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CHAPTER - II

THE VARIABLES OF THE PRESENT INVESTIGATION

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2.0 Introduction

This chapter contains the details about the concept of dependent and independent variables. The outstanding theories of dependent and independent variables had been stated and discussed in this chapter.

2.1 Mathematical Concepts

The key concepts of mathematics from a curricular point of view are those which have wide and powerful application in the development of mathematical knowledge and understanding. In the development of a curriculum of school mathematics, the nature of mathematics as a discipline and psychological theories of learning must be considered. Thus the substantial changes to school mathematics curricula throughout the world since early 1960s, motivated by a need for greater numbers of mathematically proficient persons in increasingly technological societies have been shaped by a rapidly increasing rate of development and use of mathematics and by new knowledge of how children learn mathematical ideas.

Those who have been prominent in research into mathematics learning include Jean Piaget, Robert M.Gagne, Zoltan P. Dienes, R.R. Skep, J.B.Biggs and K.F.Callis, studies have shown that concept acquisition is orderly, sequential integrative and hierarchical (Piaget and Inhelder, 1969). Thus for efficient learning, the curricular sequence of the conceptual building blocks of mathematics should reflect the student's changing cognitive status.
Concepts which begin to be developed in the preschool years and have a general currency in cognitive growth, but which are of special significance in underpinning the class of concepts regarded as mathematical concepts, include classification, conservation, correspondence, seriation, reversibility, and qualitative similarity. Key concepts in mathematics include:

(a) **Set**: This concept of a set provides a basis for the effective and efficient further development of ideas such as inclusion, cardinality, equivalence, and correspondence which are, in turn, prerequisite to the understanding of number.

(b) **Number**: This concept, critical to mathematical understanding, is one of the most difficult and much research has been focused on the process by which children acquire it. Understanding of cardinality requires previous conceptualization of conservation and correspondence, and the notion of seriation is prerequisite to understanding ordinality. Cardinality and ordinality provide the intellectual base for the concept of equality.

For the fundamental operations of arithmetic, the concept of place value has great significance, while extension of number system through integers and rational numbers to real numbers introduces the need for further concepts such as directionality of number and ratio.
Investigations by Mott traced the growth of number concepts in young children.\textsuperscript{1} It was found that 92 percent had developed concepts for numbers from one to ten. The concepts developed by children who had attended a nursery school and kindergarten were superior in quality to those of children who had not had such school experiences. Mott and Martin interviewed sixty-six first grade children, who had previously been tested at the end of their kindergarten period of schooling to determine whether or not number concepts acquired in kindergarten are retained through the summer months.\textsuperscript{2} Only in rote counting in the higher decades was any loss noted. This provided evidence that children, once they have developed certain number concepts, use them in their home and play environment and thus retain them. There is some evidence from this study (which has been substantiated by other studies and in the experiences of qualified teachers) that readiness for number learning depends upon the experiences of the child as well as his degree of maturation.

(c) \textbf{Variable}: The notion of a variable which may be replaced by any element of a prescribed set is central to the understanding and communication of generalized mathematical arguments and to the formulation of mathematical models.

(d) \textbf{Relations and Functions}: The concept of a function, a special class of relations, pervades mathematics. Students must have become familiar with the various points of view from which
relations and functions can be considered - correspondence, sets of ordered pairs, sets of points, tables, mappings, the generation of a set of ordered pairs by rule - before they are ready to understanding the general concept.

(e) Measurement: Few students are ready for the concept of measurement of length before age 7 to 8 years and concepts of measurement of area and volume are acquired still later. An appreciation of the invariance of length and angle measure under isometric transformation is fundamental to the understanding of many school geometry concepts.

(f) Space and Spatial Relationship: The concept of perceptual space developed during the early years is built on to give the concept of representational space needed to demonstrate and mentally manipulate relationships between points, lines, planes, and figures. Initially these manipulations can be tied to motor acts but eventually the concept must be internalized to the extent that complex combinations of transformations can be comprehended. At this level algebraic description of spatial relationships is possible and the concept of locus is introduced.

(g) Proof: Deductive proof is at the heart of mathematical thinking but the concept of a mathematical proof requires many years to develope in students minds. A long-term spiral approach
beginning with very simple deductive arguments is necessary (Bell 1978).

(h) **Structure**: Familiarity; with such properties of mathematical systems as closure, commutativity, associativity, identity, and inverse aid students to appreciate the concept of structure in mathematics. This unifies a number of other concepts in each of number theory, algebra, geometry and analysis.

(i) **Probability**: The concept of probability; is basic to statistical thinking which enables decisions to be made in the face of uncertainties. Although probability is not fundamental to mathematics as a discipline as the above concepts are, it must be regarded as one of the most important branches of mathematics in terms of its application to a wide range of other discipline.

2.1.1

**The epistemological concepts of Mathematics**

There are four concepts of mathematics, both on a philosophical level and on a level more directly didactical.

(a) **Descriptive concept**:

Mathematics is considered as something already existing in an ideal world. It has a unitary and coherent architecture of its own. The task is to make it known patiently and become masters of it. The principal aims in teaching it are those of
considering and understanding definitions, theorems and
demonstrations which are already well-ordered in their logical
structure. Thus, there is a "natural" order to be followed in
the teaching of arithmetic and geometry without which it is
impossible to understand the whole structure in its complexity.
This way of thinking on a practical level means considering the
text books as a store of mathematical truths which both teacher
and students can draw from.

(b) **Constructive Concept**

Mathematics is something referring more to building up
process where concepts, definitions, theorems and their
demonstrations are being fittingly heaped up, rather than to a
logical structure pre-existing an understanding of it. There are
no mathematical objects independent of the process producing
them. Therefore the goals in teaching are based more on promoting
the ability to build up concepts, models, theories and
applications in mathematics rather than on reproducing already
existing organizations. Mathematics is therefore something more
internal, intimately linked to ways of thinking, rather than
something external.

(c) **Formal Concept**

In this case, attention is concentrated on the form by which
the various mathematical propositions can be expressed as well as
on the rules allowing their combination. Thus mathematics
is spoken of as a language understood above all in
its grammatical and syntactic aspects a language however that is quite formalized, that is to say reduced to very abstract and synthetic symbols. The teaching of mathematics therefore concentrates on the ability to manipulate correctly formulas and propositions written in a symbolic manner. A closer idea can be obtained by thinking of how algebra is studied at present and also by looking at computation with decimal numbers and fractions.

(d) **Substantial Concept:**

Instead, here the real substance of things should be borne in mind rather than the form. Interest is focused more on the meanings, the concepts and the reality lying beneath the formulas or definitions. In teaching, one aims more at the substance of the discourse at the meaning of various propositions and the content hidden beneath the symbols; and this refers not only to mathematics, but also to its various fields of application. For instance, when speaking of fractions, decimal numbers and percentages, one tries to build the concept of ratio and therefore have it expressed knowingly in one of its representations.

The influence of the mathematical concept that a teacher or a pupil has accepted, even implicitly, has considerable influence on concrete action. Nevertheless none of these concepts is to be found in a pure state. The interact, and thus it is possible to represent them by means of a diagram. (See
Four regions or quadrants can be singled out in it. Region (a) seems to refer more frequently to didactic work done at present in classrooms, and is formal and descriptive in other words, reproductive and more attentive to correct definitions and manipulations than to the substance of concepts and to skill in interpreting and applying mathematical formulas above all on an elementary level.

Alternatively, there is the concept illustrated by (d). That is, a definition favouring the construction of concepts, processes, models and applications in mathematics; a definition insisting above all on the meaning of things, and taking into account the skill and knowledge which child has already acquired during school days and later on. Every new concept, every new
skill must thus be developed starting from what the child has already mastered, from experience already codified and assimilated, and attained by means of constructive processes within which the child has played an active role.

2.1.2 Mathematical Vocabulary

The ability to understand written mathematical vocabulary and to read text containing mathematical terms and discussion is an important component of literacy. Without this ability, adults would not be able to cope with many financial, statistical and other quantitative situations that daily confront them in a technological society. In addition, virtually all school children must repeatedly face text books and standardized tests for which the ability to read mathematical material may be essential.

Since the ability to read mathematically related text is so important, a measure of children's ability to read mathematical vocabulary would be useful. Such an instrument (Mathematical Vocabulary test) might identify children whose poor achievement mathematics stems from lack of reading knowledge of mathematical vocabulary and related concepts.

Mathematics reading involves the application of word recognition and comprehension skill to interpreting factual details and learning a new and sometimes difficult vocabulary.
Word recognition ability depends upon facility in sight recognition, adequacy in understanding word meaning and skill in word analysis. Vocabulary development is closely related to all these. As an integral part of the total reading programme vocabulary provides (i) the background for learning word analysis skills, (ii) the basis for understanding and interpreting printed materials, (iii) the essential elements for smooth, rapid reading and (iv) a motivational force for independent reading. Vocabulary is the most important direct objective in teaching word recognition because all skills and abilities essential in the reading process rely upon a student's knowledge of words and their meaning. It serves a number of functions in furthering word recognition skills.

Mathematics key words are derived from other language. Students especially in the elementary grades, do not have the knowledge of language structure to recognize the root words from which many technical terms have been constructed. Since derived words do not always follow regular phonetic rules or generalizations, and since the meanings may be taken directly from another language, students find it difficult either to pronounce such words correctly or to understand their meanings. Derived mathematical words should be taught systematically and explained thoroughly when they occur in mathematics reading.
Due to mathematical vocabulary development, student can understand real meaning of word which is used in special way. Student also can develop comprehension skill and computational ability.

2.1.3 Computation Ability

Mathematics has become a prime topic in the cognitive psychology of instruction. This is partly because of its obvious importance in the school curriculum and partly because mathematicians carefully formulated statements of the subject matter provide a well defined arena for the study of psychological processes. Among the themes that characterize recent work on the psychology of mathematics are the relationships between computational skill and understanding, the role of mental representations in learning and the ways in which new knowledge is constructed by learners. As in the field of reading comprehension, close associations and mutual influence exist between cognitive psychology and artificial intelligence.

Calculation is traditionally at the heart of the elementary school mathematics curriculum, and psychologist's interest in the learning and teaching of calculation dates back at least to Thorndike's (1922) work on the psychology of arithmetic studies of calculation aimed to establish relative difficulty of various types of problems without attempting a psychological explanation of why some problems are more
difficult than others. Since the early 1970, cognitive psychologists have been testing detailed models of the process involved in various kinds of computational problems. In the process, they have begun to explore how the understanding of number and computational skill are related.

By research on computational skill learning in school mathematics, it seems well established that effective skill development can not be separated from conceptual understanding or its uses in problem solving. There is still a very strong tradition supporting skill development in arithmetic and algebra as central goals of the elementary and secondary curriculum. But the level and type of skilled behaviour expected from school graduates of 1990 are likely to be very different from past days, because free classroom use of calculators need not impair development of computational skills and might enhance the problem solving strategies of elementary school students.

2.2 Mathematical Achievement:

Mathematical achievement is influenced by mathematical concepts of the pupils. Mathematical abilities are also related with mathematical achievement.

The international study of achievement in mathematics (Husen, 1967) arrived at a classification of the objectives of mathematical learning through a detailed analysis both of possible objectives and of those actually followed in the
curriculum of the 12 participating nations. It gave rise to a general view which considers 10 fundamental mathematical abilities. They are:

(1) Ability to recall and to reproduce definitions, notations, operations and concepts.
(2) Ability in rapid and accurate computation and symbols manipulation.
(3) Ability in translating data into symbols.
(4) Ability in interpreting data appearing in symbolic form.
(5) Ability in following a line of reasoning on a proof.
(6) Ability in constructing a proof.
(7) Ability in applying concepts to mathematical problems.
(8) Ability in applying concepts to nonmathematical problems.
(9) Ability in analysing problems and determining the operations which may be applied.
10) Ability in finding mathematical generalizations.

This succession is included in the matrix of three dimensions. The first dimension specifies the behaviour that the student is acquiring. In fact the behaviour singled out is three fold, cognitive, affective and motor. Second dimension concerns mathematical topics, which are arithmetic, algebra, plane geometry, analytical geometry, trigonometry etc. Third dimension concerns the use of the knowledge or of the skill acquired.
The classification of the National Longitudinal study of Mathematics Achievement (NLSMA) were completed by a group of American researchers belonging to the School Mathematics Study Group (SMSG) and called the "National Longitudinal Study of Mathematical Abilities" (Wilson, 1971) is a model with five dimensions. Only the behavioural dimension is considered here.

(a) **Computation:**

This level refers to recalling the fundamental mathematical facts, the terminology, and the skill required in order to carry out algorithms. The accent is placed on the simple evocation of knowledge and on the fulfilment of operations in an appropriate way.

(b) **Comprehension:**

This category covers remembering concepts and mathematical generalization. The student must show comprehension of concepts and of relations among them; translation of data from one mode to another.

(c) **Application:**

This involves the solution of familiar problems, similar to those the student had to face during the process of learning; pupils have to choose an algorithm as a solution and apply it successfully.
(d) **Analysis:**

The student must go beyond what was done during previous instruction; meeting new mathematics experiences, solving uncommon problems.

### 2.3 Mathematical Learning

#### 2.3.1 Arithmetic Learning:

Our knowledge of the nature of learning leads to the conclusion that there must be order and sequence in the development of mathematical concepts. It has already been pointed out that a learning program in arithmetic must take into consideration the readiness of the learners. Arithmetic learning is systematic. This may be observed in the case of counting, addition, and multiplication.

Experimental and control groups of children, aged ten years and three months upward, were used in a study by Middleton of the effects of systematic teaching of number combinations.\(^5\)

The experimental method "proved significantly superior in addition, multiplication, division, and mechanical arithmetic and there appears to have been some transfer to problem arithmetic. For the brighter children the value of the experimental method for subtraction is less marked". These results emphasize the extent to which children's ability in mathematics depends on a thorough grasp of the basic number
combinations. Weak foundations, accompanied by errors, lead to poor achievement and to unfavourable attitudes toward mathematics as a school subject.

Activities involving numbers and number relations are useful in helping the pupil understand arithmetic not merely as a skill subject but also as a system of ideas. Functional problems encountered in classroom activities in nutrition, nature study, and in informal activities are useful. The use of concrete objects involving simple arithmetic problems will give meaning to addition and subtraction. Well-organized field work makes indirect measurements a reality, when the problems encountered are in harmony with the maturation and experiences of the children.

2.3.2 Learning difficulties in algebra:

There are two ways of developing meaning in the teaching of algebra. The first involves stating a rule or principle and then illustrating the rule by a number of typical examples. The assumption here is that a statement is to be made, then meaning are to be built up from the statement. Unfortunately, pupils rarely return to the rule or principle after reading the illustrations; they go directly on to the problems and attempt to work them by the same methods used in the illustration. Therefore, the general concept is never completely clarified.
Meaning are learned in actual situations in algebra as elsewhere in life. Rules and principles should grow out of actual experiences. Since the pupils' experiences from which meanings in algebra may be secured are limited, it is necessary to supply meanings for them. The notion of a function is one that should arise out of the pupil's study of equations and formulas. The concept of function is easily developed in practical situations; what pupils need is experience in dealing with situations involving the idea rather than lengthy verbal statements that in themselves need explanation.

Readiness has too often been conceived of in connection with the primary school child's readiness for reading, computation, spelling, and the like. Opportune timing is important in all subjects, it is particularly important in algebra and geometry. Fulkerson has analyzed the stages involved in teaching an education in algebra. In this connection, he emphasizes the value of the student's having developed certain meaning and interpretations before he attempts to understand and perform operations involving equations.

2.3.3 Mental processes in learning geometry:

The solution of geometry is not different from other types of problem solving activities. However, the lack of correlation of such problems with life situations at school or in the home has made this course abstract and meaningless to a majority of students. Schunert noted that boys excelled girls in geometry achievement.
A splendid opportunity to use meaningful problems is afforded by interrelating geometry with the practical arts, physics, specific situations on the athletic field, and the like. Problems in geometry should be genuine and realistic. They will then yield to a treatment in which the principles of association and unity in learning are used to a large degree. Some of the mental processes involved in studying geometry may be stated in the following manner.

1. Securing a clear notion of what is to be done;
2. Conceiving the figure that is to be used;
3. Determining just what is to be done to the figure, what feature is to be used and what additional lines are to be drawn so as to recall memories and facilitate logical thinking;
4. Grasping all the essential elements that lead to a conclusion;
5. Arranging the essential elements in logical sequence.

The lack of a method of attack is an important cause of failure in problem-solving in geometry. Most students will need some selective direction in the organisation of their attack upon a problem situation. The dull pupil will profit most from such direction. Wherever possible graphs should be used in problem solving activities for they enable pupils to perceive existing relationships better. Graphs and other supplementary
devices make geometry materials more vital and meaningful. Achievement in algebra and geometry is enhanced by frequent reviews, differentiated assignments, and the application of principles to life situations.

2.4 **Intelligence**

The fact that intelligence is not the sole ability which is inherited by birth is now a proved thing. Intelligence is not only a biological factor, but it is also a factor increasingly affected by environment. This truth has gained fast acceptance. The fact that intelligence is related to mathematical ability is so well known that it scarcely requires comment. And just as obviously, intelligence bears a strong relation to mathematical concept and mathematical achievement. As a result, the level of intelligence is often used for ascertaining the level of mathematical concept and mathematical achievement of a pupil.

Since the first practicable scale for measuring intelligence was developed by Binet (1905) in France almost seventy nine years ago, educators and researchers have been highly impressed by the tremendous range of performances on intelligence and by the positive correlations that have almost always been found between intelligence test scores and mathematical achievement test scores.
The following paragraphs clarify the concept of intelligence, the kind of intelligence and the distribution of intelligence.

2.4.1 Meaning and Concept of Intelligence:

Intelligence is that allround mental power which shows itself as an ability to see relationships between items of knowledge and then to apply these relationships to new situations.

Lee Deighton categorizes definitions of intelligence as follows:

(1) Intelligence as the ability to adapt to the environment;
(2) Intelligence as the ability to deal with symbols or abstractions;
(3) Intelligence as the ability to learn.

Another term, the intelligence quotient (IQ), refers to the rate of mental development. According to Albert Harris, "The IQ is a measure of the rate of mental development which indicates in a rough way what the child's future rate of mental growth is likely to be. The more the IQ is above 100, the faster is the probable rate of progress; the more below 100, the slower".
Some definitions of intelligence as follows:

E.L. Thorndike: The power of good responses from the point of view of truth or fact.

L.M. Terman: Intelligence is the ability to carry on abstract thinking.

S.S. Calvin: An individual possesses intelligence in so far as he has learned, or can learn to adjust himself to his environment.

R. Pinter: Intelligence is the ability to adapt oneself adequately to relatively new situations in life.

V.A.C. Henmon: Intelligence involves two factors: the capacity for knowledge and knowledge possessed.

J. Peterson: Intelligence is a biological mechanism by which the effects of a complexity of stimuli are brought together and given a somewhat unified effect in behaviour.
L.L. Thurstone: Intelligence is the capacity to inhabit an instinctive adjustment in the light of imaginally experienced trial and error and the volitional capacity to realize the modified instinctive adjustment as overt behaviour to the advantage of the individual as a social animal.

H. Woodrow: It is an acquiring capacity.

W.F. Dearborn: The capacity to learn or profit by experience.

Edward: The capacity for variability or versatility of response is intelligence.

Buckingham: Intelligence is the ability to learn.

Knight: It is the capacity for relational constructive thinking, directed to the attainment of some end.

Burt: It is capacity of flexible adjustment.

Woodward: Intelligence is the capacity to acquire capacity.

Binet: Intelligence is judgement or commonsense, initiative, the ability to adapt ourselves, to judge well, understand well, reason well.

Spearman: Intelligence is relational thinking.
The different categories of definitions are not exclusive of each other but are interdependent on each other. Suppose a child has no learning ability, then how can we expect that he would be able to adjust in social environment, and on the learning of concepts and symbols depends the development of ability to carry on abstract thinking and problem solving ability of the individual. Thus we find that one ability is the basic requisite condition for the other two aspects of intelligence.

2.4.2 Kinds of Intelligence:

Thorndike has classified intelligence into three categories as given below:

(1) Concrete intelligence

(2) Abstract intelligence

(3) Social intelligence

(1) Concrete intelligence:

It means "ability to understand and deal with things" intelligence in relation to concrete materials. It helps to deal readily and effectively with machines and mechanical contrivances. It is evident from various activities of daily life. Concrete intelligence is measured by performance tests and picture tests in which the individual has to manipulate concrete materials.
(2) **Abstract Intelligence:**

It is the ability to respond to symbols of various sorts, such as words, numbers, letters and the like. It refers to the ability for learning, to read, to understand and to solve problems presented in the form of words, symbols, formulas, diagrams, etc. It is required in the ordinary academic subjects in schools. The highest level of abstract intelligence is manifested in the thoughts of philosophers or in the reactions of the students dealing with the relations of things symbolized.

(3) **Social Intelligence:**

It is the capacity to understand and deal with persons. An individual's ability to react to social situation of daily life is social intelligence. It does not include the feeling or emotions aroused in individuals by other people but merely the ability to understand others and to react in such a way towards them that the ends desired could be attained. Individuals who are able to handle people well possess high social intelligence. Adequate adjustment in social situations is the index of social intelligence.

2.4.3 **Distribution of Intelligence:**

The good teacher will attend to the uniqueness of boys and girls and will make an effort to discover each child's limitations and capacities. One type of data that reveals
vividly the variations within a class may be obtained from an intelligence test. If an intelligence test is given to 100 typical school children, some extraordinarily high and some very low scores will be found. In fact, such great disparity will exist between the highest and the lowest scores that, if the deference is translated into mental age units, a range of several years will result. The slowest child of 100 ten year old pupils may be eight years old mentally, and the brightest, twelve or thirteen. However, the difference between the most retarded child and the one just above him will be relatively small, and similarly small will be the internal between the highest and the child just below him. Of course, many children will make similar scores, and if the scores are presented graphically, most of them will be found to cluster about a central point. Moreover, if these scores are changed into mental ages are divided by the chronological ages, the distribution in IQ's will appear according to the same general characteristics of a normal distribution curve. The teacher, therefore, will find it valuable to know as accurately as possible the mental maturity of each child in order that he may provide materials suitable for mastery by each child.

Test scores for many types of school children have been found to be distributed roughly according to the normal probability curve. The majority of the population will be found in the intelligence quotient interval 90-110 this large group
is sometimes referred to as "normal" or "average," because it represents best the typical school child and includes some 60 percent of the total school population. Consideration of a typical distribution of intelligence test scores indicates that fewer cases appear as the scores become higher. Thus, it was found that whereas approximately 3 percent of our children achieved IQ 125 and above, only 1 percent (the gifted) reached or exceeded IQ 130.

Somewhat similar distributions of test scores will be found in children of different age and grade levels. Of course, in an inferior social district, where homes are poor and the general cultural conditions are poor, a disproportionately large number of low scores will be obtained, but the wide range and the concentration of scores about the central point still will remain typical features of the distribution. In a superior social district one will obtain an unusually large number of high IQ's, but the range will be great and the scores will cluster about a central point. The teacher may expect, therefore, to deal with children varying widely in ability, regardless of the nature of the district or the type of community in which he is teaching.

2.5 Anxiety:

In recent years anxiety and learning has been a popular topic for research. Those who work with troubled people find
excessive anxiety a common symptom. Especially the teachers who are closely related to troubled pupils know well that their school life is not always happy. From research findings on anxiety in general and school anxiety in particular comes the popular view that anxiety is an indication of maladjustment and a cause of school failure.

A number of anxiety tests are developed by S.B. Sarason and his colleagues (1960) and others. From various researches on anxiety it appears evidently that anxiety level is an important level variable in learning. Whether anxiety is conductive to academic achievement is yet a debatable issue among researchers. But it is perhaps accepted and approved by all that high anxiety generally but not uniformly handicap performance, be it a performance related to learning mathematics.

2.5.1 Meaning and Concept of Anxiety:

The concept of anxiety is very important for understanding the emotional life of the child even though there is much diversity, at present, in the definition of anxiety.

To define anxiety is not easy. Anxiety, operationally, is a combination of overt behavioural characteristics. According to Siddiqui and Akhtar, "Anxiety can be a mood, a feeling an emotional response, a symptom, a syndrome". In the words of Jersild, "Anxiety springs from a condition of inner conflict."
This implies that anxiety does reflect internal discomfort.

According to English and English, "Anxiety means an unpleasant emotional state in which a present or continuous desire or drive seems likely to miss its goal; a fusion of fear with anticipation of future evil; marked and continuous fear; a continuous fear of low intensity."

Anxiety, operationally, means generalized feelings of worry and apprehension growing out of unresolved frustrations.

According to H. Sorenson, "Anxiety is a basic difficulty and is characterized by generalized fear, excessive concern, and uncertainty." Anxiety, thus, to him is felt a state of pervasive fearfulness and over concern.

Fear and anxiety have long been accepted as basic human emotions. James Kritzeck (1955) observed that anxiety was a central concern in the writing of the Medieval Arab Philosopher Ala Ibm Nazim of Cordov. In his book "A Philosophy of character and conduct" written in the eleventh century, Hazm expressed the view that anxiety was fundamental to human nature and that one of the basic aims of all human actions was escaping anxiety. In his survey of evidence concerning the importance of anxiety in literature, religion, psychiatry, psychology, politics and philosophical thought.
Anxiety is one of the most pervasive phenomena in the present age of complexities and tensions. People have anxiety of general kind, while school-pupils have school anxiety. Anxiety, indeed, has been a nodal problem of the present generation.

2.5.2 The Nature of Anxiety:

The psychological needs we have been describing account for a great deal of human behaviour. Particularly the kinds of behaviour that are in our best interests. It is not easy. However, to determine how needs related to the attainment of adequacy or competence are basic to behaviour that is not in our best interests. Here is an example.

"Howard teases George whenever they are together George is bigger than Howard and he does not tolerate being teased. Every time Howard teases him, George pummels him unmercifully until some one separates them. This goes on day after day. It is plainly not in Howard's best interests to tease George and be beaten by him. Why, then, does he do it ?

Lucy has the intelligence to get good marks - an IQ of 130 - but her grades are below average. She is what educational psychologists call "an underachiever". Her parents and teachers are concerned about her inability to get grades consistent with their expectations for her, and Lucy herself is quite worried.
Although she tries to do better. She always manages to sabotage her own efforts. It is against Lucy's best interests to get poor grades, just as it is against Howard's interests to pick a fight with a bigger boy. Why don't Howard and Lucy act sensibly? And why don't they respond to psychological needs for competence and adequacy?"

Explaining the behaviour of Howard or Lucy would take much time and careful investigation, investigation that is best undertaken by a person with special psychological training. Without attempting to predict the results of such investigation, it is nevertheless quite likely that the findings would indicate that Howard and Lucy are attempting to cope with some form of anxiety.

Fear and anger are "primitive" emotions: they are the spontaneous and sometimes dramatic accompaniment to situations involving (1) immediate or present danger to ourselves or (2) some direct and drastic interference with on-going behaviour. But frustrations that threaten needs at more abstract and socialized levels are likely to be of a more subtle, indirect nature. Not only are they harder to identify, but they also involve behaviour that is highly complex, behaviour that is a part of the intricate web of our relations with others. Perhaps we feel irritated when some one in authorities accuses us of carelessness, but our anxiety about our status leads us to
swallow our anger or perhaps we feel that we are being left out of plans being made by our group but are really not sure and would feel silly bringing it up. Hence, we feel awkward and insecure in our relations with the group; we have a feeling of comptiness whenever we think about the problem. It is a bothersome, elusive feeling and it will not go away.

This is the quality of anxiety. It is elusive bothersome, and hard to identify. It commonly develops within the context face-to-face relations with others. What psychologists call "interpersonal relations". In its most intense form, it can be quite painful. So painful that we are usually willing to go to great lengths to avoid it. Because anxiety is so painful, we sometimes do things that are not in our best interest in order to avoid or reduce anxiety. We do not know what the source of Howard's anxiety is, but it appears to be so strong that he is willing to suffer physical pain in preference to the pain of anxiety. For her part, Lucy is willing to suffer the disgrace of poor marks rather than face and deal directly with her anxieties.

2.5.3 Origins of Anxiety

The observations of Harry Stack Sullivan, the great psychiatrist and teacher, led him to the conviction that the initial experiences with anxiety occur in infancy, when infants sense displeasure or emotional upset in their parents, particularly their mothers. Sullivan noted that infants displayed such symptoms as restlessness, irritability, and feeding problems,
when their mothers were displeased or disappointed, or even when their mothers were troubled by events that had nothing to do with the child. So close is the emotional linkage between mother and infant, according to Sullivan, that negative feelings on the part of the mother are likely to disturb the infant's sense of security, that is, his need to be loved and to feel secure in his mother's love. This feeling of insecurity and psychological isolation from the mother is what Sullivan terms "anxiety". (It is understood, of course, that negative feelings and anxiety, occur in the best ordered households and are part of the normal process of human interaction. It would be as undesirable to shelter a child from all negative feelings as it would be to over-expose him to such feelings).

The anxiety we first experience as infants continues to have an effect on our behaviour throughout life. It appears whenever others criticize, snub, or disapprove of us - whenever we are "rejected". The more important the rejecting individual is to us, and the more power he has, the greater our anxiety. The future is a major source of anxiety because of its uncertainty. Hence, we lay plans and take precautions to make the future somewhat more predictable and thus allay our anxieties to some degree.

According to Camilla M. Anderson, who has developed a theory of human behaviour similar to Sullivan's, all human behaviour is based on the avoidance of anxiety. "Everything one does, every choice one makes, every reaction one gives, every
item and detail of one's behaviour is calculated to forestall anxiety or to deal with if it arise.\footnote{14}

Although we have stressed the unpleasant features of anxiety, there is no question but that it has positive values our wish to avoid anxiety is a major factor in our learning to be careful and considerate in our relations with others, to conform to the laws and customs of society, and to provide for the future. Anxiety that enables us to behave like civilized individuals in a civilized society is what we shall call "normal anxiety." A certain degree of normal anxiety is therefore necessary as a kind of goad or stimulus to keep us at the task of becoming more adequate. But an overabundance of anxiety distracts us from the positive direction of development, and leads us to develop forms of behaviour concerned solely with the avoidance or reduction of anxiety. Hence the appearance of behaviour that is not in our best interests. It should be clear, then, that our basic need to become competent and adequate and our tendencies to develop varying degrees of anxiety are both likely to have a significant effect on learning.

2.6 n-Ach (Need for Achievement)

The intimate relationship between n-Ach and the experiences of success or failure has been recognized in a particular way for untold centuries.
It is being realized that need for achievement is a governing factor for the present day acute need to inspire and motivate the school pupils to learn.

It has now become a common concern of most of the educators and parents to see that need for achievement or achievement motivation (shortly known as n-Ach) is favourable to learning in order to avoid educational procedures and situations.

The child's interests in learning activities may be termed achievement motivation. This may be observed in the third-grade pupil's intense interest in working arithmetic problems or the seventh-grade pupil's interest in collecting and classifying leaves or butter flies.

Individual differences in achievement motivation may be noted among preschool as well as school-age children. This is frequently an important motivational force in the educational process. The achievement need, like many other needs, is a product of social learning and reinforcements which children have experienced. As children experience satisfactions and rewards for their achievement, their achievement motive tends to increase. Approval from teachers and parents, favourable report cards and other indicators of achievement serve to reinforce the learning. Berlyne noted that when rats were stimulated with increased variety, they spent more time exploring their environment.
Teachers have continuously observed that achievement motivation is reinforced by changed classroom procedures or by the introduction of new or different elements into the learning situation.

2.6.1 Meaning and concept of n-Ach.

The term "Need for Achievement" has a multiplicity of meanings. No two didactic definitions of need for achievement appear to agree.

The concept of need for achievement or achievement motivation can be made more clear and meaningful if the meanings of 'motive' and need are thoroughly understood.

"A motive or drive is a condition within the organism that initiates activity in the direction of a goal - tension or pain reduction. Need is a state of tension created by organic deficiencies or by painful external stimuli. Whenever the organism cannot maintain the balance among the tissues, the organism is 'motivated' to action. This presumes that the organism is essentially active when motivated by internal or external stimuli. The motivating condition begins within the organism and is more psychological than physiological.

The Need for Achievement Theory implies that man wants, desires and is goal-seeking. His behaviour is influenced not so much by his past experiences as by his expectations."
According to Bortner,\textsuperscript{17} with respect to teaching, motivation can be defined as a conscious effort on the part of the teacher to establish a motive, that is a drive, urge, or desire in his pupils so that learning goals will be attained or to link their already existing motives with the learning goals."

According to Ruch,\textsuperscript{18} "One of the psychological motives in man but not in lower species is the need to achieve. The need for achievement is defined operationally as behaviour which shows effort to do one's best, to do better than others, or in general, to accomplish something".

n-Ach and n-Ach score should not be misunderstood. The n-Ach score is an 'operant', not a 'respondent' measure. That is, it records how often a person spontaneously thinks about improving things and not how interested he says he is in improvement in response to another's question.

Need for achievement, thus, is a component related internally to the individual's success.

2.6.2 The Origins of n-Ach.

It will be recalled that, in the McClelland formulation of the nature of motivation, all motives are learned. In the case of achievement motivation, which is the motive most thoroughly studied by the McClelland group, the motivation involves
performance in the context of standards of excellence against such standards. Hence, it would be argued that the history of someone who has high n-Ach must be one of competition with performance standards or one in which the individual was expected by himself to do things well.

On this hypothesis several investigations were carried out. Thirty men on whom n-Ach scores were available rated their parents on several behavioral variables, and a psychiatrist also rated the parents on these variables after an interview with the subjects. A combination of these rating into an overall rating of severity of upbringing, and both the sons' and the psychiatrists ratings of severity, correlated significantly (r=0.40) with achievement scores. Further data were obtained from the subjects concerning personality traits of their parents. Here negative correlations were found between achievement scores and the parental trait of being friendly and helpful and the characteristics of being successful, clever, and self-confident. McClelland et al summarize these various findings as follows: "College males who give evidence of being very 'close' to their parents in their admiration of them and perception of them as particularly loving and helpful do not for the most part score high on n-Ach. On the contrary, it is the students who see their parents as 'distant' unfriendly, severe unsuccessful who have high N-Ach scores". These findings, however, were reversed for male high school students.
Better investigations of the origins of n-Ach involve measures of parent behavior independent of the individuals whose n-Ach is being assessed. The family or parent variable looked for is independence training, that is, pressure on the child to master various skills and tasks early so that he can do them by himself, independently of his parents. In one study folk tales of several North American Indian tribes were collected and scored for n-Ach. Independently, the stress on independence training of these cultures were rated. Significant relations in the anticipated directions, were found between n-Ach and the existence of initial indulgence training started and severity of the training.

Somewhat indirect evidence of a similar kind of relationship was obtained by McClelland et al. They administered questionnaires concerning independence training and educational level to groups of parents who were classified as protestant, Jewish, Irish-Catholic, and Italian-Catholic. The reason for using these religious groupings is that, according to Max Weber (1930), capitalism was fostered in Protestant than by Catholics, since presumably Protestants have higher n-Ach scores than catholics. The Jewish group was expected to be like the protestants.

The data show that Protestants and Jews expect children to have mastered certain items indicative of independence training at earlier ages than do catholics, and this source of variation
is significant. Educational level and sex of parent also were significantly related to age of expected independence training. The more highly educated parents and mothers at any educational level expecting earlier development of independence than the less educated parents and the fathers.

A last study in this tradition was reported by Winterbottom (1958). She interviewed mothers of 29 eight-year old boys concerning various aspects of independence-training and also measured n-Ach of the boys by means of a procedure suitable for their age. She found evidence of a strong relationship between n-Ach, on the one hand, and independence training, on the other. While the mothers of the high and low n-Ach boys did not differ in the number of demands for independence they made, the mothers of the high n-Ach boys made them earlier than the mothers of the other boys. Some of the items which differentiated the two groups in terms of age at which they were demanded were: to stand up for one's rights, to know one's way around the city, to go out to play, to try hard things for oneself. Non-differential items include eating alone without help, earning spending money, doing tasks around the house. The mothers of the boys scoring high on n-Ach also evaluated the children's accomplishments higher and were more rewarding than the other mothers.

These studies point to the kind of investigation which examines the relation between a relatively specific motive and fairly specific kinds of early experiences hypothesized to be
related to the motive in question. Obviously, much more work is required to confirm the relation between independence training and n-Ach, as well as to find relations between early experiences and other motives.

2.7 Caste

In a country like India where much more stress is being laid on democracy, socialistic pattern of society, secularism and national integrity, caste has been viewed as one of the social hazzards. In spite of the nation's struggle to make the Indian society casteless, a number of castes exist. The caste and its levels play their part in making or ill-making of the individual. As far as the school pupils are concerned, their language experiences learning facilities and home background by large are positively or negatively affected by their caste levels.

2.7.1 Meaning and concept of Caste

Caste is a label which is inherited by the individual by his birth. Castes are, traditionally, classified into main sub-castes like Hindu, Muslim, Sikhha, Jain, Parasi and Christian. Broadly speaking all these castes, from the educational and/or social progress point of view, are categorized into two major classes, namely backward class and non-backward class. The Indian nationals who belong to scheduled castes, scheduled tribes, denotified tribes, migratory tribes and certain castes approved and declared by the Baxi Commission are termed as backward class (shortly know as B.C.) while all the remaining castes are
considered as advanced class or generally known as non-backward class (shortly known as Non-B.C.)

As per delimitation of the research problem, only scheduled caste and Scheduled Tribe pupils under the study, are treated as B.C. pupils, while all other pupils belonging to other than S.C. and S.T. pupils are treated as Non B.C. pupils only these two major caste levels (i.e. B.C. and Non B.C.) have been treated as caste levels in this study.

2.7.2 Impact of caste on Learning

The pupil's fund of learning experiences as well as his most behavioural patterns and performances are generally affected by his caste he belongs to. The caste does cast its shadow or light on the being of the pupil. The levels of caste, to some extent, prove to be the chief determinants of literacy or illiteracy.

According to Dr. D.N. Patel, the fabric of the Indian Society is woven by the heirarchical caste structure. The census Report of 1971 and 1981 speak eloquently about the relationship with illiteracy and the poverty. The lower rung of the society which forms majority quantitatively is poor because of illiteracy. Since independence, backward class pupils have been given continuously increasing encouragement for education and job
opportunities. Still however, these pupils do not show overall good performance of a high order."

2.8 Family size:

The influence of the family size on the moral behaviour of children has received some attention from experiments, but no general conclusions can be drawn.

Since learning problems are often related to home background or family-conditions, it is highly desirable for schools and teachers to eliminate handicaps, to carry forward a positive remedial programme and to develop pupils' learning.

The family size has also been felt as one of the factors that determine school pupils' progress.

2.8.1 Meaning and Concept of family size:

Family size can, operationally, be termed as the structure of family in relation to its principal members that constitutes the family. Family size is determined by the number of parents and their children. Thus, father and/or mother and their children/wards constitute the structure of any family.

In this research the investigator considers that family as an average family which consists of father and/or mother together with their only three children. If the number of family members
is above the average number of five, it is a large family. If it is below five, it is a small family. This criterion has been borne in mind by this investigator while classifying any family into a large family or a small family.

2.8.2. The Family's Contribution to Learning

The family, not the school, provides the first educational experiences of the child. These experiences begin in infancy with the first attempts to guide and direct the child to 'train' him, as we say. Some of these attempts to guide and direct take place at a conscious level, but most of the time parents are not aware that they are attempting to influence behaviour at all. Probably most of the training that they undertake deliberately and consciously is not as effective as that which is undertaken unconsciously. This is the most especially true of attempts to train infants. Infants do learn but not necessarily what parents think they are teaching them.

Research studies on family reveal that it is the family size that positively or negatively influences the pupil's overall performance in their learning. It affects the pupil's scholastic achievement the most. The provision of learning facilities also depends on the size of the family. It is generally believed that in large families the pupil's physical amenities are not adequately paid attention to, while in small families the parents with their small income, too can take due care to enhance their wards' learning progress.
Large families, sometimes, due to their complexities create mental tensions which prevent children attaining progress in learning.

2.9 Birth Order

Scant researches have been done on the person's birth order and other variables. The present research, perhaps, will be one which would strive to explore the effects of pupil's birth order on mathematical concept and mathematical achievement. Whether there is any positive or negative influence of the pupil's birth order on his mathematical concept and mathematical achievement is to be judged and scientifically predicted through this research study.

The lexical and operational definitions of birth order, its meaning and concept is described in the lines that follow:

2.9.1 Meaning and Concept of Birth Order:

According to English and English, "Birth order means the relative order of birth of the children in a single family".

Birth order operationally can be termed as the rank of a child or individual in the family in relation to his birth order.

In other words, birth order is the specific ordinal position in the form of rank in the child or man.
2.9.2 **Impact of Birth Order on Learning:**

Everybody would be willing to agree that order of birth plays an important role in influencing the child's or person's personality and behaviour. According to Dr. H.G. Desai "Specific psychology has been interested for some decades in the effects of ordinal position on intelectual and social adjustment. The theoretical logic at ordinal position in research is that a specific position in the family importantly affects the kinds of experiences on encounters".

In the words of Dr. H.G. Desai. "The hypothesis has been advanced that children who are the first born in their families suffer, on the average, a handicap in mental development due to both physical and social disadvantages. " This implies that poor physical condition and comparatively less intellectuality may adversely affect learning but the studies have not yielded consistent results. The educational and social handicaps of the first-born are a matter of speculation rather than of direct proof.

Many studies on birth order reveal that the first born child of a parent is more likely to attain a position of intellectual eminence. He is more likely to be serious and sensitive as compared to his younger brothers or sisters. This first born has a special productivity for language. The second child grows up looking outward upon a word of peers and learns
these skills for coping up with similars. The youngest child in the family has some what inflated selfesteem. He accomplishes his work through shrewdness and wisdom. "The last borns, particularly the last born from larger families, are likely to be over represented in the population of alchoholics." 26

2.10 Sex Differences in Ability and Achievement:

For nearly a century there has been continuing research into the nature and origins of six differences in ability and achievement. This research has both led and supported the marked change in views towards the education of girls that has occured during this period. In turn, however, the nature of the research being undertaken has changed several times in response to changing social views and concerns. Perhaps more studies concerning sex difference have been taken and reported in the fields of education, psychology, and sociology than on any other single topic during this time.

The research carried out in the United States into the sex difference in ability and achievement has been surveyed successively by Tyler (1956). Anastasi (1955) and Maccoby (1966). They have reported that in the United States boys generally show stronger numerial and spatial abilities and perform better on tests of mathematical reasoning than girls, but girls usually do better in verbal and linguistic studies. However Tyler (1969) has exphasized that the differences between the sexes in these area are, in general, not large when compared with differences within each sex group.
In 1906, E.L. Thorndike rejected the view that the differences between the sexes which he had observed could be inherent, since such differences were too small to be of practical significance. Halling Worth contended that "the small differences observed were due to social influences and not to biological causes, and that the true In intellectual potential of women would only be revealed when women received a similar education and has right to choose equivalent careers".

2.10.1 Sex Differences in Achievement:

The basic issue in the examination of sex differences in achievement is concerned with cognitive factors that lead boys and girls to study different subjects during the years of secondary schooling and thus to prepare themselves for different types of occupations and different careers. The rapid growth of the women's liberation movement and the increasing recognition of equal pay for women and men have led to some change in the patterns of subjects studied at school and in the courses taken at tertiary level, and thus to changes in career path for women.

Tyler (1956) in a review of research in the United States reported that in all studies girls achieved consistently higher grades than did boys, were less frequently retarded, and were more frequently accelerated through the years of schooling than boys. When batteries of achievement tests were used to assess achievement rather than using school grades for this purpose, girls continued to exceed boys in performance in language
studies and boys tended to perform better in mathematics and science. However, the differences between the sexes were small and frequently inconsistent within the same subject area, for example, boys performed better on problem solving in mathematics, while girls frequently performed better on computation.27

2.10.2 Sex Differences in Ability

It is of course possible that the sex differences recorded above have their origins not in societal and cultural factors but in differences in abilities between the sexes.

2.10.2.1 Intelligence

Many research workers have from time to time reported differences between the sexes in performance on intelligence tests. However, some tests have given boys a slight advantage and other tests would appear to have favoured girls.

2.10.2.2 Verbal and Quantitative Abilities

In the context of the achievement differences discussed above, it is more relevant to consider whether the sexes differ with respect to specific abilities rather than whether they differ in general intelligence.

Female students would appear to perform better on tests of verbal ability than do male students, although the results supporting this conclusion show some inconsistencies. There is greater consistency in the results for all areas of verbal
function, but generally the differences are relatively small.

Males generally score higher than female on tests of quantitative ability, when this is assessed in terms of quantitative reasoning or problem solving rather than in terms of computational skill. Again there are inconsistencies in the results obtained up to the age of about 12 or 13 years, when the quantitative ability of boys appear to develop at a faster rate.

The effects of differences in ability on achievement test scores would be more soundly based if the origins of the differences in ability could be identified, and the possibility thus examined that the differences in both ability and achievement have related origins.

2.10.3 The Origins of Sex Differences in Ability

The origins of sex differences in abilities and achievement, under the assumption that effects of the factors on achievement are mediated through their effects abilities, or that identified factors will influence cojointly both abilities and achievement.

(1) Biological differences
   (a) Genetic differences
   (b) Maturational differences
   (c) Hormonal differences
   (d) Brain lateralization differences
(2) Socialization differences
(3) Affective differences
   (a) Expectancy of success
   (b) Attitudinal and value differences.

Resume:

Investigator had been taken dependent variables (mathematical concept, mathematical achievement) and independent variables (intelligence, anxiety, n-Ach, casto, family size, birth order, sex) theoretical discussion has been made by investigator in this chapter for better understanding of study.

Investigator got the concept about the meaning of variables, nature of variables and the impact of variables on learning from this chapter.
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