot exist. Mill went on to offer an account of the way in which arithmetic and algebra are found on experience. Here the essential point is that groups of four items, for example, may be rearrangement into, or formed from, two groups of two items each, or a group of three items together with a group of one item. Seeing that this is always so, we come, thought the operation of psychological laws, to believe that 2+2, or 3+1, must be the same as 4. Algebra is simply a more abstract extension of this sort of belief.

This form of reasoning is not nearly as easy to describe as reaching conclusions thought intuition or inductive reasoning, but in its simplest form it is a syllogism. The dictionary defines a syllogism as "an argument stated in logical form, consisting of three prepositions, the first two being called the premises, and the last the conclusion, containing the matter to be proved. If its classic form the first premise is a general statement about a group of objects, it is called the major premise. The second, called the minor premise, is a specific statements about a specific object belonging to the group mentioned in the major premise. The conclusion maintains that whatever is true about the entire group is true of the specific object, belonging to the group.
Illustration:

* All men are mortal - Major premise
* John is a man - Major premise
* Therefore, John is mortal - Conclusion.

If the process of deduction is correctly done, the deduction is said to be valid. Sometimes it is said, the argument is valid. The validity of a deduction (i.e., an argument) cannot easily be tested by using circular diagrams.

Fig. 1. CIRCLE REPRESENTING MORTALS

1. Draw a circle representing mortals.
2. Draw a smaller circle representing all men. By the conditions of the major premise the smaller circle representing all men must be placed wholly within the circle representing mortals.
3. Draw a still smaller circle to represent John. By the conditions of the minor premise the circle representing John must be placed wholly within the circle representing all men.
4. Now, real the conclusion, "John is a mortal" look at Fig-1 and free whether all of the circle representing John is wholly within the boundary of mortals. It is the deduction is said to be valid, if it had not been, the deduction would not have been valid.
Consider the following syllogism in which the deduction is not valid.

According to Henry L. Roediger and Others in their book Psychology have mentioned three types of deductive reasoning.

(i) **Conditioned reasoning**

Conditioned reasoning is the reasoning tired down by some specific condition such as the following.

If there is a solar eclipse, the street will be dark. There is a solar eclipse. Therefore the streets are dark.

(ii) **Categorical reasoning**

This type of reasoning is based on some categorical statements like.

* All Robins are birds.
* All birds lay eggs. Therefore, all robins lay eggs.

(iii) **Linear reasoning**

This type of reasoning involves straightforward relationships among elements. e.g.,

(a) If Ram is taller than Mohan, and Mohan is taller than sohan, Ram is the tallest.

(b) If sita is taller than Gita, and Gita is not as short as Rita, then Rita is the shortest.

2.3 **MEASUREMENT OF REASONING ABILITY**

Although intelligence is a term used a great deal in psychology and education, there is actually no commonly accepted definition of its specific
meaning. A wide range of definitions is used. Some describe intelligence broadly as reasoning ability, while others include the ability to make effective decisions or even to along with other people.

Some individual and group ability tests provide performance. The verbal section of test may measure vocabulary ability, simple arithmatic reasoning ability to identify word similarities and background information.

The idea of an ability test based on factor analysis has proved intriguing to test makers. The several tests of this type have been developed. These are composed of students designed to measure various distinct factors of ability, each item is intended to measure one factor only, rather then several, some of these factors are as verbal comprehension, word fluency, numerical comprehension, general reasoning, deduction, rote memory, meaningful memory, spatial visualization and perceptual speed.

The Dat (Differential Aptitude Test) is designed for grades 8 through 12 and yields eight scores: Verbal reasoning, Numerical Ability, Abstract Reasoning, Space Relations, Mechanical Reasoning, Clerical speed and Accuracy, Language Usage-I, Spelling and Language usage-II, sentences: Quite high correlation have been reported between several of the scores and high school and college achievement, but validity of the scores for differential prediction is relatively low. (Nevertheless the Dat can be useful to an experienced counsellor who will treat it with caution and has knowledge in the field of measurement).

We know that a Reasoning ability is one type of Intelligence test, so this type of measuring intelligence test as a similar type of measuring Reasoning Ability Test (RAT). Intelligence is measured by Stanford Revision of the Binet-Simon Tests. Intelligence is also measured by Group-test, Performance test, the California Mental Maturity Test, The Wechsler-Bellevue Scale, the Detroit Learning Aptitude test and the kuhlmann Mental Development Tests.
are other individual tests which are administered by interviewee.  

2.4 REASONING ABILITY TEST

Through the Twentieth century, attempts to measure intellectual ability, intelligence, has played a pre-eminent role in psychological testing. 'Intelligence, like so many other terms in psychology, is meaningful to most people, but difficult to define precisely. Many definition have been proposed like, the ability to learn, adaptability to new situations, 'reasoning ability' and 'facility' in the use of symbols. Some writers broaden the definition, for example, Thorndike's use of the term abstract, mechanical, and social intelligence and Vernon's distinction between verbal-educational and concrete mechanical intelligence.'  

Intelligence is considered to be a general mental factor named as 'G' by Spearman in 1927. While aptitude is a group factor of mental characteristics as considered by Thurstones. In any activity over and above 'G' some other factors such as verbal reasoning, numerical aptitude, Abstract reasoning are also involved.

If we observe the content of the intelligence tests, the tests themselves are composed of several different types of items like opposite words, spelling, abstract thinking, numerical computation etc. Factor analyses of both general intelligence tests and test betteries of intellectual abilities have confirmed the existance of a number of distinct intellectual abilities. Even if the test is omnibus, a student may score better in some related items and may be found weak in a group of other related items. From this we can conclude that either intelligence is composed of many specific factors or it is a general factor different from specific factors which may be called aptitudes.

There are three important factor theories, namely,

(i) Two factor theory.
Spearman proposed this theory. In which the first factor was general capacity or mental factor 'G'. In addition to this factor there may be one or more specific factors.

(ii) Group factor theory

In this approach there is a general factor, a group factor and one or more specified factors. As for example scores on verbal reasoning test, may consist of 'G' verbal aptitude (a major group factor) and other specific factors like word fluency, writing ability etc.

(iii) Multiple factor theory

Which includes only group factors and specific factors without any mention of general factors.

According to Adems., there are two ways of aptitude testing.

(i) Vocational Aptitude

If means that a combination of trait and ability that result in the person's being well qualified for training in a subject, activity or occupation.

Freeman (6) in eighteenth chapter of his book and Anasti...

(ii) In fourteenth chapter of his book described first the test of vision, Hearing, Motor and manual dexterity, mechanical and clerical aptitude. And they also describe vocational aptitude in nineteenth and fifteenth chapter respectively.

In a narrower as more scientific sense the scientific definition of aptitude would provide for specificity, Unitary composition and the facility of learning of some activity or type of activity.

Here one may note down only major group factors.

As a result of factor analysis studies by Thurstone and by many others 12 ability factor have been confirmed by two or more factor-analysis studies. Admas,
VC - Verbal Comprehension
VF - Verbal Fluency
N - Numerical Reasoning
Rg - General Reasoning
Rd - Deductive Reasoning
Re - Education of Relationship (Analogy of relates)
Mg - Rate memory
Mm - Meaningful memory
So - Spatial orientation
Sv - Spatial visualization
PS - Perceptual Speed
PC - Perceptual Closure

According to Thurstone the factor used in PMA Test Battery are eight as under:

V - Verbal
P - Perceptual Reasoning
I - Inductive Reasoning
N - Number Aptitude
D - Deductive Reasoning
W - Word Fluency
S - Space or Visualization
M - Rate memory

But these are revised in 1962 and so they are reduced to five namely, V.N.R...P and S only. According DAT test battery, these are seven aptitudes which predict scholastic success-in different subjects. The aptitudes are:

VR - Verbal Reasoning
NA - Numerical Ability.
After the types aptitudes the investigator now tries to give the idea of Reasoning Ability Test. The Reasoning ability test as its name implies is a measure of ability to understand concepts of mathematics framed in works. It is aimed at the evaluation of the student's reasoning ability of concepts in mathematics.

2.5 RELIABILITY OF THE TEST

The main purpose of the measurement is to arrive at some standard and precise judgement about an individual. The judgement would be of some value, if it is based on dependable scores earned on dependable test or scale. The dependable test means a reliable test. The term reliability denotes trust worthiness of consistency.

Reliability is one of the important characteristics of a test or scale. In its simplest sense, reliability refers to the precision or accuracy of the measurement or score. A well made scientific instrument should yield accurate result both as present as well as over time. In other words, such an instrument should give consistent results. Reliability refers to the consistency of scores or measurement.

The reliability may be defined as the consistency of scores obtained from one set of measures to another. According to Anastasi, reliability refers to, "the consistency of scores obtained by the same individuals when reexamined with test on different occasion, or with different sets of equivalent items, or
Ebel has given an operational definition of test reliability as follows.

"The reliability coefficient for a set of scores from a group of examinees is the coefficient of correlation between that set of scores and another set of scores on an equivalent test obtained independently from the members of the same group."

This definition implies that reliability is not a property of a test by itself but rather of test when applied to a particular group of respondents. The more appropriate the test is to level of abilities in the group, the higher is reliability of the score it yields.

This operational definition specifies that high correlation coefficient is that it provides a relative, rather than absolute measure of agreement between the pairs of scores obtained from the same persons. If the differences between scores for the same persons are relatively small to the difference between scores for different persons the test tends to show a high reliability. But if the differences between scores for the same person are relatively large to the differences between persons, the scores will show low reliability.

The operational definition calls for two independent measures obtained from equivalent test of the same trait for each member of the group. The above discussion reflects only one aspect of reliability namely adequacy of statement sampling. Another aspect of reliability is concerned with temporal stability the extent to which the original scores could be reproduced on different occasions.

Rammers and Gage have defined reliability as, "The consistency with which a test yields the same results in measuring whatever it does measure".

The definition indicates that there should be stability of the scores for the same individual, if the scale is given repeatedly. In other words the reliable
test gives approximately the same result on two different occasions. This does not mean that there would not be any difference on two successive scores of the same individual obtained at two different occasions. There would be slight fluctuations. These fluctuations would not affect the reliability of a test.

This aspect of reliability indicates that the test should be stable with respect to those factors with operate during the interval time the test and retest to the extent that the two sets of scores are corelated; to that extent the test is reliable. If this correlation is low or insignificant it means that the items are affected by the factors operating in the time interval. However, full proof reliability is still a question since the test is to deal with human being having variety of moods at different time interval. This does not mean that one can be flexible with the 'Reliability' as aspect of the test.

Robert Lado point out: "if the scores of the students are stable, the test is reliable, if the scores tend to fluctuate for no apparent reason the test is unreliable".

In short a scale must show sufficient evidences of reliability. A scale without the statement of its reliability would be of a little value.

Anastasi has rightly said: "Despite optimum testing conditions, however, no test is a perfectly reliable instrument. Hence, every test should be accomplished by a statement of its reliability.

2.6 METHODS OF ESTIMATING RELIABILITY

The reliability is purely a statistical concept. The evaluation of the reliability of a test requires determination of the consistency of repeated measurement of the same individual or group of individuals. In practice, all procedures of estimating reliability of a scale in psychology and education are based upon getting smaller number of measurements, typically only two, for each
individual in a representative group. The stability of the results is achieved by increasing the number of individuals rather than the number of measurement of each. These measurements provide sets of scores, usually two for each individual for analysis. The usual analysis consists of computation of the coefficient of correlation between the two sets of scores, giving an estimate of reliability. This coefficient of correlation is generally expressed as the reliability coefficient of the test.

A number of different methods are used to derive the reliability coefficient. There are three most common methods of estimating the reliability coefficient of test scores. These methods are: (1) Equivalent forms method,

(2) Test-retest method
(3) Spilt-Half method, and
(4) Kuder-richardson method.

2.6.1 Equivalent Forms Method

This procedure is very simple. From the very beginning the investigator has to prepare two equal forms of the scale. These two forms must be very close in similarity. They should be close in matter of content, trait to be measured and processes required for responding the statements and in number of statements. The statements must have equal discriminative power, internal consistency and undimensional ability. The examinee takes one form of scale and then the other form soon after that. In order to control some error variance or practice effect the turns of the form should be rotated. The agreement between the two is determined by means of a correlation coefficient. This method overcomes the limitations of effect to time interval between two successive administrations of the evaluation device. This method is rarely used. Since it is very difficult to have two parallel forms of the same scale. Construction of two equivalent forms needs a lot of time. Therefore this method of estimating
reliability is rarely used.

This method is known as parallel forms method or alternate form method or comparable forms method.

2.6.2 Test-Retest Method

This method of establishing the reliability of the test or scale is indeed very simple and easy. In this method the test or scale is to be administered to the group of individuals representative of the sample on two successive occasions. The interval of time between the administration of the scale on two successive occasions must be short not to allow any great changes in the subjects. Yet long enough, so that they could not response to the scale by memory on the second administration. A pair of scores is obtained for each respondent. The set of scores are then correlated to find out the reliability coefficient of the scale.

Though simple, this method has certain limitations too. This method is a time consuming method of estimating the reliability coefficient. This method assumes that the examinee's physical and psychological set up remain unchanged in both testing situations. But in reality this is not so. In fact, the examinee's health, emotional condition, motivational condition and his mental set up do not remain perfectly uniform. Not only this, the examiner's physical and mental take up also change. Besides, some uncontrolled environmental changes may take place during the second administration of the scale. All these factors are likely to make the total score of the examinees different from the first administration. The reliability coefficient obtained by this method is high, because memory plays a large part in answering the scale at the second time. Besides the memory effects, practice and confidence gained by familiarity with the scale also affect the score on second administration.

When the examinee is once acquainted with the scale and the mode
of answer, he is likely to develop a skill which may help him in the second administration. He is also likely memorise many answers given in the first administration, if the time between two administration is too short. All the acquired skill, knowledge and memory of first time are likely to help examinees in answering them in more or less in similar way the second time thus helping them in retaining their same relative position. If the time between two administration is too long, same significant changes taking place during the time interval would produce low correlation. Thus, the time interval between two administration should be neither too long nor too short. Despite all these limitation, this method is the most appropriate method of estimating reliability, so this method is mostly used.

2.6.3 Split-Half Method

Internal consistency reliability indicates the homogeneity of the test or scale. The most common method of estimating internal consistency reliability is the split-half method. The test is divided into two equal or nearly equal halves in this method. The common way of splitting the test is the odd-even method. In this method all odd numbered items (like 1, 3, 5, 7, 9 etc) constitute one part of the test and all even numbered items (like 2, 4, 6, 8, 10, etc) constitute another part of the test. Thus the entire test would be split-up into two reasonable equivalent halves. Each examinee, thus receives two scores: one score from the all odd-numbered items and the other score from the all even numbered items. In this way from single administration of the single form of the test two sets of scores are obtained. The reliability coefficient is computed.

The advantage of the split-half method is that all data necessary for the computation of the reliability coefficient are obtained in the single administration of the same test is automatically eliminated. Therefore, a quick estimate of
the reliability is made.

A test can be split into halves through different methods and it has been found that each method yields a different coefficient of reliability. Undoubtedly, this is a weakness of the split-half method of estimating the reliability coefficient of a test.

2.6.4 Method of Rational Equivalence

This method was developed by Kuder and Richardson. It is also known as K-R Method. This method is useful for estimating the internal consistency or homogeneity of a test. The Kuder-Richardson (K-R) formulas for estimating \( r_{tt} \) depend upon item statistics. They were developed because of dissatisfaction with split-half method. A test can be split, into two equal halves in great many ways and each split might yield a somewhat different estimate of \( r_{tt} \). The use of item statistics gets away from such biases as may arise from arbitrary splitting into halves. Finally the most accurate and practical Kuder-Richardson formulas is

\[ r_{tt} = \left( \frac{n}{n-1} \right) \left( \frac{\sigma_t^2 - \Sigmapq}{\sigma_t^2} \right) \]

where 
- \( r_{tt} \) = reliability co-efficient of the whole test
- \( n \) = number of items in the test
- \( \sigma_t \) = The SD of the test scores.
- \( P \) = the proportion of the group answering a test item correctly.
- \( q = (1-p) \) = the proportion of the group answering a test item incorrectly.

This formula is called Kuder-Richardson-20. Kuder-Richardson formula 20 is applicable only to tests in which the items are scored by giving on if answered correctly and nothing if not answered correctly. For meeting this
type of requirement, the investigator gave one point to the chosen response true or false of items. Another a simple approximation to formula is often useful teachers and others who want to determine quickly the reliability of short objective class-room examinations. It reads:

$$r_{tt} = \frac{n \sigma_t^2 - M(n - M)}{\sigma_t^2 (n - 1)}$$

where $r_{tt}$ = reliability of the whole test
$n = \text{number of items in test}$
$\sigma_t$ = SD of the test scores
$M = \text{the mean of the test scores}$.

This formula is a labour saver since only the mean, SD and number of items in the test need be known in order to get an estimate of reliability.

Also a less accurate but simpler formula to compute is the Kuder- Richardson Formula 21. This formula can be applied to the results of any test which has been scored on the basis of the number of correct answer. A modified version of the formula is...

Reliability Estimate ($KR_{-21}$) = \frac{K}{K-1} \left( 1 - \frac{M(K-M)}{KS^2} \right)

where $K$ = the number of item in the test,
$M$ = the mean (arithmetic average) of the test scores
$S$ = the standard deviation of the scores.

This formula will yield approximately the same results as Kuder- Richardson Formula 20, but in most cases the reliability estimate will be smaller. Its chief advantage is the ease with which it can be applied.
process of standardization of any scale. Most of the users before selecting
the scale for the use look carefully into the value of validity. Therefore, the
construction of the scale should make clear the concept of the validity.

2.8 METHODS OF DETERMINING VALIDITY

Procedure for determining validity of the test or scale are primarily
concerned with the relationship between performance on the scale and other
independently observable facts about the behaviour characteristics under construction.
There are many techniques those are employed for investigating these relationships.

Anastasi has presented as follows: The APA Technical recommendation
has classified these procedures under four categories, designated as content,
predictive, concurrent and construct validity. Out of these four categories of
validity two namely content and construct or concept validity are described
under the heading of rational validity by many authors. Similarly concurrent
and predictive validity are described under the heading of empirical or statistical
validity.

2.8.1 Construct or Concept Validity

In case of determining the construct validity the first task is to define
the measure. Thorndike and Hagen have rightly, explained what the phase
concept or construct really mean. "Again we are thrown back on rational
analysis but this time we are trying to analyse concept and see what is
implied by it, rather than to make a catalogue of content."

Construct validation is a more complex and difficult process than content
validation and criterion validation. Hence, the investigator decided to compute
construct validity only when he is fully satisfied that neither any valid and
reliable criterion is available to him nor any universe of content entirely satisfactory
and adequate to define the quality of the scale. In other words, construct
validity is computed only when the scope for investigating criterion validity
or content validity is bleak.

Construct validation is also a difficult process because it contains several problems like systematic examination concerning the definition of the construct, unsuitability and inappropriateness of the measures of the construct, lack of high correlations among measures etc. Thus the construct validity is rarely computed.

2.8.2. **Congruent Validity**

This type of validity is essentially estimated by the means of a statistical technique. For this the set of scores on the present scale is correlated with the set of criteria of a similar measure. It means, it is correlated with some available well known powerful scale of the similar nature. The correlation of the new scale with the existing scale would show to what extent the two scales measure the same characteristics. If the correlation coefficient is very high between these, two sets it is inferred that the new scale is valid, since it measures what the criterion scale is supposed to measure. The type of evidence just proposed is somewhat circular; for this, the condition is that the criterion test must be fully valid, otherwise the correlation between two scales would not be much dependable and this type of validity would be misleading.

2.8.3. **Concurrent validity**

The evidence of the validity be obtained from the relationship with other currently obtainable information about an individual. Anastasi 38 has defined the concurrent validity as :"The relation between test scores and indicates of criterion status obtained at approximately the same time is known as concurrent validity."

For determining the concurrent validity the scale is correlated with a criterion which is available at the present time. The resulting coefficient of
correlation will be an indicator of concurrent validity.

2.8.4 Factorial Validity

The factorial validity of a scale is the correlation between the scale and the factor, common to a group of scales or other measures of behaviour. Such validity is simply the factor loading of a particular factor in the scale in question. Such factor loading is also equivalent to the correlation of the scale with factor validity of a given scale is defined by its factor loading and are given by correlation of the scale with each factor.

According to Ebel, "Factorial validity of a test is the correlation between that test and the factor common to a group of tests or other measures of behaviours, such as validity based on factor analysis."
REFERENCES


11. Breckenridge and Vincent, op, cit, P-418.


13. Ibid. P-10.


23. Ibid P-195.


