Chapter-2

CONCEPTUAL FRAMEWORK

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2.1 Introduction:

It was in 1905, when Alfred Binet a French psychologist designed a test on the needs of a Paris school. The test served its purpose and immediately caught attention of American Psychologists in 1916. Terman of Stanford University came up with the revised version of Binet’s test a very well known test named as Stanford Binet test. It served as a model to many intelligence tests. It was in 1920’s, when psychological testing blossomed very rapidly and a usual practice to measure person’s ability by administering a single test, which would yield a single score. This single score known as ‘IQ’ became the base for planning educational and vocational activities in school. But at this juncture question arises is that can we consider intelligence as a single ability?

The research and theories of Thorndike, Kelley, Spearman, Thomson, Thurstone and others have made us increasingly aware that so called intelligence is not a unitary trait but it is composed of many abilities which are present in different individuals in varying amount.

It means that suppose two students have taken a single-score test, which is composed equally of verbal and numerical items. One student answers few items correctly of verbal type and almost every numerical item correct and other student picks up very few points on numerical part but scores good in verbal items. As a result, both students will be said of having
same IQ but they are not same in their abilities this reveals the need of measurement of abilities.

Efforts are made to discover and describe the organization of mental abilities. Numbers of psychologists have done extensive research in this field. Their researches were closely connected with intelligence testing and have utilized factor analysis as the primary research technique. Few of them are discussed here.

2.2 Organization of mental abilities:

There are various views about organization of mental abilities.

2.2.1 Group Factors:

Most of our intelligence test produces one over all score. IQ further shapes our thinking about intelligence as unitary. Extensive study was conducted by Thurstone L.L. (1941). Performing factor analysis of dozens of test given to schoolchildren, he emerged with seven factors. He named the seven factors as:

Verbal meaning, perceptual speed, reasoning, number, rote memory, word fluency and spatial visualization.\(^1\)

Thurstone devised new subtests based on these seven factors and this new set of test was called as “Test of Primary mental ability (PMA)” further, he intercorrelated the scores obtained of PMA with one-another. Co-relation among the tests indicates that there is some general ability,
which is common to all the primary ability. And so he defined intelligence as both some general ability and a number of specific ability.

"This lead to belief that it is possible to describe each individual by at least seven indices which should replace the intelligence quotient, mental age and other scores for overall general intelligence. Each individual should be described by a profile of mental ability instead of by a single index of intelligence. Such a profile composed of the scores in the primary mental abilities is more helpful in educational and vocational counseling than the single composite intelligence rating."(2)

The other theory of organization of mental ability holds that all abilities can be classified into one of two types. This two-factor theory first formulated by Spearman is based on the statistical examination of correlations between various tests. The first factor was recognized as general factor “g” and second kind of mental ability is called specific factor “s”. He inferred that general factor “g” although varies from individual to individual but it remains same for any one individual for all the correlated abilities. At the same time specific factor “s” varies not only from individual to individual but even for any one individual from one ability to another.

So in general it can be said that any mental task involves a certain amount of general ability “g” which is common to all other mental tasks.
and a certain amount of specific ability “s” which is involved in no other mental task.

2.2.2 Guilford’s structure of intellect model:

J.P. Guilford concluded that there are at least 180 possible kinds of “testable” abilities (3) that can be differentiated from one another in three ways by the “content” of the test, by the product or form of the answer the test is expected to give; and by the ‘operation’, or kind of mental process that must be applied to the task given.

2.2.3 Vernon’s Hierarchical Model:

When more complex factor analytic studies were done, it was concluded that there are clearly many more varieties of special ability and they are related to one another in highly complex but orderly ways.

At the top of the hierarchy is “g’ the general factor depending on numerous overlapping bonds rather than a unitary force. There are at least two major factors: the verbal, numerical educational factor and the mechanical spatial, practical factor beneath “g”. Below the broad groups are the Thurstone’s primaries. Guilford’s more numerous primaries are presumably still further down in the hierarchy. Specific factors are at the bottom of the hierarchy. This model indicates that test can be constructed to measure a factor at any level of hierarchy one can move up or down the hierarchy to make the required kind of prediction.
The hierarchical model accommodates numerical ability as a member of "verbal, numerical educational group factor" below "g" and above the primary and specific factors in the organization of mental abilities.

In short, numerical ability is an important component of general mental ability structurally it can be further classified into specific factors but functionally it is a part of scholastic ability. As it is a part of scholastic ability, its measurement is important and useful. So, investigator decided to do a little spadework in this area.

2.3 Aptitude testing:

Studies have pointed the need to measure diverse abilities. Educational psychologists are concerned with matching students abilities with schools or course, industrial psychologists are interested in placing workers in jobs that match their skills and abilities, counselors consider abilities helping their clients in educational and vocational guidance. In these entire situation instead of reliance on a single intelligence score measuring abilities is apparent

To address the above-mentioned scenario, test constructors develop integrated test batteries that measure a small number of quite broad abilities or to construct separate test for each specific abilities.
2.3.1 Multiple Test Batteries:

There are various multiaptitude test batteries. Few are listed here and described in brief.

❖ DAT: (Differential Aptitude Test)

DAT is probably the most widely used multiaptitude battery on the secondary school level. DAT published by The psychological corporation consists of eight separately administered tests. They are verbal reasoning, Numerical ability abstract reasoning, Space relations, mechanical reasoning, clerical, speed and accuracy ad language usage and spelling.

❖ PMA (Primary Mental Ability)

The PMA is important historically because it was developed from Thurstone’s pioneering research on the structure of abilities and was the first multifactor theory. The current revision of battery has five levels covering k-12 grade range.$^{(4)}$ They are verbal meaning, Numerical facility, Spatial relations, Reasoning and perceptual speed.

❖ FACT (Flanagan’s Aptitude Classification Test)

They are two separate though overlapping test batteries the FACT consists of 16 test and Flanagan industrial test consists of 18 test These test were explicitly designed to tap abilities that are important in successful occupational performance.
GATB (General Aptitude Test Battery)

GATB was developed by the U.S. Employment Services, includes several performance measures. Two factors—finger dexterity and manual dexterity utilize performance test and the remaining seven are Intelligence, Verbal aptitude, Numerical aptitude, Spatial aptitude, Form perception, Clerical perception and Motor coordination are measured by paper-pencil tests. GATB was designed for use in pre employment counseling of high school students and adults seeking employment.

2.3.2 Measure of specific ability:

Multiaptitude batteries attempt to measure a wide range of abilities within the context of single, integrated test battery. The another approach of measuring aptitude is of constructing separate tests to measure each specific ability. This type of focus on a specific ability or a small group of related abilities rather than attempting to provide a comprehensive picture of an individual's abilities and skills. The major advantage of constructing specific aptitude tests is that the ability of concern can be measured in more depth and by concentrating on a single ability; one can probe its various facets in detail. As this study attempts to measure a single ability, it was important to identify the nature of numerical ability. Information regarding to the same is given below.
2.4 Numerical Ability:

Human abilities are neither completely specific nor completely general. Various theories are discussed in this chapter, which contribute in making us understand about the organization of abilities. This study is an effort to construct and standardize a tool, which can measure numerical ability of students.

Measure of numerical ability of a student gives us the measure of how well does he understand the ideas expressed in numbers, think and reason with numbers.

According G.K.Bennett, H.G.Seashore and A.G.Wesman “The numerical ability test is a measure of the student’s ability to reason with numbers, to manipulate numerical relationships and to deal intelligently with quantitative materials”

Numerical ability deals with the ability to handle number relationships, concepts and solving problems involving numbers. To measure numerical ability various types of items can be constructed. Test items constructed are essentially computational rather than problem solving. Some of the test items test only proficiency in four fundamental processes where as others require understanding of quantitative concepts and relationships.

Arithmetic concepts play a vital role in numerical ability. This involves use of basic numerical concepts through test items. Conceptual knowledge contributes a lot in speedy and accurate computation. If student
is clear with basic concepts, he can solve a problem in a novel way at a better speed.

It is evident that visualization of numerical pattern gives idea about how easily students can establish relation between the given number pattern, formulate the rule and supply the missing number. This gives us the judgement of student’s inductive reasoning power.

Arithmetic reasoning deals with the ability of students to apply numbers in social situations and make sound judgement with respect to quantitative problems. Here the emphasis is on reasoning in numerical situation. So by constructing test items of such nature it is possible to construct a tool that can measure numerical ability of students. Chapter-5 contains detailed information regarding the components of numerical ability and procedure of tool construction.

2.5 Conclusion:

This chapter throws light upon that so-called intelligence is not a unitary trait but is composed of many abilities. There are various views regarding organization of mental abilities. Some of them were described in this chapter. It was evident from the description that numerical ability was considered as one of the factor, which contributed majorly in deciding IQ of an individual. Vernon’s hierarchical model indicated that test could be constructed to measure the factors present in this hierarchy. Reviewing
theories of organization of mental abilities, it gave the idea about the nature of numerical ability.
Chapter Reference


