A STUDY OF SOME PSYCHOLOGICAL VARIABLES DISCRIMINATING BETWEEN UNDER- AND OVER- ACHIEVERS IN MATHEMATICS OF SECONDARY SCHOOL PUPILS OF KERALA

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DECLARATION

I, Nicemol Sebastian, do hereby declare that this study "**A STUDY OF SOME PSYCHOLOGICAL VARIABLES DISCRIMINATING BETWEEN UNDER- AND OVER-ACHIEVERS IN MATHEMATICS OF SECONDARY SCHOOL PUPILS OF KERALA**" has not been previously formed the basis for the award of a Degree, Diploma or Recognition.

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CERTIFICATE

Certified that the thesis "**A STUDY OF SOME PSYCHOLOGICAL VARIABLES DISCRIMINATING BETWEEN UNDER- AND OVER-ACHIEVERS IN MATHEMATICS OF SECONDARY SCHOOL PUPILS OF KERALA**" is a record of bonafide study and research carried out by Mrs. Nicemol Sebastian, under my supervision and guidance and that it has not been previously formed the basis for the award of a Degree, Diploma or Recognition.

Dr. V. SUMANGALA
(Supervising Teacher)

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Today's world is shaped in substantial measure by a high order of scientific knowledge and technological skills; and is often described as 'Knowledge Society'. Information Technology has reduced its spatial dimension and converted it into a 'global village'. Concepts, ideas, procedures and principles are being evolved faster than these are understood and assimilated by mankind. The human cloning, which we cannot even imagine a decade ago has now became a reality. Thus when new information comes into existence and circumstances change, it is no longer possible to solve today's problems with yesterday's solutions. This demands our educational system to develop scientifically and technologically talented young citizens. But educationists and scholars are of the opinion that our educational system is facing numerous challenges to cope with the needs of the modern society.

One such challenge is the students' under-achievement in spite of the motivation and facilities given by parents, teachers and educational authorities. Pursuit of performance is always a key factor for individual and national progress. Moreover, the efficiency of an educational system is measured by the academic achievement of students, whether it is in cognitive, affective or psychomotor domain and hence as Buch (1991, p. 807) said "the whole system of education revolves round the academic achievement of students". Hence maximum achievement is the major goal of teachers, educationists and administrators.

While we concentrate on raising the level of achievement, there are cases of low scholastic performance by high ability students as well as average or below average ability students. Disparity in achievement is an indication of the fact that there exist individual differences among learners. Students differ from each other in a variety of ways, which influence how well they learn. Research studies conducted so far revealed that achievement in school subjects is not an independent phenomenon. Rather it is directly influenced by a number of factors, some of which are personal to the individual, while many others are located in the environment in which the learning process takes place.

In every school we come across pupils with outstanding, average and below average capabilities and attainments. Difference in academic achievement among pupils who have almost equal intelligence is a usual feature found in our schools. If a student scores low despite his/her capacity in scoring high marks he/she is considered to be an Under-achiever. Similarly the student, who scores more than what he/she is capable of, is the case of Over-achievement. In general, Under-achievers are those whose achievement is not up to the expected level of achievement. Where as, Over-achievers are those whose academic achievement is in excess of expectation.

Under-achievement in school subjects is a serious problem to educators all over the world. The incidence of this phenomenon has attracted the attention of educational researchers for obvious reasons. Under-achievement means wastage of human resource, the most valuable capital, which India as a developing country, needs to be avoided. Teachers and parents feel confused, frustrated and disappointed when students fail to work to their potential. This significant loss of human potential affects not only the national strength but also personal satisfaction and productivity through out the individual's lifetime. Incidence of under-achievement can be considered as an indication of the inefficiency and low quality of the educational system.

In discussing the problem of the Under-achievers, the Education Commission (1964-66, p. 242) says "The group of Under-achievers consists of children who are not intellectually dull, but are at least of average and may even be of superior ability. The failure of such children should be of great concern to a developing country like ours, which cannot remain indifferent to this loss of potential manpower within the high ability range." So an educational system that fails to enable a pupil to perform as par with his potential needs to be thoroughly reoriented.

When the maximum fulfillment of an individual's ability is blocked, his contribution to society will become proportionality less. If a child turns out to be an Under-achiever, it is a sufficient indication that the system has failed to tap or develop the potential present in him. It is the responsibility of the nation to ensure that the individuals makes the best one of his capacities and secures the growth, which his potentialities permit him to do.

One of the important concerns of a democratic educational system is to ensure that each child makes the most of his abilities. Every nation wastes much of its talents primarily because many of its bright youths do not get the proper education that would make them able to work at levels that match their potentialities. At the same time a quite number of Over-achievers are not getting conducive environments which will enable them to work at levels for which they are qualified.

Incidences of academic Under- and Over-achievement are noticed by many educationists and psychologists all over the world. Behrens and Vernon (1978) observed that among the grade 7 students, 20 percent are Under-achievers, 20 percent are Over-achievers and the remaining 60 percent are Normal-achievers. Whitmore (1980) estimated that at least 20 percent of gifted students Under-achieve while United States Commission on Excellence in Education (1983) estimated 50 percent.

Flory (1987) found that out the 681 students studied, 149 are Under-achievers, 430 are Normal-achievers and 102 are Over-achievers in Mathematics. Kaile and Kaur (1992) found that in a sample of 203 IX standard girls, 57 are Under-achievers and 56 are Over-achievers. Ajawani and Rungta (2004) reported that out of the 90 pupils studied, 6 are Under-achievers, 70 are Normal-achievers and 14 are Over-achievers.

Many researchers have shown concern over the problems of Under- and Over-achievement. Studies by Sharma (1981), Gupta (1983), Maitra (1985), Ayishabi (1987), Puri (1987), Ramachandran (1990), Madhavan (1990), Maitra (1993), Sharma (1995), Ford (1995), Ramesan (2000), and Bindu (2001) are some of the studies conducted in this field.

To add this present investigation is to find the extent of Under- and Over-achievement and to find out the psychological variables discriminating between Under- and Over- achievers in Mathematics.

1.1. NEED AND SIGNIFICANCE OF THE STUDY

As the major aim of education is to prepare children for a successful living, Mathematics education in its broadest sense is the highest necessity as certain amount of mathematical ability is indispensable for everyone. Computer technology has impacted every aspects of human life, which in turn necessitates mathematically talented pupils. There is no Art, no Science, and no profession where Mathematics does not play significantly. Being a tool subject, any increase in the efficiency of Mathematics learning is likely to improve the learning of other subjects.

When the Third International Mathematics and Science Study result showed that, for Mathematics, United States eighth and twelfth grade children performed below the international level, the then president Clinton (1998) called experts in all fields and told them to take steps to improve Mathematics and Science Education. In that conference he reminded them of the words of former President Eisenhower, "If we were going to conquer the Heavens we had to strengthen Math and Science education here on Earth". This throws light into the superiority of Mathematics learning and that of Mathematics education. As the importance of Mathematics has been well recognized, achievement in Mathematics plays a vital role in the academic life of a student.

However, many researchers and agencies (Ramakrishnan, 1998; NCERT, 2000; Directorate of Public Instruction, 2002) observed that the failure rate in Mathematics is very high. While student's ability is a significant determining factor of his or her scholastic performance, many students fail to attain the scholastic level as predicted by their abilities. Failure and low achievement of capable children may be an important reason for wastage and stagnation at school level. Moreover to achieve below an individual's capacity in any field of endeavor leads to personal loss and national waste.

This significant loss of human potential affects not only the national strength, but also personal satisfaction and productivity throughout the individual's life. Under-achievement in any subject, especially in Mathematics, should be looked upon as a drain of national wealth and talents. Such a loss of talent in Mathematics is intolerable both for the individual and the society. A country that has placed its full faith in its ability to transform a 'developing country' to 'a developed' country cannot afford to ignore the incidence of Under-achievement in Mathematics. Hence all concerned in the field should work relentlessly to reshape our educational system to help students make the best use of their capacities and secure the growth which potentialities permits them to do.

A serious examination of factors affecting Mathematics achievement in Secondary school level is critical because it is in these years the students contemplate and negotiate future trajectories. Under-achievement is not a problem but a symptom of problems. To address these problems educators must explore factors contributing to under- and over-achievement. One or many of the factors can hinder student achievement. Hence identification of psychological factors contributing to achievement in Mathematics is of paramount importance.

Identification of the major factors that contribute to under-achievement is the first step in the process of eradicating under-achievement. To stress this point the Education Commission (1964-66, p. 242) comments as follows. "The first step is to diagnose the causes of these factors by observation, interrogation and the application of psychological tests, if possible. Such a collection of data will make it possible to have a total appraisal of the situation and indicate remedial treatment". Once these factors are identified, the next question that needs to be answered is: which of these factors can be manipulated through education? Factors, which can be educationally controlled, can be suitably manipulated so as to minimize the incidence of under-achievement and maximize the possibility of normal- and over-achievement.

To identify Under- and Over-achievers in Mathematics and giving them encouragement to attain their maximum potential is of primary importance to a Mathematics teacher. This may help to minimize the incidence of under-achievement and will provide opportunities for bright children to work to their potential. Although the discrepancy cannot be completely eliminated, the incidence of under-achievement can be minimized. To obtain this objective Under-achievers in Mathematics are to be identified and factors, which discriminate Under- and Over-achievers in Mathematics, are to be found out. Techniques for their manipulation have to be identified. Instructional programmes are to be organized to suit the abilities, capacities, and personalities of each child and should enable them to progress satisfactorily. In this circumstance, the investigator feels that the present study is highly relevant and significant.

The investigator is a Mathematics Teacher. As a result of experience gained from the classrooms for several years, the investigator observed that pupils with almost equal intelligence and receiving the same instruction differ in their performance in examinations. The investigator also noticed that many pupils who are sufficiently intelligent and scoring high marks in other subjects do not get comparable marks in Mathematics. This is a problem always felt by the investigator requiring close scrutiny and study.

Many studies were conducted to find out the causal variables of overall Under- and Over-achievement. But only a few have made attention to Under- and Over- achievement in Mathematics. Studies by Menon (1972), Vishoi (1975), Iyer (1977), Nair (1981), Sharma (1981), Puri (1987), Nair (1987), Flory(1987), Ramachandran (1990), Stella and Purushothaman (1995), Bindu(2001), Ajawani and Rungta (2004) are some of the noticeable studies.

A review of the studies revealed that many psychological variables have significant relation with Under- and Over-achievement. Under- and Over-achievement is related with Achievement Motivation (Kulwant, 1973; Gupta, 1983; Singh, 1983; Madhavan, 1990; Ford, 1995), with Interest (Pathak, 1972; Tandon, 1983; Maitra, 1985; Bindu, 1996), with Anxiety (Vishnoi, 1975; Soman, 1977; Somasundaram, 1980; Nair, 1984), with Creativity (Lalithamma, 1973) and with Aptitude (Sharma, 1995). Reviewed studies also revealed that studies on the relation of Under- and Over-achievement with cognitive variables are very rare. Again it is noticed that many a researchers had given attention to only one dimension of disparity viz., Under-achievement.

Most of the studies reviewed, seemed to be related to overall Under- and Over-achievement of pupils. And only a few of the studies are on Mathematics Achievement. Though the effect of the psychological variables on Under- and Over-achievement in Mathematics had been studied individually by many researchers, the influence of these variables collectively on Under- and Over-achievement is lacking. As the effect of psychological variables on Under- and Over-achievement in Mathematics vary, it is necessary to identify the combination of variables, which discriminate Under- and Over-achievement in Mathematics.

Hence in this study, the investigator has made an attempt to find the extent of Under- and Over-achievement in Mathematics and also to identify the combination of psychological variables, which discriminates Under- and Over-achievers in Mathematics. The Discriminant Functions derived in the study will be helpful in future to classify student as Under-, Normal- and Over-achievers in Mathematics using the scores of the select psychological variables.

The investigator further hopes that this study has a special significance in our society, which wants to meet the challenges of the modern technological developments and exploit the opportunities of globalization.

1.2. STATEMENT OF THE PROBLEM

Incidence of Under-achievement is a crucial problem facing educationalists and psychologists all over the world. Under-achiever is considered to be a tragedy because such a person represents a drain in the reservoir of talent available in the society. Hence solution of this problem is an urgent need for the development of the society and for improving the welfare of individuals. The present study is aimed at finding out the extent of Under- and Over-achievement in Mathematics and to find out the psychological variables discriminating between Under- and Over-achievers in Mathematics. The investigator hopes that the present study will be helpful to minimize Under-achievement and maximize Over- and Normal-achievement in Mathematics. The problem for the present study is entitled: "**A STUDY OF SOME PSYCHOLOGICAL VARIABLES DISCRIMINATING BETWEEN UNDER- AND OVER-ACHIEVERS IN MATHEMATICS OF SECONDARY SCHOOL PUPILS OF KERALA**".

1.3. DEFINITION OF KEY TERMS

The key terms used in the study are defined below for their meaning in the study.

1.3.1. Psychological Variables

The term psychological variables stands for a set of cognitive and affective variables presumed to have relation with academic Achievement in Mathematics

1.3.2. Discriminating

In the study the term is used to indicate the nature of the study as comparative survey and to indicate the statistical process 'discriminant analysis' for finding out variables capable of differentiating between Under- and Over-achievers in Mathematics.

1.3.3. Under-and Over-achievers in Mathematics

In Blond's Encyclopedia of Education, Blishen (1969) defines Under-achievement and Over-achievement as follows:

1.3.3.1. Under-achievement: This is a term generally used to describe academic performance well below the expectations raised by the results of an Intelligence test.

1.3.3.2. Over-achievement: This term usually refers to academic performance that is far better than one could predict from the results of an Intelligence test.

In Encyclopedic Dictionary of Education, Mehnderata (1997) defines Under-achiever and Over-achiever as follows:

1.3.3.3. Under-achiever: A student whose academic performance is thought to fall below the evaluation and expectation of his or her potential.

1.3.3.4. Over-achiever: A student whose academic performance is thought to exceed the evaluation and expectation of his or her potential.

On the basis of the above definitions, Under-and Over-achievers in Mathematics are defined for the study as follows.

1.3.3.5. Under-achievers in Mathematics (UA)

Under-achievers are pupils whose scores in the test of Achievement in Mathematics are below the predicted scores of Achievement, when statistical prediction is made on the basis of scores obtained on a standardized test of Intelligence.

1.3.3.6. Over-achievers in Mathematics (OA)

Over-achievers are pupils whose scores in the test of Achievement in Mathematics are above the predicted scores of Achievement, when statistical prediction is made on the basis of scores obtained on a standardized test of Intelligence.

Thus Under-and Over-achievers are deviant or discrepant achievers from the normal expectation of achievement based on the level of Intelligence. Therefore this type of under/over achievement is referred in the study as **Discrepant Achievement**.

1.3.4. Secondary School Pupils

Pupils studying in standards VIII, IX and X are theoretically secondary school pupils. For the present study, standard IX pupils were considered to represent the three standards of secondary school pupils.

1.4. OBJECTIVES

The study is designed with the major objective that two linear functions of the select psychological variables can be identified, which will help to predict Under-achievement in Mathematics. For this, the objectives set for the study are the following:

1. To find out the incidence rates of Under-, Normal- and Over-achievement in Mathematics among standard IX pupils.
2. To compare the mean scores of each of the select psychological variables between Under-, Normal- and Over-achievers in Mathematics and to know the variables for which the three groups are significantly different.
3. To estimate the extent of relationship of each of the select psychological variables with Achievement in Mathematics.
4. To test the dependency of the select Psychological variables with Discrepant Achievement classified as Under-, Normal- and Over-achievement.
5. To identify a Discriminant Function in terms of psychological variables to predict group membership as Under-, Normal-, and Over-achievers.

1.5. HYPOTHESES

The hypotheses set for the study are the following:

1. The three groups of pupils Under-, Normal- and Over-achievers in Mathematics will differ significantly for each of the select psychological variables.
2. Each of the select psychological variables will be significantly related to Achievement in Mathematics.
3. Discrepant Achievement in Mathematics (classified as Under-, Normal- and Over-achievers) is dependent on each of the select psychological variables.
4. Group membership as Under-, Normal- and Over-achievers can be significantly predicted by a Discreminant Function in terms of the select set of psychological variables.

1.6. METHODOLOGY

1.6.1. Sample

The study was conducted on a final sample of 992 pupils of standard IX drawn from 19 schools of Kozhikode district, using stratified sampling technique. The strata considered were gender of pupils, locale of pupils and type of management of schools.

1.6.2. Variables

The study is designed with two types of variables viz., criterion variables and predictor variables. The criterion variables are,

1. Achievement in Mathematics, and
2. Intelligence

The predictor variables of the study are the following psychological variables,

1. Mathematical Creativity
2. Mathematics Aptitude
3. Mathematical Problem Solving Process Skills
4. Mathematics Anxiety
5. Mathematics Interest
6. Achievement Motivation in Mathematics

1.6.3. Tools of the Study

The investigator constructed and standardized the following tools for the study:

1. Achievement Test in Mathematics
2. Test of Mathematical Creativity

To measure all other variables the investigator used available standardized tools.

1.6.4. Statistical Techniques Used

The investigator used the following statistical techniques for the analysis of the data.

i) Two-tailed test of significance of difference between means for large independent samples (t-test).

ii) One-way analysis of variance

iii) Estimation of Pearson's product moment coefficient of correlation.

iv) Chi-square test of independence

v) Discriminant analysis by Fisher.

1.7. SCOPE OF THE STUDY

The present study is aimed at finding out whether the select psychological variables are capable of predicting group membership as Under-, Normal-, and Over-achievers in Mathematics of secondary school pupils of Kerala. To identify these groups of pupils, the investigator used two standardized tests. One is the standardized test of Intelligence developed following Sternberg's three-factor theory of Intelligence. For this test, the items comprised of three parts of Intelligence viz., Componential part, Contextual part and Experiential part. The other is a standardized test of Achievement in Mathematics. This is a purely objective type test (multiple-choice) and the test consists of items to measure the objectives viz., knowledge, understanding, application and skill. The investigator therefore believes that the groups identified on the basis of these two criterion tests are valid to yield dependable results.

The investigator selected the psychological variables on the hope that each of these will be significantly related to Achievement in Mathematics and hence will be significantly different for the three categories of Achievement. Review of the literature also helped the investigator to select the psychological variables that have relation on Achievement in Mathematics.

The t-test and one-way analysis of variance used in the study helped to identify the variables for which Under-achievers differ from Normal- and Over-achievers in Mathematics. Further, the relationship of Achievement in Mathematics with each of the select psychological variables revealed the extent of relationship between the variables. This will be helpful for teachers to find out the strategies for developing the psychological characteristics, which have high relation with Achievement in Mathematics.

The Discriminant Functions derived in the study will be useful to identify Under-, Normal- and Over-achievers in Mathematics. Identification of Under-achievers will be helpful to give special attention by way of instructional or learning strategies and thereby reduce Under-achievement. Encouragement can be given to Normal- and Over-achievers.

Since the tools used are standardized and the sample selected is stratified, the investigator hopes that the findings of the study will be valid and can be generalisable.

1.8. LIMITATIONS OF THE STUDY

Even though precautions were taken to make the study as valid as possible, certain limitations have crept into the study. The following are some among these.

1. Even though the population of the study comprises of all secondary school pupils of Kerala, the sample for the study is not a statewide sample, but confined to only one district of Kerala viz., Kozhikode, for practical reasons.
2. Secondary school pupils comprise of pupils belonging to standard VIII, IX and X. But limitation of time and other practical difficulties forced the investigator to confine the study to standard IX students as standard IX pupils will reasonably represent secondary school pupils.
3. Previous studies suggest that many psychological and environmental variables contribute to Achievement in Mathematics. But for the present study only six variables of cognitive and affective domains were selected for testing. The number of variables was restricted to six for practical consideration such as scoring, collection of data etc.

In spite of all these limitations the investigator hopes that the study will give dependable findings, which will lead to valuable contributions to the theory of Under-achievement and for better practices in education.

1.9. ORGANIZATION OF THE REPORT

The report of the study is organized in five chapters, viz., Introduction, Review of Related Literature, Methodology, Analysis, and Summary, Conclusions and Suggestions.

The first chapter presents the need and significance of the study, statement of the problem, definition of key terms, variables, objectives, hypotheses, methodology, scope and limitations of the study.

The second chapter presents a detailed review of studies on the incidences of Under-, Normal- and Over-achievement, psychological variables discriminating Under-, and Over-achievers and relation of psychological variables with Academic Achievement.

Chapter three presents the methodology used for the study in detail. This chapter includes description of variables, tools used for data collection, sample used, identification of different types of Achievement, data collection procedure, scoring and consolidation of data and statistical techniques used for the analysis.

Chapter four gives the details of analyses of data. Apart from preliminary statistical analysis of the data and the extent of Under- Normal- and Over-achievement, this chapter presents the results of t-test, one-way analysis of variance, correlational analysis, chi-square test of significance and discriminant analysis. Major findings of the study and tenability of the hypotheses are given at the end of this chapter.

Fifth chapter deals with the major findings, conclusions drawn, educational implications of the study and suggestions for further research in the area.

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CHAPTER II

REVIEW OF RELATED LITEARATURE

- ***Studies on the Incidence of Under-, Normal- and Over-Achievement***
- ***Studies on Psychological Variables Discriminating between Under- and Over-Achievers***
- ***Studies on the Relation between Psychological Variables and Achievement in Mathematics***
- ***Trend Report***
- ***Conclusion***

A careful review of the related literature is one of the major stages or steps in any research study. When the study is based on the literature, we can hope for cohesive and integrated approaches to our problems and for resolution and solution of them through research. "Review of the previous research will yield clues to the techniques of research. The researchers would hope to gain help in deciding how to do his own project by seeing how others have studied in the area, and the success they have achieved with different research approaches, methods and techniques." (Fox, 1969, p.44).

Any scientific investigation can be successfully completed only if the background concepts and earlier studies are adequately surveyed. The originality of research often depends on a critical reading of a wide-ranging literature. The nature of this concerns, on the one hand, immersing oneself in the topic to avoid the shallowness of quick and dirty research and, on the other, there is the need to identify the key ideas and methodologies from which some contribution to knowledge is made.

The present study is in the area of Under- and Over-achievement in Mathematics with a view to find the factors discriminating Under- and Over-achievers in Mathematics. By the review of related literature, the investigator found that the area of Under- and Over-achievement in Mathematics is not much researched. Therefore, the investigator reviewed literature related to academic Under- and Over-achievement, not concentrating on Under- and Over-achievement in Mathematics alone.

Reviewed studies and literature made by the investigator are given in three sections viz.,

Section I: Studies on the Incidence of Under-, Normal- and Over-achievement

Section II: Studies on Psychological Variables Discriminating between Under-, and Over-achievers

Section III: Studies on the Relation Between Psychological Variables and Achievement in Mathematics.

2.I. STUDIES ON THE INCIDENCE OF UNDER-, NORMAL- AND OVER-ACHIEVEMENT

The concept of Under-, Normal-and Over-achievement takes into account the Academic Achievement in relation to the intellectual level of the individual. Under-and Over-achievers are individuals whose Achievement is respectively below and above their proven ability level and Normal-achievers are individuals whose Achievement is at par with the ability level.

Incidences of Under-, Normal-and Over-achievement have been studied in a number of studies. Some of the available studies are presented below.

In a comparative study of Under-and Over-achievers of High-Ability group, **Menon (1972)** found that among 663 boys 18 are Over-achievers and 15 are Under-achievers in the High-Ability group. Among 656 girls, 19 are Over-achievers and 19 are Under-achievers in the High-Ability group.

Lalithamma (1973) studied on factors related to Achievement in Mathematics and found that out of 732 pupils 196 are Under-achievers, 374 are Normal-achievers and 162 are Over-achievers in Mathematics.

Abraham (1973) in her study found that out of 820 students covered for the study, 126 are Under-achievers; 572 are Normal-achievers and 122 are Over-achievers in English.

Nair (1974) noticed that nearly 28 percent of pupils of high intelligence are Under-achievers in Mathematics. **Dhaliwal and Saina (1975)** estimated that 47.46 percent of pupils are Under-achievers in Mathematics.

Iyer (1975) studied on some personality factors related to Under-achievement in Science and found that 14 percent of the sample studied is Under-achievers.

Mathew (1975) while studying on some personality factors related to Under-achievement in Science found that out of 803 students studied, 126 (15.69 percent) are Under-achievers, 565 (70.36 percent) are Normal-achievers and 112 (13.95 percent) are Over-achievers in Science.

Iyer (1977) studied on some factors related to Under-achievement in Mathematics and estimated that out of 651 secondary school students studied, 94 (14.43 percent) are Under-achievers, 374 (51.04 percent) are Normal-achievers and 81 (12.44 percent) are Over-achievers in Mathematics.

Behrens and Vernon (1978) observed that among the grade VII students 20 percent are Under-achievers, 60 percent are Medium-achievers and 20 percent are Over-achievers in their Academic Achievement.

Whitmore (1980) estimated that at least 20 percent of gifted students Under-achieve, while the U.S. Commission on Excellence in Education (1983) estimated 50 percent.

Nair (1984) found that out of the 877 students studied, 151 (17.22 percent) are Under-achievers, 146 (16.65 percent) are Over-achievers and 580 (66.13 percent) are Normal-achievers in Biology.

While investigating the study habits and Under-achievement among rural girls **Sharma (1986)** found that out of 1225 girls studied 200 are Under-achievers.

Flory (1987) studied on Under-achievement in Mathematics of University entrants and found that out of the 681 students studied, 149 (21.88 percent) are Under-achievers, 430 (63.15 percent) are Normal-achievers, and 102 (14.97 percent) are Over-achievers in Mathematics.

Sreethamony (1987) studied on the Academic Achievement of secondary school students and observed that out of 710 students studied, 100 (14.71 percent) are Under-achievers, 466 (68.53 percent) are Normal-achievers and 144 (16.76 percent) are Over-achievers.

Nair (1987) while studying on High-creative and Low-creative Under-achievers in secondary school Science pointed out that out of the 977 students, 260 (26.61 percent) are Under-achievers, 578 (59.16 percent) Normal-achievers, and 139 (14.23 percent) Over-achievers in Science.

In a comparative study of Under- and Over- achievers, **Uchat (1987)** found that among 1143 pupils, 111 are Under-achievers and 88 are Over-achievers.

Raj (1991) estimated Under-, Normal- and Over-achievers in Mathematics and found that 19 percent are Under-achievers, 58 percent are Normal-achievers, and 23 percent are Over-achievers in Mathematics.

Badwal and Sood (1991) reported that in a sample of 96 rural class V pupils 84 are Under-achievers in Arithmetic.

Kaile and Kaur (1992) studied on Under-and Over-achievers and found that in a sample of 203 IXth standard girls 57 are Under-achievers and 56 are Over-achievers.

Ford (1995) studied on the Academic Under-achievement of Black gifted students and found that 46 percent of them are Under-achievers in Academic Achievement.

Sharma (1995) in her study reported that out of the 500 standard X pupils studied, 78 (15.6 percent) are Under-achievers and 85 (17 percent) are Over-achievers.

Ramesan (2000) in his study found that out of 715 students, 123 (17.2 percent) are Under-achievers, 471 (65.9 percent) are Normal-achievers and 121 (16.9 percent) are Over-achievers in Malayalam.

Bindu (2001) studied on the affective correlates of Under-and Over-achievement and reported that out of 879 standard IX pupils, 125 (14.22percent) are Under-achievers and 93(10.58 percent) were Over-achievers in Mathematics.

Ajawani and Rungta (2004) reported that out of the 90 pupils studied, 14 are Under-achievers, 70 are Normal-achievers, and 6 are Over-achievers.

2.2. STUDIES ON PSYCHOLOGICAL VARIABLES DISCREMINATING BETWEEN UNDER-, AND OVER-ACHIEVERS

Studies conducted in the field of Under-, Normal- and Over-achievement in relation to the psychological variables of this study are given below.

Pal and Saxena (1970) studied the problems of Over-, Normal- and Under-achieving college students and found that Under-achievers lack Motivation and are less interested in their studies.

Dhaliwal (1971) studied the personality correlates of Under- and Over-achievement and found that both Over- and Under-achievers have high Need for Achievement as compared with Normal children. The study also revealed that Over- and Under-achievers have greater Anxiety than Normal- achievers.

Quigley (1972) studied the effect of order of success reinforcement on Problem Solving Persistence of Over-achievers and Under-achievers and found that Under-achievers lack Motivation.

Saxena (1972) in a study of Interest, Need pattern and Adjustment problems of Over- and Under-achievers found that Achievement is an area that requires Interest in associated activities.

Menon (1972) conducted a comparative study to find out the personality characteristics of Under- and Over-achievers of High-Ability using a sample of 1319 students (663 boys and 656 girls) and found that Over- and Under-achievers can be differentiated in Academic Interest and endurance.

Pathak (1972) studied the factors, which discriminate between High- and Low- achievers in Science and found that Under-achievers show lack of interest in their studies.

Kulwant (1973) studied the difference existing among Under-, Normal- and Over-achieving students and found that Achievement Motivation affects Under-achievement.

Lalithamma (1973) studied on Creativity of Under-, Normal- and Over-achievers among Xth grade students and found that significant positive relation exists between Creativity and Scholastic Achievement.

Simmon and Bibb (1974) studied on Under-achievement and found that Achievement Motivation affects Under-achievement.

Chaudhari and Jain (1975) studied on factors contributing to Academic Under-Achievement. He found that Achievement Motivation of Bright-achievers is greater than that of Bright-Under-achievers, and Dull-achievers are low in Achievement Motivation than that of Bright-Under-achievers. The study also revealed that Dull-achievers with low level of Achievement had high level of Anxiety.

Mathew (1975) studied on some personality factors related to Under-achievement and found that General and Test Anxiety can discriminate Under-achievers from Over-achievers.

Vishnoi (1975) studied the effect of Anxiety in relation to Under- and Over-Achievers and found that Under-achievers are more anxious than Over-achievers.

Tandon (1975) found that male Under-achievers displayed the following personality characteristics- easy going and outgoing, emotionally less stable, low in frustration, shy, apt to inferiority feelings, pessimistic, harsh, assertive and highly anxious.

Nair *et al.* (1975) studied the influence of sixteen personality variables that are related to Under-achievement in Mathematics. The study found that General Anxiety and Test Anxiety are helpful in discriminating between High-Intelligent Normal-achievers and High-Intelligent Under-achievers.

Kohli (1975) while studying the behavioral and environmental correlates of Academic Achievement found that Achievement Motivation affects Under-achievement.

Ghuman (1976) found that out of the 1948 students of IX, X and XI, 291 are Over-achievers and 236 are Under-achievers. The Over- and Under- achievers do not differ significantly on the variables Aptitudes, Achievement Motivation and personality traits. Over-achievement is primarily determined by the non-intellectual personality variables whereas Under-achievement is closely related to the intellectual factors.

Soman (1977) found that Under-achievers in Mathematics are more anxious than Normal-achievers in both General and Examination Anxiety. Test Anxiety discriminates significantly between Over- and Under-achievers at 0.01 level. But General Anxiety could not discriminate between the two groups.

Iyer (1977) studied on some factors related to Under-achievement in Mathematics of secondary school students and found that I) out of the fourteen personality variables selected ten variables including Test Anxiety and General Anxiety are most effective in discriminating between the Achievement pairs viz., Over-achievers and Normal-achievers and Normal-achievers and Under-achievers ii) none of the fourteen personality variables is able to discriminate between Over-achievers and Non Over-achievers, Non-Under-achievers and Under-achievers, Normal-achievers and discrepant Achievers.

Aggarwal and Krishna (1978) found that Achievement Motivation affects Under-achievement.

Nagpal (1979) studied the non-intellectual characteristics of Over- and Under- achievers and found that Under- and Over-achievement were dependent on the students' interest on the specific subject.

Somasundaram (1980) conducted a comparative study of personality variables related to Over-, Normal- and Under-achievers in Mathematics and found the variable Test Anxiety can discriminate between Under-achievers and Non-Under-achievers. The variables General Anxiety discriminate between unselected groups of Over-achievers and Under-achievers.

Srivastava (1981) found that Under-achievement is related to low Academic Motivation.

Krouse and Krouse (1981) studied on achieving and under-achieving bright elementary students and found that Under-achievement is associated with Test Anxiety.

Sharma (1981) using a sample of 1225 secondary school girls of Haryana studied the factors related to academic Under-achievement and found that poor Academic Motivation contributed to Under-achievement.

Gupta (1983) using a sample of 312 female and 310 male students studied on Academic Achievement and found that Achievement Motivation is significantly correlated with Academic Achievement and with Over- and Under-achievement.

Singh (1983) found that the motivational organization of Under-achievers to be significantly less than that of Over-achievers.

Tandon (1983) studied the personality characteristics of 200, tenth standard Under-achievers and found that both male and female Under-achievers are less interested in studies and spend their time in roaming. The study also revealed that male and female group of Under-achievers are highly anxious.

Assia (1984) found that General Anxiety could differentiate High-Intelligent Under-achievers and Low-Intelligent Under-achievers, latter showing more Anxiety. She also found that Achievement Motivation does not differentiate Under-achievers from Over- and Normal-achievers, and High-Intelligent Under- and Low-Intelligent Under-achievers.

Valsamma (1984) found that General Anxiety is capable of differentiating Under-achievers from Over-achievers and Normal-achievers. It was also found that Achievement Motivation could not differentiate Under-achievers from Over- and Normal-achievers.

Nair (1984) studied the factors related to Under-achievement in Biology and found that mean Attitude towards Problem Solving is high for Over-achievers than Under- and Normal-achievers. Attitude towards Problems Solving is helpful in discriminating between Over- and Under-achievers in Science at 0.01 level.

Nair (1984) conducted study to find out the variables discriminating Under-achievers and Non-Under-achievers and found that Anxiety and Achievement Motivation can differentiate Under-achievers from Over- and Normal-achievers in Malayalam.

Gaver and Golicz (1984) found that Under-achievers are highly anxious.

Gitanjali (1984) in her study of some personality variables discriminating between High-Intelligent Under-achievers and Low-Intelligent Under-achievers in Chemistry found that Attitude towards Problem Solving influence the Achievement of pupils in Chemistry.

In a study on secondary pupils of Kerala, **Nalini (1984)** found that Achievement Motivation is a significant factor differentiating High-Intelligent Under-achievers and Low-Intelligent Under-achievers.

Maitra (1985) studied on Gifted Under-achievers using a sample of 1020 class VII students of Delhi and found that i) Gifted Under-achievers lack interest in their studies and extra reading, and are more interested in mechanical work ii) Over-achievers have manifold interest and general reading habits iii) the gifted Over-achieving boys showed a higher score on Achievement Motivation than gifted Over-achieving girls.

In a comparative study of certain cognitive, affective and social variables discriminating between High-Creative and Low-Creative, Under-achievers in secondary school Science, **Nair (1987)** found that there is no significant difference between the two groups in Examination Anxiety and General Anxiety. But there is significant difference in Achievement Motivation between the two groups.

Madhavan (1990) investigated some factors related to Achievement in Malayalam and found that Over- and Under-achievers differ significantly in General Anxiety at 0.01 level and Achievement Motivation at 0.05 level.

Chel (1990) examined the problems of Under-achievement in Mathematics and found that the reasons for Under-achievement are Fear and Anxiety in the part of students.

Raj (1991) in his study of some attitude variables discriminating between Over-, Normal- and Under-achievers in Mathematics at secondary school level, tested the mean scores of each attitude variables and found that there is no significant difference in Attitude towards Problem Solving of Over-, Normal- and Under-achievers in Mathematics.

Ford (1995) studied on Achievement and Under-achievement among Black students and found that Under-achievers are unmotivated and disinterested in their studies.

Sharma (1995) using a sample of 500 class X students studied the impact of specific aptitudes of Over- and Under-achievers. The findings are I) Over-achievers surpassed Under-achievers in Scientific Aptitude ii) Under-achievers surpassed Over-achievers in Reasoning Aptitude, Verbal Aptitude and Numerical Aptitude iii) No significant difference between Over-achievers and Under-achievers in terms of sex and stress of study.

Bindu (1996) studied the causes of Under- and Over-Achievement of secondary school pupils and found that lack of Interest is a cause of Under-achievement.

Ford and **Thomas (1997)** studied Under-achievement among minority students and reported that Under-achievers are unmotivated and are discriminated in school.

Ramesan (2000) studied on High-Creative Under-achievers and Low-Creative Under-achievers in Malayalam and found that the two groups differ significantly in the mean scores of Achievement Motivation.

Bindu (2001) studied on the association of certain affective variables with Under- and Over-achievement in six school subjects and found that Examination Anxiety is not significantly associated with Under- and Over-achievement in Mathematics.

Lau and **Chan (2001)** studied on the Motivational characteristics of Under-achievers in Hong Kong classified pupils (N=126) as Under-, Low- and High-achievers. They found that the three groups differed on the combination of Motivational variables, Verbal and Intellectual Ability and Interest in study.

Ajawani and **Rungta (2004)** investigated on the Intelligence variance of Under- and Over-achievers and found that Intelligence is not a variance in Under- and Over-achievement.

Jones and **Myhill (2004)** in their U. K. based study associate boys with Under-achievement and girls with High-achievement in Mathematics. They also found that i) girls are easier to motivate ii) Under-achievers are more likely to be off-task than High-achievers iii) Under-achievers are not much interested in academic activities related to Mathematics.

2.3. STUDIES ON THE RELATION BETWEEN PSYCHOLOGICAL VARIABLES AND ACHIEVEMENT IN MATHEMATICS

By the review of literature investigator could locate many studies on the relation between the psychological variables and academic achievement long back. But to make this section precise, the investigator presented studies from 1980 onwards only.

The psychological variables considered for the present study can be divided into two groups viz., cognitive variables and affective variables. So Studies reviewed in this section are presented in two heads.

a) Cognitive Variables and Achievement in Mathematics

b) Affective Variables and Achievement in Mathematics

2.3.1. Cognitive Variables and Achievement in Mathematics

Studies on the relation of each of the cognitive variables with Academic Achievement are given separately.

2.3.1.1. Creativity and Academic Achievement

Kabu (1980) conducted a psychological analysis of 550 Mathematically Gifted and Non-Gifted students. Mathematically Gifted are found to be significantly higher on all the six factors of Creativity.

In a study **Asha (1980)** found significant positive relation between Creativity and Scholastic Achievement.

In a study of Creative Thinking of high school students of Himachal Pradesh in relation to some cognitive and non-cognitive variables, **Singh (1982)** found that there is positive correlation between Creativity and Scholastic Achievement. **Dey (1984)**, and **Ramjee (1984)** found that there is positive correlation between Creativity and Achievement.

Sreelatha (1984) in her study on the interaction of Creativity, Intelligence and Achievement in Mathematics on secondary school pupils found that there exists significant positive correlation (r=0.251) between Creativity and Achievement.

Tuli (1985) carried out a study using a sample of 439 class IX students and found that Mathematical Creativity is significantly related to Aptitude for Mathematics and Achievement in Mathematics, whereas it is not significantly related to Attitude towards Mathematics.

Gakhar (1985) using a sample of 170 standard IX students conducted a study on Creativity in relation to Mathematics Achievement and found that there exists significant correlation between Creativity and Achievement in Mathematics.

Raina (1986), Brar (1986), Rani (1986) and **Desai (1987)** found that there exists significant positive correlation between Creativity and Scholastic Achievement.

Malini (1990) in her study on the effect of certain cognitive variables and Mastery Learning Strategies on Achievement in Mathematics found that the main effect of Mathematical Creativity on Achievement in Mathematics is significant at 0.01 level.

Chadha and **Chandna (1990)** studied on the relation of Creativity, Intelligence and Scholastic Achievement and found a positive first order correlation between Creativity and Achievement. When Intelligence was partialled out, they got only negative relationship between Creativity and Achievement.

In a study of the future orientation of ninth grade pupils with high level of Creativity with respect to certain cognitive and non-cognitive variables **Gore (1990)** found that there is significant positive correlation between Creativity and Scholastic Achievement.

Dhalla (1990), Padhan (1990) and **Loomba** and **Verma (1990)** found that there is significant positive correlation between Creativity and Scholastic Achievement.

McCabe and **Marita (1991)** studied the influence of Creativity and Intelligence on Academic Performance using a sample of 126 female students. The study found that to a lesser extent high Creativity scores are associated with Achievement in Mathematics. Although high levels of Creativity may be associated with high levels of Academic Performance, their role is not a causative one.

Carroll and **Howieson (1991)** carried out a study using a sample of 48 seventh grade students and obtained that in Mathematics highest scores are achieved by the High-Creative group.

Subrahmaniyan and **Ramadevi (1991)** reported that there exits significant relation between Creativity and Academic Achievement.

Srivastava and **Srilatha (1992)** studied the impact of enrichment program to foster Creativity among academically gifted school children and found that Creativity and Scholastic Achievement have positive significant correlation. **Patel (1992)** and **Arora (1992)** also found significant positive correlation between Creativity and Achievement.

Padhi (1992) studied the effect of Creativity and classroom environment on pupils' Academic Self-Concept and Academic Achievement and found that there is significant relation between

Creativity and Academic Achievement. He also found that the interaction effect of Creativity and classroom environment is significant on Scholastic Achievement.

Bhawalkar (1992) studied the relationship of Scientific Creativity with Achievement in Mathematics and Academic Achievement separately using a sample of 663 students of class IX and X from six schools situated in Ujjain, Mhow and Indore and found that students with high Academic Achievement and high Achievement in Mathematics possess high Scientific Creativity.

Mondel's (1992) study with a sample of 48 students of class VI drawn from the schools situated in semi urban area obtained that the correlation between Achievement and Creativity scores is highest in the case of Medium-achievers and lowest in the case of Low-achievers. The High- achievers are not so much creative as Medium-achievers.

Thampuratty (1994) in her study on the interaction effect of Creativity and Attitude towards Problem Solving on the Achievement in Mathematics of secondary school pupils found that the main effect of Creativity on Mathematics Achievement is significant (F=5.02 with (2, 752) degrees of freedom).

Kim and **Michael (1995)** studied the relationship of Creativity measures to School Achievement of Korean high school students and found that measures of Creativity showed little relationship to school performance.

Padhi (1995) studied the influence of Creativity on Academic Performance of standard IX students using a sample of 636 pupils (379 boys and 257 girls) found that there exists a significant positive correlation (r =0 .3) between Creativity and Mathematics Achievement.

Bawa and **Kaur (1995)** studied on Creativity and subject wise Achievement using a sample of 600 class X students from thirty high and higher secondary schools of Patiala district. The findings are:

i) In the case of males, there is significant positive correlation between all the four measures of Creativity and Achievement in all subjects except Social Science.

ii) As regards females there exists positive correlation between all four measures of Creativity and Academic Achievement.

iii) Prediction of Academic Achievement in school subjects is quite reliable if it is made on the basis of measures of Creativity in the case of males, females and total sample.

Sobha (1995) found that Mathematical Creativity could discriminate between High- and Low- Mathematically able pupils.

Kapoor (1996) studied the Creative Thinking Ability of high school pupils of Arunachal Pradesh in relation to the sex and Academic Achievement using a sample of 300 pupils consisting of 110 tribal and 190 non-tribal pupils found that there exists no difference in the mean scores of Creativity of High- and Low- achievers.

Using two-way ANOVA **Resmi (1997)** found that the main effect of Mathematical Creativity on Achievement in Mathematics is significant (F= 234.44). She also found that the correlation between Mathematical Creativity and Achievement in Mathematics is very high ($r = 0.84$).

Using a sample of 300 standard VIII students **Jyothi (1997)** studied the influence of Creativity on Mathematics Achievement. She found that Mathematics Achievement increases with Creativity. There exists significant positive correlation between Creativity and Mathematics Achievement ($r = 0.53$).

Chadurvedi (1997) conducted a study on 1130 tribal students of class XII drawn from 12 tribal schools and found that High- and Low-Creative tribal boys and girls significantly differ in Academic Achievement.

Using a sample of 595 students (335 urban and 260 rural) from nineteen primary schools of Bhopal division studying in class V, **Khare and Grewal (1997)** found that the coefficient of correlation between Creativity and Academic Achievement of students studying in urban and rural primary schools are significant.

Behera (1998) found that level of Academic Achievement has significant effect on all the components of Creativity and total Creativity. The relationship between Achievement and Creativity is found to be significant in the case of High-achievers and central school students but negligible in the case of Low-achievers and state school students.

Mumthas (2001) found that all components of Creativity, fluency (r=0.55), flexibility (r=0.54), and Originality (r=0.45) have significant relation with Mathematics Achievement.

Vidyapati and **Rao (2003)** found that pupils with high Creative Abilities have good Achievement scores.

Gakhar and **Sood (2003)** found that only one measure of Creativity i.e. Fluency was positively and significantly correlates with Mathematics Achievement in residential school sample (r=0.123) but no significant correlation with non residential school students.

Chaudhary (2004) compared urban and rural high school boys and girls in relation to Creativity and found that boys and girls are scoring nearly equal for all Creativity factors viz., Fluency, Flexibility, Originality and Elaboration. Mean Creativity score of High- Intelligent group were significantly higher than that of Low- Intelligent group. The study also found differences in mean Achievement scores between rural girls and rural boys for all the Creative Abilities.

Shi (2004) studied the Intelligence current in Creative Abilities and found that higher the Intelligence level, the greater the Creative performance one can achieve.

Kuncel *et al.* (2004) studied Academic Performance, Career Potential, Creativity and Job performance and found that general cognitive ability could predict School Performance and Creativity.

2.3.1.2. Aptitude and Academic Achievement

Kabu (1980) conducted a psychological analysis of 550 Mathematically Gifted and Non-Gifted students. Numerical Ability and Abstract Reasoning are found significantly more in Mathematically Gifted than in the Non-Gifted, both at the undergraduate and post graduate level. Mathematically Gifted are found to be significantly higher on all the six factors of Creativity.

Thomas (1981) using a sample of 501 students of standard X studied the relationship of Verbal Reasoning and Numerical Ability with Mathematics Achievement and found that there is significant relationship between them. He also found significant difference between boys and girls in Verbal Reasoning and Numerical Ability.

Menon (1982) in a study found that General Mental Ability, Space Relation, Numerical Ability, Mechanical Reasoning and Abstract Reasoning differentiated between High- and Low- Performance.

Consuegra (1982) in a study of gifted children reported that the obvious characteristics of the gifted in Mathematics is the Ability to use Numbers and that gifted pupils are capable of Abstract Thinking. Also found that gifted pupils have advance mental abilities and unusual abilities to solve problems.

Patel (1984) studied Mathematics Achievement in the context of some cognitive and affective variables and obtained that among the five cognitive functions studied in relation to Mathematics Achievement, Numerical Reasoning and Numerical Ability occupy prominent place.

In a cross-sectional study on some Differential Aptitudes of secondary school pupils **Bhattacharya (1986)** found that Abstract Reasoning and Mathematics Achievement are positively correlated.

Dubey (1987) studied the functional nature of Numerical Aptitude and it's bearing on Mathematical learning and found that Numerical Reasoning and Numerical Ability are best predictors of Achievement in Mathematics.

Mohan and **Ummat (1987)** in their study on Aptitudes as related to Academic Achievement found that Academic Achievement and Aptitudes for Mechanical Reasoning, Abstract Reasoning and Numerical Reasoning are found to be significantly correlated, but the correlations are low.

Budev (1990) in a study on the effect of cognitive variables on Achievement of 737 standard IX pupils in Mathematics found that Mathematics Aptitude affects Achievement in Mathematics. The study also revealed that the scores of Achievement in Mathematics of High-Mathematical Aptitude group are higher than that of the Low-Mathematical Aptitude group ($F=38.81$).

Gowrykuttyamma (1991) found that Numerical Ability is the best predictor of Mathematics Achievement. The correlation between Numerical Ability and Achievement is significant ($r = 0.42$)

Lalitha (1991) investigated the cognitive factor structure of High-, Average-, and Low- Mathematics-achievers and found that Abstract Reasoning, Numerical Spatial Ability and Non-Language Reasoning are the factors of the factor structure of High-achievers.

The study of **Dubey** and **Vijayakumar (1992)** using a sample of 300 class X students found that Numerical Reasoning and Numerical Facility are more important for predicting performance in Algebra.

Okamoto and **Kitao (1992)** studied the role of meta cognitive knowledge and Aptitude in Arithmetic Problem Solving and found that High-Aptitude children had higher performance than Low-Aptitude children.

Dubey (1992) using a sample of 300 class X male students studied the factorial nature of Numerical Aptitude and found that Numerical Reasoning and Numerical Facility are the best predictors of Mathematics Achievement.

Boyd (1993) reviewed studies conducted in the area of giftedness and concluded that better performance of males is a result of their higher Spatial Abilities.

Vijayakumari (1993) studied the efficiency of certain psychological variables in predicting Achievement in Mathematics of secondary school pupils and found that there exits significant positive relationship (r=0.49) between Mathematics Aptitude and Achievement in Mathematics

A study of **Gustin** and **Corazza (1994)** revealed that Verbal and Mathematical Reasoning Ability are the most powerful predictors of success in accelerated secondary Science course.

Byrnes and **Takahira's (1994)** study on a sample of 40 high school students on the Mathematics subtests of the Scholastic Aptitude Test found that successful students are better in defining problems, assembling strategies and avoiding computational errors.

Using a sample of 750 standard IX pupils **Sumangala (1995)** studied on some psychological variables discriminating between High- and Low- Achievers in Mathematics found that i) Mathematics Aptitude discriminates significantly between High- and Low-Achievers in Mathematics, ii) the relation of Mathematics Aptitude with Achievement in Mathematics is significant and positive.

Meeker *et al.*, (1995) studied using a sample of 288 students and found that students GPA were predicted by grade in Mathematics Aptitude and high school Mathematics grade.

Jovanovic and **Lerner (1995)** studied using a sample of 160 American and 242 Siberian students and found that Spatial Ability was linked to Mathematics Performance.

Malini (1995) using a stratified sample of 703 secondary school pupils revealed that i) real relation exists between the variables Numerical Reasoning and Achievement in Mathematics for boys and girls, ii) real relationship exists between the variables Ability to use Symbols and Achievement in Mathematics for boys and girls ii) low relation exists between Spatial Ability and Achievement in Mathematics for boys and girls iv) marked relation exists between Abstract Reasoning and Achievement in Mathematics for boys and girls.

Waxman ***et al.*** **(1996)** conducted a study using a sample of 284 children studying in pre-school or Kindergarten who were advanced in Mathematics and found that Spatial Reasoning is closely related to their Mathematics Reasoning.

Patricia and **Phyllis** **(1998)** studied on Attitude Towards Mathematics and the predictors of college Mathematics grades and found that Attitude rather than Scholastic Aptitude test scores are more useful in predicting grades.

Seokhoon and **Betty** **(2000)** investigated the nature of Spatial Ability as measured by four instruments based on Spatial Orientation and Visualization, and its relationship to the Mathematical Performance of elementary school pupils using a sample of 127 elementary school students (72 boys and 55 girls) aged 10 to 11 years. Results indicate a positive relationship between Spatial Ability and Mathematics Performance.

Nijenhuis ***et al.*** **(2000)** using Differential Aptitude Test compared the scores of minority and majority pupils and their relationship with Mathematics Achievement found that the components of Mathematics Aptitude (Abstract Reasoning, Spatial Relation and Numerical Ability) have strong predictive efficiency with Mathematics Achievement for both the groups. All these variables have significant positive correlation with Mathematics Achievement.

Nainitha **(2000)** found that High- Mathematical- Aptitude group had higher mean level of Achievement in Mathematics as compared to the pupils belonging to Low- Mathematical- Aptitude Group.

Mumthas (2001) found that the components of Mathematics Aptitude viz., Ability to use Symbols (r=0.42) Spatial Ability (r=0.16), Abstract reasoning (0.44), Problems Solving Ability in Mathematics (r=0.59) and Numerical reasoning (r=0.23) have significant relation with Achievement in Mathematics.

Reuhkala (2001), studied the Mathematical Skills of Ninth graders and their relationship with Visuo-Spatial abilities, found that the Low and High Mathematically able groups significantly differ in Visuo-Spatial Abilities. Visuo-Spatial Skills correlates significantly with Mathematics Achievement (r = 0.62).

2.3.1.3. Problem Solving Skills and Academic Achievement

Consuegra (1982) in a study of gifted children reported that the obvious characteristics of the gifted in Mathematics include unusual abilities to solve problems.

Kumar (1984) in his study of the influence of Intelligence and Attitude towards Problem Solving on Mathematics Achievement of secondary school pupils found that Mathematics Achievement depends on Intelligence and Attitude towards Problem Solving.

Caballos and **Estaban (1988)** in their study using a sample of 197 high school students found significant correlation with Academic Success and Successful Problem Solving Strategies.

Krishnan (1990) found that there is no significant relation between Identification of Problem Solving Strategies (IPSS) and either Application of Problem Solving Strategies or Achievement of Problem Solving in Mathematics, though the last two are significantly correlated.

Saljo and **Wyndhamn (1990)** studied on the Problem Solving and Academic performance of 45 pupils and found that the higher the Academic Ability, the larger the Problem Solving Procedures are.

Montague *et al.* (1991) conducted a study on 60 eighth grade students and found differences among students of low, average and high achieving on their knowledge of Mathematical Problem Solving Strategies and knowledge to use and control problem representation strategies.

Montague and **Applegate (1993)** examined the verbalizations of 90 middle school students while solving Mathematical word problem and reported that Average-achievers are less strategic in approaching Mathematical problem solving than gifted students.

Thampuratty (1994) in her study on the interaction effect of Creativity and Attitude towards Problem Solving on the Achievement in Mathematics of secondary school pupils found that Attitude towards Problem Solving has significant effect on Achievement in Mathematics ($F=259.037$ for (2, 752) degrees of freedom).

Lawson and **Chinnappan (1994)** compared the Problem Solving Performance of high-achieving and low-achieving eleventh grade students during solution of Geometry problems. Detailed analysis of Problem Solving protocols indicated that high-achieving students not only accessed a greater body of Geometrical knowledge but also used that knowledge more efficiently.

In his study using a sample of 859 students **Kumar (1997)** found that no significant gender difference exists on Mathematical Problem Solving Process Skills.

Gakhar and **Sood (2003)** found that the Problem Solving Ability is significantly and positively related with Mathematics Achievement for residential school students (r=0.14) and non-residential school students (r=0.22).

Asthana (2003) studied Problem Solving as a function of Intelligence and Anxiety and found that Problem Solving performance is influenced by both Anxiety and Intelligence.

2.3.2. Affective Variables and Academic Achievement

Studies on the relation of each of the affective variables with Academic Achievement are given below

2.3.2.1. Achievement Motivation and Academic Achievement

Zargar (1980) in a study found a positive correlation between Achievement Motivation and Achievement.

Narang (1981) found that high and low Academic Achievement and Achievement Motivation is not significant. Low-Achievers had the tendency to over estimate their performance.

The study of **Mathew (1981)** on high school students of Kerala revealed that there is significant positive relation between Achievement Motivation and Achievement.

Gandhi (1982) studied Academic Achievement in relation to Motivation using a sample of 500 boys and 500 girls and found that Achievement Motivation and Academic Achievement are positively and significantly related for both sexes.

Rajeeva (1982) in a study of Achievement Motivation of IX grade pupils of Bangalore found that there is significant difference between the Achievement scores of High- and Low-Achievement-Motivation students.

In a study of Need Achievement and Intellectual Capacity of high school students, **Reddy (1983)** found that there is positive correlation between Achievement Motivation and Achievement.

Singh (1983) revealed that High-achievers have high Need for Achievement compared to Low-achievers.

Kaur (1983) using a sample of 200 students from three schools of Patiala, studied Academic Achievement in different subjects in relation to Achievement Motivation and found that i) in boys, Achievement Motivation is positively related with Academic Achievement ii) Achievement Motivation can serve as a predictor of Achievement in all subjects

Rajput (1984) studied the Academic Achievement of students in Mathematics in relation to Intelligence, Achievement Motivation and

SES and found that Achievement is not affected by Achievement Motivation. **Sween (1984)** on the other hand, in a study using a sample of 140 students found that there is positive correlation between Achievement Motivation and Achievement.

Ahluwalia (1985) using a sample of 200 children of eight to twelve years found that there is positive relationship between Performance and Achievement Motivation.

Sontakey (1986) conducted a comparative study of personality factors and Achievement Motivation of High- and Low-Achievers using a sample of 482 students (281 High-Achievers and 231 Low-Achievers) and revealed that there is no difference in Achievement Motivation of High- and Low-Achievers, indicating that Achievement Motivation is not related to Academic Achievement.

Fatmi (1986) in a study of achievement related motivation among tribal and non-tribal high school students found that Achievement Motivation is positively related to Achievement.

Chakrabarti (1986) found in a study that Motivation is one of the main factors, which influence the performance of students of both middle and lower socio-economic classes.

Mehta (1987) studied the effect of some psychological factors on School Achievement of SC and ST students and found that there is positive correlation between Achievement Motivation and Achievement.

Saxena (1988) in a study of the impact of some psychological variables on Academic Achievement of high school students found that Achievement and Achievement Motivation are positively related.

Sherrill (1988) in a study of Achievement, Attitude and Achievement Motivation of grade III and IV pupils found a significant positive relation between Achievement and Achievement Motivation for both the grades.

Saraswat (1988) in a differential study of Achievement Motivation, Occupational Aspiration and Academic Achievement of adolescents found that there is positive relation between Achievement Motivation and Achievement.

Dubey (1989) studied the effect of School Environment and Approval Motive on memory and Achievement and found that Motivation and Achievement are positively related.

Paul (1990) studied on Achievement Motivation Socio-Economic Status and Scholastic Achievement and found that Motivation and Achievement are positively related.

Suman's (1989) study using a sample of 400 students from Bhatinda district found that Achievement Motivation has significant independent influence on Mathematics Achievement of students.

Sinha (1990) carried out a study using a sample of 400 high school students and reported that successful students showed higher Academic Motivation as compared to the failure students irrespective of sex.

Harlod *et al.* **(1990)** studied Mathematics Achievement of students and found that US students' poor performance appears to be attributable in part to low Motivation for devoting more attention to Mathematics.

Cassidy and Lynn (1991) found that the Achievement Motivation dimensions of acquisitiveness, dominance and work ethic are important predictors of Academic Achievement.

Bennet *et al.* **(1991)** examined the effects of "Square One TV", a television series about Mathematics aimed at eight to twelve years old children on the problem solving behavior of 240, fifth graders and found that Motivation is closely related to Arithmetic Achievement.

Lewis (1991) in a study of 400 Caribean immigrant students studied the relation between Achievement Motivation and Academic Performance and found that Motivation influence Academic Achievement.

Bhaskaran (1991) studied on Achievement Motivation, Attitude towards Problem Solving and Achievement in Mathematics of standard X students and found that Achievement Motivation and Achievement are positively related.

Reynolds and **Herbert (1992)** conducted a study to formulate a structural model of high school Mathematics outcome and reported that Motivation has significant effect on Mathematics outcomes.

Sundarajan and **Gnanaguru (1992)** in their study of high school pupils' Achievement Motivation and Academic Performance found no significant correlation between the two.

Hagborg (1992) compared School Motivation, Scholastic Competence and Intrinsic Motivation of 157 white ninth and tenth grade students and found that on measures of Scholastic Competence and Motivation Orientation the High-group is different from both Medium- and Low-group.

Harikrishnan (1992) in a study of Academic Achievement of students in relation to Achievement Motivation found that Motivation and Achievement are positively related. **Meena (1992)** and **Rani (1992)** also found that Motivation and Achievement are positively related.

Jackson *et al.* (1994) reported that High-achievers have strong preferences for Motivation and are more motivated than Low-achievers. **Laranger (1994)** found that successful students are more motivated to succeed.

Schiefele and **Csikzentimihalyi (1994)** studied on Interest and the quality of experience in classroom using a sample of 208 highly able freshmen and found that Achievement Motivation and Ability in Mathematics proved to be considerably weaker predictor of quality of experience than Interest.

Snyder (1994) studied on 150 British and Mexican students' attributes of Academic Success and found that Motivation contribute to Academic Success.

Fortier *et al.* (1995) found that perceived Academic Competence and perceived academic self-determination are positively influenced

Autonomous Academic Motivation which in turn had a positive impact on school performances.

Singh and **Varma (1995)** studied the effect of Academic Aspiration on Scholastic Success of class XI students and found that Academic Aspiration correlates positively with Scholastic Success of both rural and urban students and the positive nature of correlation is statistically significant.

Study conducted by **Pramod (1996)** using a sample of 300 students (150 boys and 150 girls) belonging to class XI of Tamil Nadu and found that Achievement Motivation is the most dominantly influencing factor on Academic Performance. Canonical value indicated linear relationship between school test performance and Achievement Motivation.

A study done by **Rao** and **Rao (1997)** on a sample of 60 students found that there is positive correlation between Achievement Motivation and Academic Achievement.

Adami *et a1.* **(1999)** Studied on student Motivation and Achievement in Mathematics and found that student confidence, past success rate and ability have impact on student Motivation.

Saroda (1999) studied the impact of Academic Motivation on Academic Achievement of higher secondary students using a sample of 563 standard XII pupils and obtained that the Academic Motivation has influence on Academic Motivation.

Kuyper *et al.* (2000) in a longitudinal study in Dutch secondary school found that Achievement Motivation and Fear of Failure are prominent predictors of mean Achievement.

Anthony (2000) studied on factors influencing pupils' success in Mathematics and found Self Motivation is the most related item, which influence success in Mathematics.

Mumthas (2001) studied on psychological variables as predictor of Mathematics Achievement and found that Achievement Motivation in Mathematics (r=0.20) has significant relation with Achievement in Mathematics.

Zsolnai (2002) studied on a sample of 218 6^{th} and 220 10^{th} grade Hungarian students and found that there exists positive relationship between Learning Motivation and Achievement.

Bouffard and **Couture (2003)** studied the Motivational Profile and Academic Achievement of high school students using a sample of 226 students and found that Motivational variables are related to Academic Achievement in Mathematics.

Krishnamurhty (2003) studied on the relationship between Achievement Motivation, Interest and Achievement, and found that relationship between Academic Achievement Motivation and Achievement (r=0.41) are significant and positive.

Smith (2003) studied on Mathematics Achievement of secondary school students and found that Motivation contribute to Achievement.

The study also found that gender difference is very weak in Mathematics Achievement.

De Jung *et al.* (2004) found that subject Motivation contributes to effectiveness in Mathematics. The study also found that cognitive factors are better predictors than affective factors in Mathematics.

Yeung and **McInerney (2005)** studied Achievement related Orientation of students using a sample of 199 students from a school in Hong Kong and found that Motivational factors are the major driving factor for excellence.

2.3.2.2. Anxiety and Academic Achievement

Somasundaram (1980) studied on some personality variables and found that there is negative correlation between Anxiety and Achievement in Mathematics. **Sivappa (1980)** also observed that there is negative correlation between Anxiety and Achievement.

Gopinathan (1981) found that Anxiety at a moderate level facilitate Achievement but at a high level Anxiety affect adversely on Achievement.

Shell (1981) observed that High-Anxious students had better task performance than Low-Anxious students.

Deshpanda and **Lodhi (1981)** conducted study on 60 Low-Achievers and 60 High-Achievers and found that in the case of boys Anxiety and Achievement are related, but in the case of girls Anxiety and Achievement are not related.

The result of **Siddiqi** and **Akhtar's (1983)** study revealed that i) Anxiety and Achievement are negatively related ii) when inter group comparison between mean of Anxiety scores of High-, Average- and Low- Achievers were made, the difference was found to be highly significant iii) as compared to boys, girls are more anxious and hence the Academic Achievement is adversely affected.

Purandare (1984) found that the Low-Anxious students are better in performance in the general learning task as compared to High-Anxious students.

Mohanty (1986) and **Mehotra (1986)** found that Anxiety and Achievement are negatively correlated. **Sreevastava (1986)** found that High- and Low-Achievers differ on the level of Anxiety scores and the two variables are negatively correlated.

Dubli (1986) found that High-Anxious students retain better than Low-Anxious students.

Sabapathy (1986) conducted studies on 574 boys and 531 girls and found that Manifest Anxiety is negatively and significantly related to Achievement in Mathematics.

Pal (1989) studied the dependence of Mathematics Achievement on Anxiety, Attitude, Academic Motivation and Self-Concept. He found the regression equation to predict the performance in Mathematics as a linear combination of the four affective variables.

Ramachandran (1990) studied the relation between performance and some psychological variables and found that Anxiety and

Achievement are related. **Thilagavathi (1990)** also found that Anxiety and Achievement are related.

Luethal (1990) studied Test Anxiety, Mathematics Anxiety and teacher comments in relation to Achievement in remedial Mathematics and found that Test Anxiety has a greater effect on Mathematics Achievement of students than Mathematics Anxiety.

Zollar (1991) studied about the effect of Anxiety on real life problem-solving performance of gifted children. He found that the performance of all the groups who expressed Anxiety is lower than that of their matched groups who preformed under natural testing condition.

Miller (1991) studied on the relationship of Mathematics Achievement and found that Anxiety is not correlated with gender and Mathematics Achievement.

Hadfield *et al.* (1992) conducted a study on a sample of 358 middle school students and found that Mathematics Anxiety and Mathematics Achievement are negatively related.

Seipp (1992) conducted 126 studies with an aggregate sample of 36626 students on the relation between Anxiety and Performance and found that Anxiety goes with poor Performance.

Williams (1992) assessed the influence of Test Anxiety on students' test performance across four subject matter areas viz., English, Mathematics, Reading and Science using a sample of 217 public high school students in northern Oklahoma. The study revealed that Test Anxiety contributes to Academic Achievement and student performance is uniformly affected by Test Anxiety across all four academic subjects.

Gupta (1992) in a comparatively study of Self-Concept, Level of Aspiration, Anxiety and Scholastic Achievement found that Anxiety and Achievement are related.

Coleman (1992) investigated the prevalence and intensity of Mathematics Anxiety and found that Mathematics Anxiety appears to be negatively related to Mathematics Achievement.

Jameela (1993) conducted a study to find the relationship between Achievement in Mathematics and selected affective variables and found that correlation between Achievement in Mathematics and Mathematics Anxiety is significant ($r=-0.139$).

Dutt (1993) found that High-Anxious as well as Low-Anxious group performed equally well on the Problem Solving Ability test. Jean and Eatrina (1993) in a study on 75 students found that Trait Anxiety is an element, which predicts Examination Performance.

Roy and **Roy (1994)** studied on Mathematics Performance, Anxiety and Achievement in Mathematics and found that there is significant interaction effect of both the variables on Mathematics Achievement.

Singh (1994) conducted a study on 316 scheduled tribe students and found an inverse relation between Anxiety and Academic Achievement.

Suja (1995) using a sample of 570 students studied the influence of Examination Anxiety and Intelligence on Problem Solving Ability of secondary school students in Mathematics and found that there is significant correlation among the three experimental variables.

Study carried out by **Singh** and **Broota (1995)** with a sample of 60 students who were selected from class X of a public school in north branch of Delhi revealed that there is significant negative relationship between Test Anxiety and Performance.

Ball (1995) found that Test Anxiety is not the main reason that under- prepared groups of students does poorly on certain tests. Nor is Test Anxiety the cause of general debility in students' performance on major examinations.

Sobha (1995) found that Mathematics Anxiety discriminate significantly between High-, Average- and Low- Mathematically able pupils.

Bandalos, *et al.* (1995) found that Mathematics Anxiety directly and negatively affect Achievement in Mathematics. **Trivedi (1995)** also found that Anxiety and Achievement are negatively related in the case of girls but positively related in the case of boys.

Patel (1996) examined the effect of General Anxiety on the Academic Achievement in Mathematics of secondary school students by using a sample of 293 secondary school students studying in class IX from Khire district in Gujarat and found that the effect of General Anxiety on the Achievement in Mathematics is significant.

A study conducted by **Verma (1996)** on a sample of 500 male students studying in class X in ten secondary schools of Delhi reported that the main effect of Test Anxiety on Academic Performance of the students in English, Mathematics, General Awareness and social Science are significant.

Patel (1997) studied the effect of Test Anxiety on Achievement in Mathematics of secondary school students by using a sample of 393 class IX students of Kheda district in Gujarat and found that Low-Test - Anxiety group showed better performance in Mathematics than High-Test-Anxiety group.

Jayasree (1997) studied on test anxiety and Academic Achievement among students of standard IX and found that test anxiety is significantly and inversely related to Academic Achievement.

Xin (1999) studied on the relationship between Anxiety towards Mathematics and Achievement in Mathematics and found that the relationship is consistent across gender groups, grade level groups and ethnic groups.

Study carried out by **Rajathi *et al.* (2000)** on a sample of 81 students revealed that Anxiety has influence on Achievement among History and Mathematics students.

Minimol (2000) in a study found that examination anxiety and achievement are positively correlated (r=0.26).

Mumthas (2001) studied on psychological variables as predictor of Mathematics Achievement and found that Mathematic Anxiety (r=-

0.34) has significant relation with Achievement in Mathematics.

McDonald (2001), reviewed literature on Test Anxiety and reported that Test Anxiety impairs test performance.

Sud and **Prabha (2003)** studied on a sample of 200 high school boys and girls using stepwise multiple regression analysis and found that Test Procrastination and Test Anxiety are the most relevant variables in predicting Academic Performance.

Asthana (2003) found that High-Anxious High-Intelligent students perform better than Low-Anxious High-Intelligent students. That is high Anxiety facilitated the performance at high intelligence level. Problem Solving Performance is influenced by both Anxiety and Intelligence.

Keozh *et al.* (2004) found that high anxiety scores were associated with less performance. Correlation of anxiety with combined grade (-0.182) and with written examination is (-0.19) negative.

Abu-Rabia (2004) studying on a sample of 27 male and 40 female students of Israel found that Anxiety is negatively and significantly correlated to Foreign Language Achievement (r=-0.26).

Nasser and **Birenbaum (2005)** studied on a sample of 478 Jewish and 283 Arab eight graders and found that the correlation of Mathematics Anxiety and Achievement is significant (r=-0.26) for Arab students and is not significant (r=-0.04) for Jewish students. For the whole sample the effects of Mathematics Anxiety on Mathematics Achievement is insignificant.

Laura (2005) examined the relationship between background characteristics and Mathematics Achievement of 8th grade students, using the TIMSS data from 23 countries. The study revealed that self-pressure composites are associated with slightly high student level Achievement in Mathematics in majority of the countries.

2.3.2.3. Interest and Academic Achievement

Gakhar (1981) using a sample of 510 Grade VII students (352 boys and 158 girls) of Union territory of Chandigarh found that Interest in Mathematics did not significantly influence the acquisition of Mathematical concepts.

Sundarajan and **Krishnamurthy (1989)** found that higher secondary school students Interest and Achievement are positively and significantly correlated.

Suman's (1989) study using a sample of 400 students from Bhatinda district found that i) sex and residential background has significant influence on Mathematics Interest ii) sex, residential background and Academic Achievement, have significant interrelated effect in Mathematics Interest.

Sreelatha (1992) found that there exists significant positive relationship between Interest and Achievement in Science of secondary school pupils.

Schiefele and **Csikzentimihalyi (1994)** studied on Interest and the quality of experience in classroom using a sample of 208 highly able freshmen and found that Interest contributed significantly to the prediction of grade in Mathematics.

Snyder (1994) studied on 150 British and Mexican students' attributes of Academic Success and found that Interest contribute to Academic Success.

John (1995) studied on 600 standard IX students and found that their Interest and Achievement are correlated.

Bindu (1996) studied on Under and Over-achievement and found that the combined effect of Intelligence and Interest on secondary school pupils is high ($r=0.76$). The study also revealed that there exists significant positive correlation between Interest and Achievement ($r=0.30$).

Indu (1996) studied on 300 standard IX students and found that Achievement increases with their Interest in the subject.

Sobha (1997) Studied on the correlation between Interest and Achievement and found that there is high correlation between Interest and Achievement in Biology.

Antony (2000) studied Achievement in Mathematics in relation to Interest in Mathematics and Mathematical Aptitude of secondary school pupils and found that there is significant positive correlation between Interest in Mathematics and Mathematics Achievement.

Anthony (2000) studied on factors influencing pupils' success in Mathematics and found that general liking and Interest in Mathematics influence success in Mathematics.

Mumthas (2001) studied on psychological variables as predictor of Mathematics Achievement and found that Mathematics Interest (r=0.23) has significant relation with Achievement in Mathematics.

Krishnamurhty (2003) studied on the relationship between Interest and Achievement and found that the relationship between Interest and Achievement (r=0.237) is significant and positive.

Bottiger (2004) in a case study of Mathematics club at St. Paul's Episcopal school in Kansas City, Missouri, found that the variables of 'Being Good in Mathematics' and 'Liking Mathematics' have positive significant correlation with Mathematics Grade (r=0.60). Correlation with Mathematics Grade and their responses in 'How Good in Mathematics' is also significant and positive (r=0.49)

TREND REPORT

In order to have an overall view of the studies reviewed the investigator tabulated the studies in the following Tables.

TABLE 1

Extent of Under- Normal and Over-achievement

Name of Investigator	Percentage of Pupils		
	Under-achievers	Normal-achievers	Over-achievers
Menon (1972)	2.58 (in high ability group)	–	2.80 (in high ability group)
Lalithamma (1973)	26.78	51.09	22.13
Abraham (1973)	22.03	56.64	21.33
Nair (1974) Iyer (1975)	28 (in high intelligence group) 14	–	–
Dhaliwal & Saina (1975)	47.46	–	–
Mathew (1975)	15.69	70.36	13.95
Iyer (1977)	14.43	51.04	12.44
Behrens & Vernon (1978)	20.00	60.00	20.00
Whitmore (1980)	20.00 (in gifted group)	–	–
Us Commission on Education (1983)	50.00	–	–
Nair (1984)	17.22	66.13	14.60
Sharma (1986)	16.33	–	–
Flory (1987)	21.88	63.15	14.97
Sreethamony (1987)	14.71	68.53	16.76
Nair (1987)	26.61	59.16	14.23
Uchat (1987)	9.71	82.59	7.70
Raj (1991)	19.00	58.00	23.00
Badwal and Sood (1991)	87.5 (for rural	–	–

Name of Investigator	Percentage of Pupils		
	Under-achievers	Normal-achievers	Over-achievers
	students)		
Kaile and Kaur (1992)	28.08	44.36	27.59
Sharma (1995)	15.60	_	_
Ford (1995)	46.00 (in back gifted group)	67.40	17.00
Ramesan (2000)	17.20	65.90	16.10
Bindu (2001)	14.22	74.20	10.58
Ajawani and Rungta (2004)	6.67	87.77	5.56

TABLE II

Studies Related to Under-, Normal- and Over-Achievement and Psychological Variables

Name of Investigator	Variables associated with Under- and Over-achievement	Variables not associated with Under- & Over-achievement
Pal and Saxena (1970)	Motivation, Interest	
Dhaliwal (1971)	Anxiety	
Quigley (1972)	Motivation	
Saxena (1972)	Interest	
Menon (1972)	Interest	
Pathak (1972)	Interest	
Kulwant (1973)	Achievement Motivation	
Lalithamma (1973)	Creativity	
Simmon & Bibb (1974)	Achievement Motivation	
Chaudhuri& Jain (1975)	Achievement Motivation and Anxiety	
Mathew (1975)	Anxiety	
Vishnoi (1975)	Anxiety	
Tandon (1975)	Anxiety	
Nair *et al.* (1975)	Anxiety	
Kohli (1975)	Achievement Motivation	
Ghuman (1976)		Aptitude, Achievement Motivation
Soman (1977)	Test Anxiety	General Anxiety
Iyer (1977)		Anxiety

Name of Investigator	Variables associated with Under- and Over-achievement	Variables not associated with Under- & Over-achievement
Aggarwal & Krishna (1978)	Achievement Motivation	
Nagpal (1979)	Interest	
Somasundaram (1980)	Anxiety	
Srivasatava (1981)	Achievement Motivation	
Krouse and Krouse (1981)	Anxiety	
Sharma (1981)	Achievement Motivation	
Gupta (1983)	Achievement Motivation	
Singh (1983)	Motivation	
Tandon (1983)	Interest and Anxiety	
Assia (1984)	Anxiety	Achievement Motivation
Valsamma (1984)	Anxiety	Achievement Motivation
Nair (1984)	Anxiety, Achievement Motivation	
Gaver *et al.* (1984)	Anxiety, Motivation	
Gitanjali (1984)	Attitude towards Problem Solving	
Nalini (1984)	Achievement Motivation	
Nair (1984)	General and Test Anxiety	
Maitra(1985)	Interest	
Nair (1987)	Achievement Motivation	General and Test Anxiety

Name of Investigator	Variables associated with Under- and Over-achievement	Variables not associated with Under- & Over-achievement
Chel (1990)	Anxiety	
Raj (1991)	Attitude Towards Problem Solving	
Ford (1995)	Motivation and Interest	
Sharma (1995)	Aptitude	
Ford & Thomas (1997)	Motivation and Interest	
Bindu (1996)	Interest	
Ramesan (2000)	Achievement Motivation	
Bindu (2001)	Anxiety	
Lau & Chan (2001)	Motivation and Interest	
Jones & Myhill (2004)	Interest	

TABLE III

Studies on the Relation between Psychological Variables and Academic Achievement

Variable	Associated with Achievement	Not Associated with Achievement
Creativity		
	Asha (1980)	
	Kabu (1980)	
	Singh (1982)	
	Dey (1984)	
	Ramjee (1984)	
	Sreelatha (1984)	
	Tuli (1985)	
	Gakhar (1985)	
	Raina (1986)	
	Brar (1986)	
	Rani (1986)	
	Desai (1987)	
	Malini (1990)	McCabe & Marita (1991)
	Chadha & Chanda (1990)	
	Gore (1990)	
	Dhalla (1990)	
	Padhan (1990)	
	Loomba & Varma (1990)	
	Carroll & Howieson (1991)	

Variable	Associated with Achievement	Not Associated with Achievement
	Subrahmaniyan & Ramadevi (1991)	
	Dubey &Vijayakumar (1992)	
	Srivastava & Srilatha (1992)	
	Patel (1992)	
	Arora (1992)	
	Padhi (1992)	
	Bawalkar (1992)	Kim & Michael (1995)
	Mondal (1992)	
	Thampuratty (1994)	
	Bawa & Kaur (1995)	Kapoor (1996)
	Sobha (1995)	
	Padhi (1995)	
	Resmi (1995)	
	Jyothi (1997)	
	Chaudhuri (1997)	
	Khare & Grewal (1997)	
	Behera (1998)	
	Mumthas (2001)	
	Vidyapati & Rao (2003)	Gakhar & Sood (2003)
	Chaudhary (2004)	
Aptitude		
	Kabu (1980)	
	Thomas (1981)	
	Menon (1982)	

Variable	Associated with Achievement	Not Associated with Achievement
	Conseugra (1982) Patel (1984) Bhattacharya (1986) Dubey (1987) Mohan & Ummat (1987) Budev (1990) Gowrikkuttyamma (1991) Lalitha (1991) Dubey & Vijayakumar (1992) Dubey (1992) Okamoto & Kitao (1992) Boyd (1993) Vijayakumari (1993) Gustin & Corazzal (1994) Meeker *et al.* (1995) Javanovic & Lerner (1995) Sumangala (1995) Malini (1995) Waxman *et al.* (1996) Patricia & Phyllis (1998) Seokhoon and Betty (2000)	

Variable	Associated with Achievement	Not Associated with Achievement
	Nijenhuis *et al.* (2000) Nainitha (2000) Reuhkala (2001) Mumthas (2001)	
Problem Solving Skills		
	Consuegra (1982) Kumar (1984) Caballos & Esteban (1988) Krishnan (1990) Saljo and Wyndhamn (1990) Montegue *et al.* (1991) Bull (1993) Montague & Applegate (1993) Thampuratty (1994) Lawson & Chinnappan (1994) Kumar (1997) Mumthas (2001) Asthana (2003) Gakhar & Sood (2003)	
Achievement Motivation		
	Zargar (1980) Mathew (1981) Rajeeva (1982)	Narang (1981)

Variable	Associated with Achievement	Not Associated with Achievement
	Gandhi (1982)	
	Reddy (1983)	
	Singh (1983)	Rajput (1984)
	Kaur (1983)	
	Sween (1984)	
	Ahluwalia (1985)	Sontakey (1986)
	Fatmi (1986)	
	Chakrabarthi (1986)	
	Mehta (1987)	
	Saxena (1988)	
	Saraswat (1988)	
	Suman (1989)	
	Sherril (1988)	
	Dubey (1989)	
	Paul (1990)	
	Sinha (1990)	
	Harold *et al.* (1990)	
	Sinha (1990)	
	Cassidy & Lynn (1991)	
	Bennet *et al.* (1991)	
	Lewis (1991)	
	Bhaskaran (1991)	
	Reynolds & Herbert (1992)	Sundarajan and Gnanaguru (1992)
	Hagborg (1992)	
	Harikrishnan (1992)	

Variable	Associated with Achievement	Not Associated with Achievement
	Meena (1992)	
	Rani (1992)	
	Jackson *et al.* (1994)	Schiefele & Csikszentimihalyi (1994)
	Snyder (1994)	
	Laranger(1994)	
	Fortier *et. al (1995)*	
	Pramod (1996)	
	Rao & Rao (1997)	
	Saroda (1999)	
	Kuyper *et al.* (2000)	
	Anthony (2000)	
	Mumthas (2001)	
	Zsolnai (2002)	
	Krishnamurthy (2003)	
	Bouffard & Couture (2003)	
	Smith (2003)	
	DeJung et al. (2004)	
	Yeung & McInerrney (2005)	
Anxiety		
	Somasundaram (1980)	
	Sivappa (1980)	
	Gopinathan (1981)	

Variable	Associated with Achievement	Not Associated with Achievement
	Shell (1981)	
	Siddique & Akthar (1983)	Deshpande & Lodhi (1981)
	Purandare (1984)	
	Mohanty (1986)	
	Mehotra (1986)	
	Sreevastava (1986)	
	Dubli (1986)	
	Sabapathy (1986)	
	Pal (1989)	
	Thilagavathi (1990)	
	Ramachandran (1990)	
	Luethal (1990)	
	Williams (1991)	Millar (1991)
	Zollar (1991)	
	Hadfield *et al.* (1992)	
	Seipp (1992)	
	Williams (1992)	
	Gupta (1992)	
	Coleman (1992)	Dutt (1992)
	Jameela (1993)	
	Roy & Roy (1994)	
	Singh (1994)	
	Suja (1995)	
	Singh & Brook (1995)	Ball (1995)
	Shobha (1995)	
	Bandalos *et al.* (1995)	
	Patel (1996)	
	Verma (1996)	
	Patel (1997)	

Variable	Associated with Achievement	Not Associated with Achievement
	Xin (1999)	
	Rajathi *et al.* (2000)	Minimol (2000)
	Mumthas (2001)	
	McDonald (2001)	
	Sud & Prabha(2003)	
	Keozh *et al.* (2004)	
	Abu-Rabia (2004)	Nasser & Birenbaum (2005)
	Laura (2005)	
Interest		
	Sundarajan & Krishnamurthy (1989)	Gakhar (1981)
	Suman (1989)	
	Sreelathaamma (1992)	
	Csikzentimihalyi (1994)	
	Snyder (1994)	
	John (1995)	
	Bindu (1996)	
	Indu (1996)	
	Shobha (1997)	
	Antony (2000)	
	Anthony (2000)	
	Mumthas (2001)	
	Krishnamurthy (2003)	
	Bottigar (2004)	

CONCLUSION

Studies reviewed helped the investigator to arrive at a conclusion on the nature of the findings, which are as follows:

1. Studies reviewed with regard to Under- and Over-achievement revealed that academic Under- and Over-achievement is prevalent among students even though the extent is different in different studies. The percentage of Under-achievement varies between 6.67 to 47.46 and that of Over-achievement from 5.66 to 27.59. But for the high ability group the extent of Under-achievement is from 2.58 percent to 47 percent and for Over-achievement, from 2.8 percent to 17 percent. But for the high ability the extent of Under-achievement in one study is 2.58 percent and in another it is 50 percent. In the same case, the rate of Over-achievement varies from 2.8 percent to 17 percent. Further, an overall examination of the discrepancy rates shows a normal distribution of this phenomenon.

2. Among the studies reviewed on Under- and Over-achievement most of the studies considered the overall Academic Achievement of students. Ten of them were related to Mathematics Achievement and seven were related to other subjects. All the studies related to Interest showed that Interest of students is a significant factor leading to Under- and Over-achievement. Most of the studies on Achievement Motivation and Anxiety showed that these variables are associated with

Discrepant Achievement. But very few studies found that Achievement Motivation is not related with Under- and Over-achievement and three of the reviewed studies could not find any relation with discrepant Achievement.

3. Studies on Under- and Over-achievement related to cognitive variables are rare. Only six of the studies considered cognitive variables. One study each revealed that Creativity and Aptitude are related to Under- and Over-achievement and one study reported that Aptitude is not related to Under- and Over-achievement. No study reviewed considered the variable Problems Solving Process Skills. Three studies available in the area of Attitude towards Problem Solving revealed that this variable is related to Under- and Over-achievement.

4. All the studies reviewed on the relation of Academic Achievement with Problem Solving Process Skills and with Aptitude revealed that Academic Achievement is significantly and positively related to Problem Solving Ability and Aptitude. Out of the 44 studies reviewed on the relation of creativity to achievement 40 showed significant relation and remaining could not find any relation between the variables.

5. Out of the 52 studies reviewed on the relation between Achievement Motivation and Academic Achievement, 47 showed significant positive relation between the two variables and 2 could not find any relation. Limited number of studies was available in the area of Academic Achievement and Interest. Out

of 15 studies reviewed, 14 of them showed significant positive relation and two studies showed no relation between the variables.

6. Of the 46 studies reviewed in the area of Anxiety with Academic Achievement, majority of the studies showed significant negative relation and 6 of them showed significant positive relationship between the two variables. Some studies could not find any relation between the two variables and in some studies the relation between the variables is different for different sub samples. Some studies showed that Anxiety at a moderate level promotes Achievement and at higher level it affect Achievement adversely.

7. It was found that much studies were not done to find out the variables that could discriminate significantly between Under- and Over-Achievers. About half of the studies in this area concentrated on factors contributing to one form of discrepancy, viz., Under-Achievement. Again it is noticed that there is lack of attempts to find the combined influence of psychological variables on Discrepant Achievement using multivariate statistical techniques. None of the studies used the discriminant analysis technique to find the combinations of psychological variables discriminating Under- and Over-achievers or for deriving functions to classify pupils as Under-, Normal- and Over-achievers on the basis of psychological variables.

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12

CHAPTER III

METHODOLOGY

- *Design of the Study*
- *Variables*
- *Tools Used for Data Collection*
- *Sample Selection*
- *Data Collection, Scoring and Consolidation*
- *Statistical Techniques Used*

"Research being the process of arriving at dependable solution to problems through planned and systematic collection, analysis and interpretation of data, the need for adopting the right procedure for carrying out a study is important. The methodology adopted enables an investigator to look at the amorphous data in a meaningful statistical and orderly way" (Mouly, 1963, p.4). The success of any research depends on the methods followed and the proper tools and techniques used for data collection and analysis.

The methodology adopted for the study is presented under the headings viz.,

i) Design of the study

ii) Variables

iii) Tools used for data collection

iv) Sample selection

v) Data collection, scoring and consolidation

vi) Statistical techniques used

3.1. DESIGN OF THE STUDY

The study was conducted by the comparative survey approach. "In comparative approach the interest is in obtaining information about more than one condition or group of subjects, that is, in obtaining more than one set of data, and comparing the multiple sets of data. The intent in comparative research is to make judgments of difference, or no difference, or of larger or smaller, or in other words to make a comparative judgment" (Fox, 1969, P.46).

As the present study is to find the combination of psychological variables discriminating between Under- and Over-achievers, the investigator used the comparative survey approach for the present study.

3.2. VARIABLES

"Variables are the condition or characteristics that the experimenter manipulates, controls or observes" (Best and Khan, 1995, p. 137). Two groups of variables are involved in the present study viz., criterion variables and predictor variables.

3.2.1. Criterion Variables

The criterion variables for the study are those variables that are used for the identification of Under-, Normal-, and Our-achievement in Mathematics. By definition three types of Achievement are identified on the basis of predicted Achievement, prediction being done on the basis of Intelligence measures. Variables thus used for the identification of Under-, Normal-, and Over-achievement are

1. Intelligence.
2. Achievement in Mathematics.

3.2.2. Predictor Variables

Predictor variables are those that are thought to be independent of the outcome itself but instead influence other variables.

Review of the literature suggested that academic achievement depends on a number of cognitive, affective, socio-familial, environmental and other factors. For the present study only cognitive and affective variables are considered. As the study is related to Achievement in Mathematics, investigator selected six characteristics of the cognitive and affective domain as the predictor variables.

The predictor variables selected for the study are, the following.

1. Mathematical Creativity
2. Mathematics Aptitude
3. Mathematics Problem Solving Process Skills
4. Mathematics Interest
5. Mathematics Anxiety
6. Achievement Motivation in Mathematics

3.3. TOOLS USED FOR DATA COLLECTION

It has been pointed out by Sukhia *et al.* (1989, p.129) that "The selection of suitable instruments or tools is of vital importance for successful research". The tools used for the collection of data for the study are the following.

1. Achievement Test in Mathematics
2. Test of Intelligence (Sumangala & Sholy, 2000)
3. Test of Mathematical Creativity
4. Test of Mathematics Aptitude (Sumangala & Malini, 1993)
5. Test of Mathematics Problem Solving Process Skills (Sumangala & Anilkumar, 1997)
6. Mathematics Interest Inventory (Sumangala & Vijayakumari, 1996)

7. Scale of Mathematics Anxiety (Sumangala & Malini, 1993)
8. Achievement Motivation in Mathematics (Sumangala & Vijayakumari, 1996)

Among the above tools the investigator constructed and standardized the following tests.

1. Achievement Test in Mathematics
2. Test of Mathematical Creativity

All the other tools used for the study are the ones availed from the Department of Education.

Each of the above tools is described below for the essential details like (i) variable measured (ii) format of the tool (iii) procedure for the development (iv) nature of items with examples, (v) scoring scheme and (vi) psychometric characteristics viz., validity and reliability.

3.3.1. Achievement Test in Mathematics

UNESCO's Glossary of Educational Technology Terms (1986, p.10) defined Achievement Test as "test designed to measure a person's knowledge, skills, understanding, etc. in a given area".

Achievement in Mathematics was measured by using an Achievement Test developed and standardized by the investigator for the study. The test consists of 25 multiple-choice items, which can be attempted within a maximum time of 40 minutes. The investigator made use of suggestions given in books like Stanley (1962), Dane and Kulkarni (1963), Bloom (1979), Asthana and Agarwal (1982), etc. to develop and standardize the Achievement test. Besides she had useful discussion with her supervising teacher who is also an expert in the field.

According to Stanley (1962, p.140) "the four major steps in the construction and standardization of an Achievement test are planning, preparation, tryout and finalisation. The procedure followed and techniques used in the development of the test are described below:

3.3.1.1. Planning the Test

The first phase in the construction of an Achievement test is planning the test. After determining the board scope of the test, a design was made in such a way as to ensure adequate coverage of objectives, content area, and form of questions.

3.3.1.1.1. Weightage to Objectives

Sidhu (1995, p.18) suggested that the objectives of teaching Mathematics at the secondary stage can be classified as knowledge, understanding, application, skills, attitude, appreciation and interest. According to NCERT (2000) the objective of teaching Mathematics are knowledge, understanding, application and skills. In view of these classifications and on the basis of discussion with experts, the objectives considered for the preparation of the present Achievement test are knowledge, understanding, application and skill. Weightage to these objectives are given in Table 4.

TABLE 4
Weightage to Objectives

Sl. No.	Name of Content	Marks	Percentage of Marks
1	Knowledge	5	20
2	Understanding	8	32
3	Application	7	28
4	Skill	5	20
	Total	25	100

3.3.1.1.2. Weightage to Content

As the period of data collection was scheduled during the third term of the academic year, the investigator decided to have the content of the test as the first and second term units of study for standard IX pupils. All the eleven units considered for the test and the weightage given to each content area are given in Table 5.

TABLE 5
Weightage to Content

Sl. No.	Name of Content	Marks	Percent of Marks
1	Sets and Relations	3	12
2	Real Number system	2	8
3	Axiomatic approach to geometry	2	8
4	Congruency and congruent triangles	2	8
5	More about identities	2	8
6	Mensuration of solids	3	12
7	Solution of equations in two variables	2	8
8	Graphs and linear equations	3	12
9	Polynomials	2	8
10	Similarity and similar triangles	2	8
11	Trigonometric ratios	2	8
	Total	25	100

3.3.1.1.3. Weightage to Form of Questions

In order to avoid subjectivity, for greater coverage of content area and to making scoring easy the investigator decided the test to be fully objective (multiple-choice) items alone. According to Stanley (1962, p.186) "multiple-choice items are usually regarded as the most valuable and most generally applicable of all test forms". As multiple-choice items are more objective, efficient and less subject to item sampling error the investigator decided to have multiple-choice items with four distracters in the test.

3.3.1.1.4. Blue Print of the Test

Blue print is a frame of reference for constructing a test according to a desired design. As the items for the present test is only multiple-choice items, a two dimensional blue print is enough. According to Dane and Kulkarni (1963, p.44). "To measure proper coverage it is necessary to employ a graphical two-dimensional chart which would bring out the objectives or behaviour on one hand and content on the other". The blue print specifying the weightage to content area and objectives for the test is presented in Table 6.

TABLE 6

Blue Print for the Test

Sl. No.	Content	Objectives				
		Knowledge	Understanding	Application	Skill	Total
1.	Sets and relations	-	1	1	1	3
2.	Real number system	-	2	-	-	2
3	Axiomatic approach to geometry	1	1	-	-	2
4	Congruency and congruent triangles	1	1	-	-	2
5	More about identities	-	-	2	-	2
6	Menuration of solids	-	1	1	1	3
7	Solution of equations in two variables	1	-	-	1	2
8	Graphs of linear equations	1	-	1	1	3
9	Polynomials	1	1	-	-	2
10	Similarity and similar triangles	-	-	1	1	2
11	Trigonometric ratios	-	1	1	-	2
		5	8	7	5	25

3.3.1.2. Preparation of Test Items

The investigator used the 1995 syllabus of standard IX for framing the questions with the assumption that the same syllabus will be followed during the period of data collection. So the Mathematics textbook for standard IX introduced in the year 1995 was used as the major source book for writing test items. Besides, teacher made

Achievement tests were also utilized as source for framing test items.

The investigator prepared double the number of items given in the blueprint so as to have the desired number of items in the final test.

Examples of test items for the objectives are given below:

1. The sum of the angles of a triangle is........

   a. 90^0 b. 270^0 c. 180^0 d. 360^0 (knowledge)

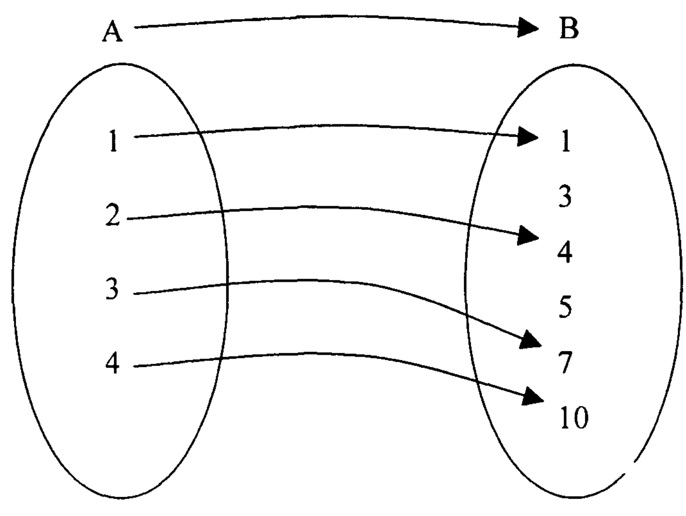
2. If one angle of a linear pair is 70^0, what is the measure of the other angle?

   a. 110^0 b. 20^0 c. 35^0 d. 290^0 (understanding)

3. If $a+\frac{1}{a}=5$, what is $a^3+\frac{1}{a^3}$

   a. 125 b. 110 c. 120 d.115 (application)

4. Write the relation given in the following arrow diagram in rule method



a. $\{(x, y)/X\in A,\ y\in B,\ y=x+2\}$ b. $\{(x,y)/x\in A, y\in B, x<y\}$
c. $\{(x,y)/x\in A,\ y\in B,\ y\leq x\}$ d. $\{(x,y)/x\in A,\ y\in B,\ y=3x-2\}$ (skill)

Scoring Procedure

Students are to choose correct answer for each item from the four possible answers given for each item. One score will be given for each correct response and no score for a wrong response.

3.3.1.3. Try Out of the Test

The draft test with 50 items was tried out on a sample of 200 standard IX pupils. The sample was selected by stratified sampling technique from five schools.

Item Analysis

Item analysis is the process of finding out difficulty index and discrimination power of the test items. Item analysis was done using the method suggested by Ebel (1972, p.383-385). According to him item analysis will be helpful in "eliminating items which may be too easy or too difficult and which may fail for other reasons to discriminate clearly between the better and poorer examinees".

The difficulty index (Di) and the discrimination power (Dp) for each item was calculated by the formula,

$$\text{Di} = \frac{U+L}{2N} \text{ and}$$

$$\text{Dp} = \frac{U-L}{N}, \qquad \text{(Ebel, 1972)}$$

where U and L are the number of pupils in the upper and lower group who answer the test item correctly and N, the number of students in each group.

The difficulty index (Di) and discrimination power (Dp) of the draft test items are presented in Table 7.

TABLE 7
Item Analysis Indices of the Draft Test of Achievement in Mathematics

Item No.	Di	Dp	Item No.	Di	Dp	Item No.	Di	Dp
1*	0.59	0.50	18*	0.51	0.42	35	0.35	0.54
2	0.60	0.40	19*	0.46	0.60	36*	0.45	0.50
3	0.74	0.36	20	0.48	0.64	37*	0.41	0.50
4*	0.58	0.44	21*	0.51	0.46	38	0.25	0.38
5*	0.43	0.58	22*	0.45	0.58	39*	0.43	0.46
6*	0.50	0.60	23	0.34	0.36	40	0.42	0.60
7	0.51	0.54	24	.0.37	0.54	41*	0.41	0.50
8	0.70	0.40	25	0.36	0.56	42	0.44	0.48
9*	0.60	0.44	26	0.33	0.50	43*	0.42	0.56
10	0.63	0.46	27	0.31	0.18	44	0.40	0.60
11*	0.44	0.64	28	0.38	0.28	45*	0.41	0.46
12*	0.50	0.56	29	0.42	0.56	46	0.33	0.50
13*	0.45	0.66	30*	0.46	0.64	47*	0.43	0.54
14*	0.42	0.52	31	0.39	0.50	48	0.30	0.48
15*	0.53	0.54	32*	0.41	0.46	49*	0.40	0.48
16	0.53	0.50	33	0.48	0.28	50	0.25	0.26
17	0.41	0.46	34*	0.45	0.62			

Note: * indicates selected items.

3.3.1.4. Finalisation of the test

The facility index (difficulty index) of a good item is considered to be between 0.40 and 0.60. A discriminating power more than 0.40 is considered to be ideal for a good item. This means that an item satisfying these criteria is acceptable for the final test. Hence items having difficulty index between 0.40 and 0.59, and discriminating power above 0.42 were selected for the final test. Thus as per the blue print, the final test was ready with 25 objective type items. As majority of the students completed the test within 40 minutes in a pilot testing, the time limit for the final test was fixed as 40 minutes.

English version of the draft and final tests are given in Appendices I and II respectively. The response sheet and scoring key for the final test are also given as Appendices III and IV respectively.

Validity

The methods of ascertaining validity of a test are to establish concurrent validity, content validity, logical validity and face validity (Asthana and Agarwal, 1982). Estimation of the concurrent validity of the Achievement test in Mathematics was done by correlating the scores of the test against second terminal examination marks of 40 standard IX students in Mathematics. The correlation coefficient obtained is 0.75.

The procedure adopted in developing the test (representation to the objectives, representation to the topics in the content, item analysis etc.) also established construct, content and internal validity of the test.

Reliability

Reliability of the test was found out by the test-retest method. For this purpose, the test was administered to a sample of 40 students after an interval of two weeks between the two testing. The reliability coefficient between the two test scores was found out by Pearson's 'r'. The reliability coefficient obtained is 0.81. This suggests that the test is highly reliable to measure Mathematics Achievement of secondary school pupils.

The indices of validity and reliability indicate that the present test is an adequate tool for measuring the Achievement in Mathematics of standard IX pupils.

3.3.2. Test of Intelligence

To measure Intelligence, the predictor variable, the investigator used the Test of Intelligence prepared by Sumangala and Sholy (2000). Psychometric details of the test are as follows.

This test of Intelligence was developed based on Sternberg's Tri-archic theory of Intelligence. According to this theory Intelligence comprises of three parts.

1. Componential part - which relates Intelligence to the internal world of the individual. This is on what goes on inside a person's head when that person thinks intelligently.

2. Experiential part - which relates Intelligence to both the internal and external world of the individual. This is on how does our Intelligence affect the kinds of environments that are available to us and that we create for ourselves.

3. Contextual part - which relates Intelligence to the external world of the individual. That is how do the experiences mediate between the internal and external world of the individual.

Sternberg's theory further suggests that the application of Intelligence to the internal, external and to the personal experiences are around three kinds of mental processes viz., meta components, performance components and knowledge acquisition components. Meta components are the executive processes used to plan, monitor and evaluate problem solving. Performance components are the lower order processes used to implement the commands of the meta components. Knowledge acquisition components are the processes used to learn how to solve problems.

Further this test is prepared based on the assumption of Strenberg that

i) Intelligence is malleable rather than fixed

ii) A task that measures intelligence should be novel but not totally outside an individual's experience.

iii) When a task is first encountered it may be non- entrenched. Through successive encounters, performance on the task may become automated.

iv) A person's Intelligence is shown not in the run-of-the mill situation of every day life but in those extraordinary situation that challenge the individual's ability to cope with one's environment.

3.3.2.1. Test of Meta Components

To Sternberg there are seven executive processes critical to intelligent problem solving. These are:

i) Recognizing the existence of a problem

ii) Defining the nature of a problem

iii) Generating the set of steps needed to solve the problem

iv) Combining these steps into a workable strategy for problem solution.

v) Deciding how to represent information about the problem.

vi) Allocating mental and physical resources to solve the problem and

vii) Monitoring the solution to the problem

For the test, the above seven processes are conceived into five which are given below with model test items under each.

i) Recognizing and defining the problem

Problem arises in virtually every domain of living, both individuals and for organization. Spotting and stating of these problems are really crucial for successful life.

Example of a test item

Balu started to walk from his home towards sea to view the sunset. After sometime he turned to his left and walked. Then he again turned to his left and walked. But he couldn't see the sunset. The problem here is

a) He was walking in the East direction.

b) He was walking in the South direction

c) He was walking in the North direction

d) He was walking in the East-West direction.

ii) Generating the set of steps needed to solve the problem

A critical meta component for achieving solution requires the generation of a set of steps towards solution.

Example of an item

I have 14 coins with Rs. 5/- as 25 and 50 paise coins. Which equation of the following will help you to find out how many 25 paise coins I have (x=number of 25 paise coins, y=number of 50 paise coins).

a) $25x+50y=5$

b) $x+y=14$
   $25x.50y=5$

c) $x+y = 14$
   $25x+50y=5$

d) $x+y=14$
   $25x+50y=500$

iii) Workable strategy for problem solving

Often intelligence is indicated by the systematic strategy used in arriving at solutions

Example of an item

You have got two measuring jars of 3 litres and 8 litres. By using those jars how can you take one litre of oil?

iv) Representing information about the problem

An important part of problem solving is the way in which information is represented - internally or externally (using mental image or a set of proposition created). Many complicated problems become much simpler. One doesn't rely totally on mental representations and also on literal representations to solve them.

Example of an item

Read the problem given below and answer the questions by noting the way by which you reached the answer to the problem in the response sheet given

Bill is taller than Tom

Peter is taller than Sam

Peter is shorter than Tom

Bill is shorter than Mike

Sam is taller than Jack

Who is the tallest

A. Bill B. Sam C. Mike D. Peter

v) Using mental and physical resources to solve problem

The wisdom with which resources are allocated can have a tremendous impact on both the short and long term future. One way of knowing them is to test for the strategy and the time spend to arrive at the solution for reasoning problems.

Example of an item

Lecturer is to learner as [a teacher b. film] is to [a. viewer b. actor]

A. Teacher is to viewer B. Film is to viewer

C. Teacher is actor D. Film is to actor

3.3.2.2. Test of Performance Components

All tests of inductive reasoning like analogy, classification, series, completion, matrix problems and practical reasoning problems are tests of performance components.

Example of test items

i) Analogy

Grades: Wine:: Wheat: _______

A. Corn flour B. Field C. Corn D. Bread

ii) Classifications

(Spot the one which is different form others in the given series)

A. Silver B. Sink C. Lead D. Iron

iii) Series completion

1, 2, 2, 5 __, 10, 4,........

A. 5 B. 3 C. 6 D. 4

iv) Matrix problem

$$\begin{bmatrix} 6 & 11 & 25 \\ 8 & 6 & 4 \\ 12 & 5 & ? \end{bmatrix}$$

The missing number in the matrix is

A. 10 B. 12 C. 16 D. 49

v) Practical Reasoning Problems

Children should not smoke because

A. It is a bad habit B. It is the advice of elders
C. It is an unnecessary expenditure D. It is injurious to health

3.3.2.3. Test of Knowledge Acquisition Components

Here insight problems are given to find the ability to sort out relevant from irrelevant information (selective encoding), how to combine pieces of information (selective combination) and how new information is related to old (selective comparison).

i) Selective encoding

The sound of one gun fired from a place takes two minutes to reach another place. How much time will it take for the sound of five guns fixed from the same place to reach the same another place.

A. 10mts. B. 2mts C. 5 mts. D. 4mts

ii) Selective combination

What is the total number of people in a line if 'A' is the seventh person from both ends of the line?

A. 12 B. 13 C. 14 D. 7

iii) Selective comparison

Paintings are made by skillful persons.

Novel is to author as painting is to ____

A. Creativity B. Artist C. Colour D. Wall

Scoring Procedure

The scoring procedure of the test is to give one score for each correct answer and zero score for each incorrect ones, except in cases of tests I (iii) and I (iv). In test I (iii) the strategy used by the respondent for arriving at the solution is critical and hence score depends on the 'systematic' strategy used. An additional score of 1 will be given to items under these tests if the strategy followed is systematic. In test I (iv) the nature of representation is crucial. Therefore scoring depends on whether the respondent used an external or literal representation of the information for arriving at the right answer. Here also an additional score of one will be given if there is correct external representation.

Validity and Reliability

As part of standardization validity and reliability were estimated and the details are as follows.

The validity of the test was estimated empirically by comparing the scores of the test with 'The Kerala Non Verbal Group Test of Intelligence for Secondary School Pupils' (Nair, 1968). The coefficient of correlation so obtained is 0.62 (N=40) indicating that the test has concurrent validity.

Reliability of the test was established by the test-retest method. The test-retest reliability coefficient is 0.79 (N=40).

The above evidences suggest that the test is reliable and valid to measure Intelligence of secondary school pupils.

A Copy of the test is given as Appendix V.

3.3.3. Test of Mathematical Creativity

Creativity is the capacity to produce something new and original. According to Lefton (1985, p.343), Creativity is "a characteristic of thought and of problem solving, generally considered to include originality, novelty and appropriateness" An original response is one that is not usually given. A novel response is one that is new or that has no precedent. An appropriate response is one that is reasonable in terms of the situation.

Guilford (1967) defined creative thinking as a form of thought that is divergent. According to him Creativity involves divergent thinking with respect to the traits of fluency, flexibility and originality of thought process.

To measure the extent of creative ability in dealing with Mathematics of secondary school pupils, the investigator prepared and standardized 'Test of Mathematical Creativity' with the help of her supervising teacher.

The procedure adopted for the development of test is described below.

3.3.3.1. Planning the Test

The working definition set for the preparation of the test is that Mathematical Creativity is the ability of pupils to think divergently and to produce a number of original and rational responses to specific situations. The investigator on the basis of the theoretical knowledge about Creativity and the guidance from her supervising teacher developed the 'Test of Creativity' with all the items mathematical.

3.3.3.2. Preparation of Items

Since the purpose of the test was to measure the Mathematical Creativity of secondary school pupils of Kerala, the items prepared were based on secondary school Mathematics. Mathematics textbooks for different standards and other related books were used as source books for framing test items. Besides, the investigator used the test of Mathematical Creativity (1993) developed by her supervising teacher as a primary source to determine the type of items that can be incorporated in this test.

Initially 25 items were prepared and some of them were omitted, as these were not good enough to measure the components of creativity viz., fluency, flexibility and originality. Finally the draft test was ready with 15 items. The time limit for responding each item was also temporarily fixed in consultation with her supervising teacher.

Two illustrative items of the test are given below:

1. In what different ways can the numbers 16, 24, 32 and 40 be related

(4minutes)

2. Show how eight circles can be arranged in different patterns.

(6minutes)

Scoring Procedure

Each test item and hence the test is to be scored for fluency, flexibility and originality. Each test item therefore receives three scores and the sum of these three scores for all the items of the test is taken as total creativity score of the pupils.

For scoring, fluency stands for the number of relevant, rational responses (excluding those repeated in an identical form). One score each is assigned for each rational response.

Flexibility refers to the number of relevant categories in which the response to an item can be conceived. The responses are classified into categories and one score is assigned for a category if at least one response comes under it. No additional score is assigned for more than one response in a category.

The scheme for scoring originality is fixed in consultation with the supervising teacher. Scoring for originality is done based on differing degrees of uncommonness of the response as shown in Table 8.

TABLE 8

Scoring Scheme of Originality

Sl. No.	Grouping in terms of uncommonness of response	Scoring
1	Response given by less than 1 percent of the sample	5
2	Response given by 1 to 2 percent in the sample	4
3	Response given by 2 to 4 percent in the sample	3
4	Response given by 4 to 7 percent in the sample	2
5	Response given by 7 to 12 percent in the sample	1
6	Response given by more than 12 percent in the sample	0

3.3.3.3. Try Out

The draft test was tried out on a representative sample of 200 standard IX pupils taken from five schools.

Proper instructions were given to the students before answering and they were asked to write as many answers as possible for each item within the prescribed time limit for that item. After administering the test and collecting answer sheets, they were scored according to the scoring procedure.

3.3.3.4. Finalisation of the Test

Items for the final test were selected on the basis of two indices viz.,

i) Discriminating power of each item, the ability of each item to discriminate significantly between high Mathematically Creative and low Mathematically Creative pupils. (two tailed ' t′ test)

ii) Internal consistency coefficient, which is the coefficient of correlation between item scores and total test scores.

These two indices for all the test items are presented in Table 9

TABLE 9

Item Analysis Data for the Draft Test of Mathematical Creativity

Item No	t-value	'r'	Item No.	t-value	'r'
1	3.86	0.29	9	6.96	0.55
2*	15.66	0.41	10*	4.83	0.54
3	9.20	0.41	11*	5.77	0.48
4	8.76	0.47	12	6.08	0.32
5	6.77	0.29	13*	6.39	0.79
6*	5.53	0.55	14	4.76	0.48
7	9.23	0.43	15*	7.62	0.58
8*	10.02	0.68			

Note: * denotes the selected items.

On the basis of the 't' values and coefficients of internal consistency several items are qualified to include in the final test. But as several tests are to be administered, for practical reasons in terms of time of administration and to make the test different from the available test of Mathematical Creativity, the investigator selected only seven items for the final test with high 't' values and high coefficients of internal consistency. The time limit for the final test with seven items was fixed as 4, 4, 5, 4, 6, 8 and 4 minutes respectively so that the total time limit is 35 minutes.

Copies of the English versions of the draft and final test of Mathematical Creativity are given as Appendix VI and VII.

Validity

Construct validity of the test was examined by testing the hypothesis "the scores of the test will be significantly and positively correlated with the scores of the test of Problem Solving Ability in Mathematics" developed by Sumagala and Vijayakumari (1996). On testing using a sample of 40 students the above hypothesis was found confirmed, indicating that the test has construct validity.

Validity of the test was further established empirically by correlating with the scores of 'Test of Mathematical Creativity' developed by Sumangala (1993). The index of this criterion related validity was found to be 0.72 (N=40).

Reliability

The test-retest reliability coefficient of the test was calculated by re-administering the test after two weeks of first administration. The reliability coefficient so obtained was 0.81 (N=40). Reliability was also calculated by estimating the Cronback's Alpha coefficient. This index was 0.74 (N=35).

The above evidences suggest that the test is a valid and reliable test to measure the Mathematical Creativity of secondary school pupils of Kerala.

3.3.4. Test of Mathematical Problem Solving Process Skills

This test was prepard and standardized by Sumangala and Anilkumar (1997). This test has five sub tests and these are tests of the five Processes of Problem Solving viz., 1) recognizing a problem from a situation 2) identifying a Mathematical problem 3) analysis of data 4) evaluation of results and 5) formulating generalization. All the test items are of objective type- multiple-choice items with four alternatives.

The test contains 40 items in all the five tests. A sample item each for each process skill is given below.

3.3.4.1. Recognizing a problem from a situation

Example

The time is midnight. It is raining heavily and too cold. The question is whether it will be sunny climate after 72 hours.

A) It will be noon

B) It will be night

C) If not raining a sunny climate

D) It can't said based on the given facts

3.3.4.2. Identifying Mathematical Problem

Example

I have a certain number of 25 and 50 paise coins. Altogether I have 14 coins worth Rs. 5 which equation of the following will help you to find out how many 25 paise and how many 50 paise I have.

(x=number of 25 paise, y= number of 50 paise)

A) $25x+50y=5$ B) $x+y=14$ $25x.50y=5$ C) $x+y = 14$ $25x+50y=5$ D) $x+y=14$ $25x+50y=500$

3.3.4.3. Analysis of Data

Example

Part of a problem reads "how much interest compounded quarterly does a bank pay on Rs. 3000/- kept in a savings account for one year." Any additional information is needed to solve this problem.

A. No additional information

B. When the money will be withdrawn

C. The purpose of the savings

D. The interest rate

3.3.4.3. Evaluation of Results

Example

If p=q then

i) $2p=2q$

ii) $2pxp=2qxq$

iii) $3p^2=2pq$

iv) $\frac{3p^2}{P} = \frac{2pq}{P}$

v) $3p=2q$
If $p=q=2$

vi) $3 \times 2 = 2 \times 2$
$6 = 4$

A) Step ii) is wrong   B) Step iii) is wrong

C) Step iv) is wrong   D) Step v) is wrong

3.3.4.5. Formulating generalization

Example

$1^3=1$

$1^3+2^3=9$

$1^3+2^3+3^3=36$

$1^3+2^3+3^3+4^3=100$

$1^3+2^3+3^3+4^3+5^3=225$

$1^3+2^3+3^3+4^3+5^3+6^3=441$

$1^3+2^3+3^3+4^3+5^3+6^3+7^3=$_______

A) 441   B) 335   C) 784   D) 1000

Scoring Procedure

The scoring procedure of the test is to give one score for every correct answer and zero score for every incorrect ones.

Validity and Reliability of the Test

Concurrent validity of the test was established empirically by estimating its correlation coefficient with examination marks in Mathematics on the assumption that a student with good process skills will be a good achiever in Mathematics. The coefficient obtained was 0.65 for N=44.

Construct validity of the test was also tested by assuming that the test scores will be related to the scores of the test of Numerical Reasoning. The correlation obtained was 0.38 (N=32).

Reliability was established by test retest method. The coefficient of correlation obtained was 0.83 (N=38).

The indices of reliability and validity reveals that the test is reliable and valid to measure Mathematical Problem Solving Process Skills of secondary school pupils.

A Copy of the test is given as Appendix VIII.

3.3.5. Test of Mathematics Aptitude

This is a test developed and standardized by Sumangala and Malini (1995) for the use of secondary school pupils of Kerala. The test has five subsets viz.,

i) Test of Numerical Ability

ii) Test of Numerical Reasoning

iii) Test of Ability to use Symbols

iv) Test of Spatial Ability

v) Test of Abstract Reasoning.

These tests contains 15, 10, 5, 8 and 15 items with time limits 10 mts, 10 mts, 5 mts, 7 mts and 8 mts respectively.

All the test items are objective type and hence the scoring scheme is give one score for each correct answer and zero score for every incorrect answer.

Some illustrative test items are given below

i) 0.1_0.11 _ 0.1010 = ...

A. 0.2120 B. 0.1220 C. 0.1202 D. 0.2102

ii) If 't' denotes multiplication, '*' denotes addition and 'O' denotes division, what is the value of the following:

12+ (14 * 7) O 2 + 4

A. 40 B. 20 C. 22 D. 64

iii) When the radius of a circle is reduced by half its area is

A. Reduced to half B. Doubled
C. reduced to one-fourth D. not changed.

Validity and Reliability

The test retest reliability coefficient of the total test is 0.72 (N=35). Alpha coefficient of reliability worked out is 0.68 (N=100)

The criterion related validity coefficient is 0.65 for N=40 with school marks as the external criterion.

The indices of reliability and validity indicate that the test is reliable and valid to measure the mathematics aptitude of secondary school pupils of Kerala.

A Copy of the test is given as Appendix IX.

3.3.6. Scale of Mathematics Anxiety

This scale was developed in the form of Likert type attitude scale by Sumangala and Malini (1995). This scale is intended to measure the extent of fear or the feeling of apprehension in working with Mathematics on the assumption that a feeling of apprehension could possibly surpass a student into working hard and hence improve his performance (Anxiety in this case is facilitating). If the apprehension is so intense that normal reasoning powers are inhibited, then it is fear and hence it is debilitating anxiety.

The scale consists of 29 statements in which 23 are for measuring debilitating Anxiety and 6 are for measuring facilitating Anxiety.

An illustrative statement of the scale is are given below

"I forget the formula at the time of examination due to anxiety even if I study well".

Scoring Procedure

To each statement students are to respond in either of the five ways viz., Strongly Agree (SA), Agree (A), Undecided (U), Disagree (D) and Strongly Disagree (SD). For a debilitating Anxiety statement the scores assigned are 5, 4, 3, 2 and 1 and for facilitating Anxiety statements the scores assigned are 1, 2, 3, 4 and 5 for responses SA, A, U, D and SD. The sum of scores for all the statements is the score on the scale of Anxiety for a candidate.

Validity and Reliability

The working of the statements itself suggests that the scale has face validity. Construct validity of the scale was examined by setting the following hypothesis viz., i) the measure of this scale will discriminate significantly between High- and Low-achievers in

Mathematics 2) measure of the scale will be negatively related to measure on the scale of Self Concept in Mathematics.

On testing using a sample of 30 students, the above two hypotheses were found confirmed.

Validity of the test was also estimated empirically by comparing the test scores with the scores of the Kerala Examination Anxiety Scale (Nair, 1976) and by correlating with achievement scores in Mathematics. In the first case the coefficient of correlation was 0.57 (N=40) and in the second case it was -0.64 (N=40).

The test-retest reliability coefficient was calculated and found as 0.86 (N=35). Reliability was also calculated by estimating Cronback's Alpha coefficient. This index is 0.80 (N=100).

The above evidences suggested that the scale is valid and reliable to measure Mathematics Anxiety of secondary school pupils.

A Copy of the scale is given as Appendix X.

3.3.7. Mathematics Interest Inventory

This inventory was developed and standardized by Sumangala and Vijayakumari (1996). This is to measure secondary school pupils' Interest in dealing with Mathematics as a subject of study. The items used in the inventory to assess Interest in Mathematics are sets of three activities (A, B, C) giving students opportunity to express their preference for Mathematical activities over other activities. The inventory contains 32 such items.

An illustrative test items is as follows:

A. Reading Biography of the Mathematician Sreenivasa Ramanuja

B. Reading Biography of the great leader Mahatma Gandhi

C. Reading Biography of the poet Rabindranath Tagore

A Copy of the inventory is given as Appendix XI.

Scoring Procedure

Each item is presented in the form of a set of three activities A, B and C and as response, the subject has to select and mark the activity he/she likes most 'to do'. If the marked activity is related to Mathematics give a score of one, otherwise give a zero score.

Validity

The inventory has face validity as each item of the inventory is a set of three similar activities of which one is Mathematical and the student is to mark the activity he or she likes to do most.

The construct validity of the inventory was examined by setting the following hypotheses.

i) The measure of the inventory will be positively related to the measure of Mathematics Aptitude.

ii) The measure of the inventory will be positively related to the measure of the Scale of Attitude towards Mathematics.

iii) Score on the inventory will be high for the members of Mathematics club compared to those who are not members of the club.

On testing using a sample of 40 students the correlation coefficient (Pearson's) obtained for Mathematics Interest with Attitude towards Mathematics and Mathematics Aptitude are 0.58 and 0.46 respectively. These values suggest that the firs two hypotheses are substantiated. The critical ratio obtained for the difference between members and non-members of Mathematics club on Mathematics Interest is 4.45, implying that the third hypothesis is also validated. Thus the inventory has construct validity and can be used to measure Mathematics Interest of secondary school

Reliability

Test-retest reliability of the inventory was estimated using a sample of 40 students with an interval of two weeks between the two administrations. The correlation coefficient obtained is 0.76, which indicates that the inventory is considerably reliable.

3.3.8. Scale of Achievement Motivation in Mathematics

This scale was developed by Sumangala and Vijayakumari (1996). This scale is to measure the striving of secondary school pupils to attain expected goals by learning Mathematics. This scale consists of 42 statements on seven construct viz., Work Ethics, Acquisitiveness, Dominance, Pursuit of Excellence, Competitiveness, Status Aspiration and Mastery.

The test contains both positive and negative statements. Illustrative statements follows:

1. I like to do Mathematical problem which others cannot do (positive statement)
2. I prefer easy problems to hard and lengthy ones (negative statements)

A copy of the scale is given as Appendix XII.

Scoring procedure

Students are to respond to the statements on any of the following ways viz., Always, Sometimes and Never. For a positive statement the scores to be assigned are 3, 2, and 1 for responses Always, Sometimes and Never. For a negative statement the scores to be assigned are 1, 2 and 3 for responses Always, Sometimes and Never.

Validity

Construct validity of the test was examined by testing the hypothesis that the scores on the scale will be significantly related to the scores on the test of Achievement in Mathematics.

On testing using a sample of 40 students it was found that the hypothesis is confirmed (r=0.72) indicating that the scale is construct valid.

Concurrent validity of the scale was established by correlating (Pearson's) the scores of the scale with that the 'scale of Achievement Motivation' developed by Pillai and Salimkumar in 1993. The validity coefficient obtained is 0.66 (N=40) suggesting that the scale is valid.

Reliability

Reliability of the scale was established by test-retest method and the value obtained is 0.80 (N=40). Reliability estimated as Cronback's Alpha Coefficient is 0.83 (N=52).

All these indices indicate that the scale is reliable and valid to measure the Achievement Motivation in Mathematics of secondary school pupils.

A Copy of the inventory is given as Appendix XII.

3.4. SAMPEL SELECTION

The population to be studied for the present study is secondary school pupils of Kerala, the size of which is very large. As it is impractical and impossible to administer all the tests to the whole population and collect the desired data, as any other survey study, the investigator used a sample of the population for administering the test to collect the data for analysis. In this respect Wilkinson and Bhandarkar (1977, p. 251) said that, "Sampling plans which if properly executed can guarantee that if we were to repeat a study on a number of different samples, each of a particular size, drawn from a given population our findings would not differ from the findings that we would get of the given population as a whole was studied by more than a specified proportion of samples"

3.4.1. Sampling Plan

The population of the present study is secondary school pupils of

Kerala. This population consists of students of different subgroups (strata) on the basis of gender, locale, type of management of schools, efficiency of schools etc. When the population belongs to different strata, Wilkinson and Bhadarkar (1977) suggested stratified sampling plan, which ensures greater representativeness of the sample. Hence, the investigator selected the sample using stratified method by considering three strata of the population viz., gender of students, type of management and locale of the schools.

3.4.1.1. Rational for the selection of strata

i) Gender of the students

Influence of gender difference was observed and reported in many of the psychological variables (Cooper and Robinson, 1990; Dresden, 1994; Kaur and Bawa; 1995 and Ali, 2002). As the Government of Kerala (2001) reported almost equal number of boys and girls in secondary schools of Kerala, the investigator decided to give equal representation to boys and girls in the sample.

ii) Locale of the School

Difference in performance in examination is noticed between rural and urban students. Also many studies (Misra, 1986; Bush, 1990; Asha, 1991; Hariharan, 1992 etc.) reported significant difference among rural and urban pupils on many of the psychological variables. As the number of schools in rural area is greater compared to urban area the investigator in consultation with her supervising teacher selected schools for the sample in the ratio, rural: urban=3:1.

iii) Type of Management of School

There are two types of schools in Kerala, based on the organization, which runs the school viz., government and private. Also many studies revealed that government and private school pupils differ in the scores of many of the psychological variables (Nair, 1984; Nambiar, 1990 and Sebastian, 1997). The ratio of private and government schools in Kerala is approximately 3:2 (Directorate of Public Instruction, 2001). Hence the investigator selected private and government schools in the ratio 3:2.

3.4.1.2. Size of the Sample

An important decision that had made relating to sampling is the size of the sample. "It should be large enough to yield statistically representative and significant results in all tabulations of importance but not so large as to entail wastage of funds, to retard the project and achieve needlessly high precision. The sample should yield the desired information with the required level of reliability at a minimum cost". (Wilkinson and Bhandarkar, 1977, p. 274).

Keeping in mind the above view, the investigator decided to have a large sample of 1000 standard IX pupils with the assumption that this will provide enough number of Under-, Normal- and Over-achievers in Mathematics for group comparison.

The break up of the basal sample is given in Table 10.

TABLE 10

Break up of the Basal Sample

Gender		Locale of school		Type of management	
Boys	Girls	Rural	Urban	Private	Government
500	500	750	250	600	400

3.5. DATA COLLECTION, SCORING AND CONSOLIDATION OF DATA

3.5.1. Data Collection Procedure

After deciding the sample for the study and tools for data collection, the investigator made necessary arrangements for data collection. After obtaining permission from the heads of the schools investigator prepared the schedule for data collection.

At the time of administration, the purpose of study was explained to the students. Instructions for marking the responses in the response sheets for each of the tools were given in simple language.

Each of the tool and the corresponding response sheets were distributed one by one. The rules of administration and procedure for responding were strictly followed for each tool. All the tools and response sheets were collected back after the prescribed time limit. Necessary time interval was given between testing to avoid boredom of answering.

3.5.2. Scoring and Consolidation of Data

The response sheets of each of the tools were scored as per the scoring scheme of the tool. Incomplete response sheets were primarily rejected before validation. Only those students for whom complete data were available are retained for statistical analysis. All the relevant data related to each student were entered in pre-designed tables.

After the rejection of incomplete data, the final sample size reduced to 992 for the study.

The break up of the final sample is given in Table 11.

TABLE 11

Break up of the Final Sample

Gender		Locale of school		Type of management	
Boys	Girls	Urban	Rural	Private	Government
449	443	740	252	599	393

Details of schools selected for the study is given as Appendix XIII.

3.5.2.1. Identification of Under- Normal- and Over-achievers in Mathematics

Identification of Under-, Normal and Over-achievers in Mathematics from a total sample of 992 was done following the definitions of the three groups. For this, scores in the test of Intelligence was used as the predictor measures and in the test of Achievement in Mathematics as the criterion measures.

Procedure

In general identification of Under- and Over-achievers fall into two broad categories: the use of statistical methods and nomination. Statistical methods are frequently used in empirical research. Specifically there are three different statistical methods in selecting Under- and Over-achievers: absolute split method, simple difference score method and regression method. Each method has its strengths and limitations.

The absolute split method is most commonly used in studies on gifted Under-achievers (Van Boxtel and Monks, 1992; Calangaelo *et al.*, 1993; Emeric, 1992; Colengalo, 1996). In this method Under-achievers are defined as students who score higher than a certain minimum (eg. top 5percent) on a measure of academic performance. Under-achievers with lower levels of mental ability are excluded in the selection. Simple difference score method is widely used to select Under-achievers with various levels of mental ability. Students whose discrepancy scores are greater than a certain value, usually greater than one standard error of estimate are selected as Under- achievers (Nurmi *et al.*, 1995; Tuss *et al.*, 1995). However, some researches have pointed out the statistical problem of regression towards the mean in this method (Lau and Chan, 2001).

The third approach to identify Under- and Over-achievers is the regression method (McCall *et al.*, 1992; Thorndike, 1963). McCall and his associates (1992) have agreed that this method enables to identify Under-achievers with different levels of mental ability, and had better reliability than the method of simple difference score. Moreover, this method will generate a constant proportion of students as underachieving in any sample (McCall *et al.*; 1992; Plewis, 1991).

In view of the reliability of the regression method as suggested by McCall *et al.*, the investigator decided to use regression method for the identification of Under- and Over- achievers in Mathematics.

Regression method itself is of two types - graphical method and the mathematical method. In both methods a regression equation is developed on the basis of the relation between scores of Intelligence and Achievement.

In the Mathematical method, the regression equation is used for prediction of Achievement in the following way. If the actual Achievement scores of an individual is more than one standard error of estimate of the predicted Achievement he/she is considered as an Over-achiever. If the actual Achievement score is less than one standard error of the predicted Achievement score, he/she is an Under-achiever

Graphical method is simpler and easier than finding the difference between actual and predicted Achievement using the regression equation. As the investigator is a Mathematics teacher, she followed the graphical method suggested by Farquhar and Payne (1964) for the identification of Under-, Normal- and Over-achievers in the study. This procedure involves the following processes:

i) Develop the regression equation for predicting Achievement in

Mathematics based on Intelligence

The worked out regression equation is

$Y' = 0.62x - 1.85$

ii) Estimate standard error of estimate of Y by the formula,

SEy.x = $\sigma y \sqrt{1 - r^2 xY}$

iii) Plot the regression line in the graph and indicate one SEy.x distance above and below the regression line by means of parallel lines. The portion contained between these lines was taken as the region for Normal-achievers. The region above and below was taken as the region for Over-achievers and Under-achievers respectively.

iv) Consider measures of pupils for Intelligence (X) and Achievement in Mathematics (Y) as points (Xi, Yi) (The plane containing the two parallel lines- region of NA, the region below to this- UA and the region above to this- OA).

v) Label pupils as UA, NA and OA by looking into the region in which their points fall.

3.6. STATSITICAL TECHNIQUES USED

All the main statistical analyses are done by computer using the SPSS (version 6.0) Program.

The statistical techniques used for the analyses of data are the following:

1. Two-tailed Test of Significance of Difference Between Mean Scores of Large Independent Sample ('t' test) (Computer Analysis)

Pair-wise comparisons of Under-, Normal- and Over-achievers in Mathematics for each of the selected predictor variables are done using the two-tailed 't' test

2. One-way Analysis of Variance (ANOVA) (Computer Analysis)

One-way analysis of variance is used to determine whether the means of Under-, Normal- and Over-achievers are different for each of the selected variables by calculating the 'F' values.

3. Pearson's Product Moment Coefficient of Correlation 'r' (Computer Analysis)

4. Test of Significance of 'r' by Fisher's t-test. (Hand Computation)

$$t = \frac{\sqrt{N-2}}{1-r^2}$$

The critical ratio used for this is,

If the 't' exceeds 1.96 or 2.58 r is treated as significant at 0.05 level or at 0.01 level respectively.

5. Verbal Description of 'r' (Garrett, 1973)

The correlation between the two variables is described as 'high', 'substantial' 'low' or 'negligible' depending upon the size of 'r'. The following criteria are used for this.

r from 0.00 to $\pm$ 0.20 denotes indifferent or negligible relationship.

r from $\pm$ 0.20 to $\pm$ 0.40 denotes low correlation present

r from ± 0.40 to ± 0.70 denotes substantial or marked relationship

r from $\pm$ 0.70 to ± 1.00 denotes high to very high relationship.

6. The 0.99 Confidence Interval of r (Garrett, 1973). (Hand Computation)

The limits within which the population 'r' may lie with 99 percent confidence are calculated using the formula, ($r \pm 2.58\ SE_r$), where SE_r, the standard error of r, is computed by the formula $SEr = \frac{1-r^2}{\sqrt{N-1}}$, r being the obtained coefficient of correlation.

7. The Shared Variance (Fox, 1969). (Hand Computation)

The percentage variance shared between the variables is calculated by the formula $r^2 x100$.

8. Chi-Square Test of Independence (Computer Analysis)

To test whether Under- and Over-achievement is dependent on the selected psychological variables, chi-square test of independence was applied. The following formula for the calculation of the χ^2 value is

$\chi^2 = \frac{\Sigma(f0 - fe)^2}{fe}$, where fo is the frequency of occurrence of observed facts, and fe is the expected frequency.

9. The coefficient of Contingency 'C' (Computer Analysis)

The extent of relation between each of the selected psychological variables and Discrepant Achievement is studied by estimating 'C', where

$$C = \sqrt{\frac{\chi^2}{N + \chi^2}}$$

10. Discriminant Analysis-Direct Method (Tacq, 1997) (Computer Analysis)

To identify the variables for which the three groups Under-, Normal-and Over-achievers differ discriminant analysis is used. This method is also used to derive the functions, which may help to classify new cases into groups of Under-, Normal-, and Over-achievers.

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CHAPTER IV

ANALYSIS

- *Preliminary Analysis*
- *Extent of UA, NA and OA*
- *Comparison of the Mean Scores of the Psychological Variables with Achievement in Mathematics*
- *Relation of Psychological Variables with Achievement in Mathematics*
- *Dependency of Discrepant Achievement with Psychological Variables*
- *Identification of the Psychological Variables for which UA, NA and OA Differ*
- *Summary of Findings*
- *Tenability of Hypotheses*

This chapter presents the statistical analyses done and the inferences drawn with regard to Under-, Normal and Over-achievers in Mathematics (UA, NA and OA).

All the statistical analyses were to answer the research questions posed as objectives. Details of the analyses and discussion of the results are presented under the following heads viz.,

(i) Preliminary analysis

(ii) Extent of Under-, Normal- and Over-achievement in Mathematics

(iii) Comparison of the mean scores of the psychological variables between UA, NA and OA

(iv) Relation of psychological variables with Achievement in Mathematics

(v) Dependency of Discrepant Achievement with psychological variables

(vi) Identification of the psychological variables for which UA, NA and OA differ

4.1. PRELIMINARY ANALYSIS

To know the nature of distributions of the psychological variables involved in the study, the investigator worked out some descriptive statistics such as arithmetic mean, median, mode, standard deviation, skewness, kurtosis and standard error of mean for the total sample.

These statistics are presented in Table 12.

TABLE 12

Descriptive Statistics of the Select Psychological Variables

Sl. No.	Predictor Variables	Mean	Median	Mode	Standard deviations	Skewness	Kurtosis	Standard Error of Mean
1.	Achievement Motivation in Mathematics	90.00	90.00	100.00	11.67	-0.43	0.38	0.37
2.	Mathematics Aptitude	20.82	20.00	18.00	6.12	0.69	0.90	0.19
3.	Mathematical Creativity	39.95	35.00	32.00	20.54	0.83	0.14	0.65
4.	Mathematics Interest	9.67	9.00	6.00	4.87	0.60	-0.13	0.16
5.	Mathematics Anxiety	90.89	90.00	89.00	14.73	0.08	-0.13	0.47
6.	Mathematical Problem Solving Process Skills	15.63	14.00	12.00	5.91	0.73	0.05	0.19
7.	Mathematics Achievement	9.33	8.39	6.68	6.14	0.46	-0.48	0.19

Discussion of Results

The descriptive statistics presented in Table 12 revealed that the three measures of central tendency (arithmetic mean, median and mode) are almost the same for the variables Mathematics Aptitude, Mathematics Interest and Mathematics Anxiety. For the variable Achievement Motivation in Mathematics, mode is greater than mean and median. For the variable Mathematical Creativity, median lies between mean and mode. But for the variable Mathematical Problem Solving Process Skills, mode is less than mean and median.

The index of skewness is almost equal to zero for the variable Mathematics Anxiety suggesting that the distribution of this variable is non-skewed for the total sample. The variables Mathematics Aptitude, Mathematical Creativity, Mathematics Interest and Mathematical Problem Solving Process Skills have values greater than zero indicating that the distributions of these variables are slightly positively skewed. For the variable Achievement Motivation in Mathematics, the distribution is slightly negatively skewed.

The indices of kurtosis for all the selected variables indicate that the distributions of these variables are slightly platykurtic. The standard deviation of each of the psychological variables shows the scattering of scores in each variable.

In general, the distributions of the psychological variables do not depart markedly from normality.

4.2. EXTENT OF UNDER-, NORMAL- AND OVER-ACHIEVEMENT IN MATHEMATICS

For the classification of the total sample (N=992) into UA, NA and OA the investigator followed the Graphical method and the details of this were described in the Methodology chapter.

Details of the classification are as follows.

A regression equation for predicting Achievement in Mathematics based on Intelligence was developed with the following data.

Intelligence (X) Achievement in Mathematics (Y)

$\overline{X} = 17.92$ $\overline{Y} = 9.33$

$\sigma X = 5.71$ $\sigma Y = 6.15$

$r_{x.y} = 0.53$

The worked out regression equation is,

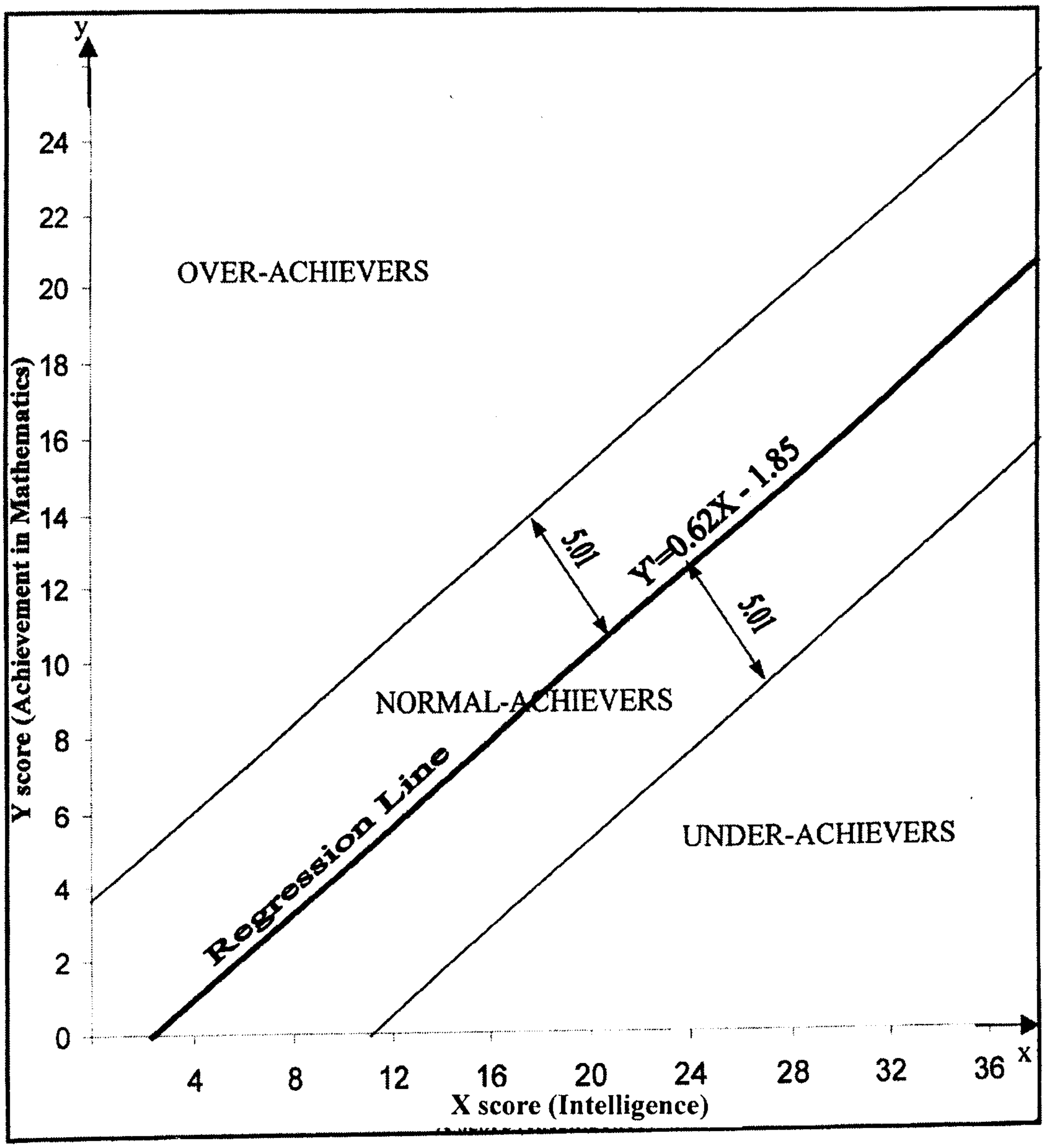
$$Y' = 0.62X - 1.85$$

Then standard error of estimate of Y (SEy.x) found out and got it as 5.01.

The investigator then plotted the regression line in the graph (Figure 1) and indicated one $SE_{y.x}$ distance above and below the regression line by means of parallel lines. The portion contained between these parallel lines was taken as the region for NA; the region above the upper parallel line as of OA and the region below the lower parallel line as of UA.

Then the measures of pupils for Intelligence (X) and Achievement in Mathematics (Y) were treated as points (X_i , Y_i). Then pupils were labeled as OA, NA, and UA by looking into the region in which each (X_i, Y_i) falls.

FIGURE 1: REGRESSION LINE FOR ESTIMATING UA, NA AND OA



To know the extent of Under-, Normal- and Over-achievement in Mathematics, the number of students and the percentage of students fall in each category are given as Table 13.

TABLE 13

Break-up of the Sample as UA, NA and OA

Group	Number of Cases	Percentage of Cases
UA	152	15.32
NA	692	69.76
OA	148	14.92
Total	992	100.00

Discussion of Results

From Table 13 it can be seen that out of 992 cases studied, 152 (15.32 percent) are UA, 692 (69.76) are NA and 148 (14.92) are OA. This means that 15.32 percent of secondary school pupils are below and 14.92 percent are above the predicted level of Achievement in Mathematics, when prediction is made on the basis of measured Intelligence test scores. Only 69.76 percent of pupils achieve as per the expected level of performance.

Findings

Out of the 992 secondary school pupils, 152 (15.32 percent) are Under-achievers, 692 (69.76) are Normal- achievers and 148 (14.92) are Over-achievers in Mathematics. The incidence rate of Under-, Normal- and Over-achievement in the present study is almost equal to that reported in studies by Mathew (1975), Iyer (1977), Nair (1984) and

Sharma (1995).

4.3. COMPARISON OF THE MEAN SCORES OF THE PSYCHOLOGICAL VARIABLES BETWEEN UA, NA AND OA

To compare the mean scores of each of the psychological variables between UA, NA and OA and to identify the variables for which the three groups are significantly different, the technique of one-way analysis of variance was used.

The results obtained by one-way analysis of variance for each of the psychological variables are presented as Table 14.

TABLE 14

Results of the One-way Analysis of Variance of the Mean Scores of the Psychological Variables between UA, NA and OA

Sl. No.	Psychological Variables	Source of variance	Sum of Squares	Mean Squares	F-ratio
1.	Achievement Motivation in Mathematics	Between groups	8227.05	4113.52	32.11**
		Within groups	126701.95	128.11	
2.	Mathematics Aptitude	Between groups	9024.21	4512.10	58.63**
		Within groups	28131. 77	28.45	
3.	Mathematical Creativity	Between groups	97950.27	48975.14	151.38**
		Within groups	319957.90	323.52	
4.	Mathematics Interest	Between groups	1901.33	950.67	43.52**
		Within groups	21601.88	21.84	
5.	Mathematics Anxiety	Between groups	11243.81	5621.90	27.25**
		Within groups	204010.87	206.28	
6.	Mathematical Problem Solving Process Skills	Between groups	13383.00	6692.00	279.67**
		Within groups	23665.09	23.93	

Note: N = 992

Degrees of freedom for between groups is 2 and for within groups is 989

** indicates $P \leq 0.01$

Discussion of Results

From the Table 14 it is found that the F-ratios obtained for all the psychological variables exceed 4.61, the tabled value of F with (2, 989) degrees of freedom at 0.01 level of significance. This suggests that the mean scores of all the psychological variables are significantly different between UA, NA and OA.

The psychological variables having significant difference in the mean scores between UA, NA and OA in the order of the magnitude of F-ratios are presented below.

i)	Mathematical Problem Solving Process Skills	(279.67)
ii)	Mathematics Aptitude	(158.63)
iii)	Mathematical Creativity	(151.38)
iv)	Mathematics Interest	(43.52)
v)	Achievement Motivation in Mathematics	(32.11)
vi)	Mathematics Anxiety	(27.25)

The present finding is that the mean scores of the selected psychological variables are significantly different between the three categories of students, viz., UA, NA and OA. These findings are in agreement with the findings in previous studies like Kulwant, 1973; Nair, 1984; Gupta, 1983; Singh, 1983; Madhavan, 1990; Lau and Chan, 2001, for Achievement Motivation; Vishnoi, 1975; Iyer, 1977; Mathew, 1984; Somasundaran, 1980; Nair, 1984; Valsamma, 1984; Madhavan, 1990, for Anxiety; Menon, 1972; Nagpal, 1979; Bindu, 1996; Lau and Chan, 2001, for Interest and Sharma, 1995, for Aptitude.

As it was found that the difference in means of all the selected psychological variables are statistically significant between the three groups, UA, NA and OA, the investigator tested for pair-wise group difference of UA, NA and OA for each of the psychological variables using two tailed 't' test of significance of difference between mean scores for large independent samples.

4.3.1. Pair-wise Comparison of the Groups UA, NA and OA

Pair-wise comparison between UA, NA and OA was made by two-tailed 't' test to locate between which of the group pairs are difference in mean scores of the psychological variables significant.

TABLE 15

Test of Significance of Difference in Mean Scores of Psychological Variables between Discrepant Achievement

Sl. No.	Psychological Variables	Group UA (N=152)		Group NA (N=692)		Critical ratio (t ratio)	Group NA (N=692)		Group OA (N=148)		Critical ratio (t ratio)	Group UA (N=152)		Group OA (N=148)		Critical ratio (t ratio)
		Mean	SD	Mean	SD		Mean	SD	Mean	SD		Mean	SD	Mean	SD	
1	Achievement Motivation in Mathematics	86.70	10.87	98.34	11.53	-2.58**	89.34	11.53	96.51	10.75	-6.95**	86.70	10.87	96.51	10.75	-7.86**
2	Mathematics Aptitude	19.26	5.20	19.62	5.05	-0.80	19.62	5.05	28.01	6.61	-17.30**	19.26	5.20	28.01	6.61	-12.78**
3	Mathematical Creativity	35.67	14.57	35.81	17.96	-0.09	35.81	17.96	63.68	21.03	-16.60**	35.67	14.57	63.68	21.03	-13.44**
4	Mathematics Interest	8.20	4.75	9.32	4.55	-2.73**	9.32	4.55	12.84	5.16**	-8.34**	8.20	4.75	12.84	5.16	-8.11**
5	Mathematics Anxiety	94.41	12.97	91.77	14.07	2.12*	91.77	14.07	83.17	16.88**	6.51	94.41	12.97	83.17	16.88	11.24**
6	Mathematical Problem Solving Process Skills	11.63	3.96	14.73	4.96	-7.23**	14.73	4.96	24.01	5.40**	-9.28	11.63	3.96	24.01	5.40	-22.68**

Note ** $P \leq 0.01$
* $P \leq 0.05$

The results given in Table15 are described below.

4.3.1.1. Comparison of UA and NA for the mean scores of the psychological variables

The critical ratios obtained for the psychological variables Mathematical Problem Solving Process Skills, Mathematics Interest and Achievement Motivation in Mathematics are greater than 2.58, the value required for significance at 0.01 level. This suggests that the mean scores of these variables obtained for the groups UA and NA are significantly different. For the variable Mathematics Anxiety, the critical ratio obtained is greater than 1.96, the minimum value required for significance at 0.05 level. This suggests that the mean scores of the variable Mathematics Anxiety for these groups are significantly different at 0.05 level.

The critical values obtained for the variables Mathematics Aptitude and Mathematical Creativity are far below the cut off point (1.96). Thus in the case of these variables the mean scores of the groups UA and NA do not differ significantly.

4.3.1.2. Comparison of the Groups NA and OA for the Mean Scores of the Psychological Variables

From Table 15 it can be observed that the groups NA and OA differ significantly (at 0.01 level) in the mean scores of all the psychological variables, as the critical ratios estimated for these variables are far above 2.58, the value required for significance at 0.01 level.

The variables for which the mean scores of NA and OA groups differ significantly are presented below in the order of critical ratios obtained.

i)	Mathematics Aptitude	(-17.30)
ii)	Mathematical Creativity	(-16.60)
iii)	Mathematical Problem Solving Process Skills	(-9.28)
iv)	Mathematics Interest	(-8.34)
v)	Achievement Motivation in Mathematics	(-6.95)
vi)	Mathematics Anxiety	(6.51)

The negative values for the critical ratios of the variables Mathematics Aptitude, Mathematical Creativity, Mathematical Problem Solving Process Skills, Mathematics Interest and Achievement Motivation in Mathematics indicate that the group NA has less scores in these variables compared to OA.

The positive critical ratio for the variable Mathematics Anxiety indicates that the mean score of this variable for the group A is greater than that for OA. This suggests that NA have greater Mathematics Anxiety than OA.

4.3.1.3. Comparison of the Groups UA and OA for the Mean Scores of the Psychological Variables

From the Table 15 of results it can be observed that the groups UA and OA differ significantly (at 0.01 level) in the mean scores of all the psychological variables, as the critical ratios estimated for these variables are greater than 2.58, the minimum value required for significance at 0.01 level. This suggests that the groups UA and OA are significantly different for these variables.

The variables for which the mean scores of the groups UA and OA differ significantly are presented below in the order of their critical ratios.

i)	Mathematical Problem Solving Process Skills	(-22.68)
ii)	Mathematical Creativity	(-13.44)
iii)	Mathematics Aptitude	(-12.78)
iv)	Mathematics Anxiety	(11.24)
v)	Mathematics Interest	(-8.11)
vi)	Achievement Motivation in Mathematics	(-7.86)

The negative values of the critical ratios indicate that UA have less mean scores in these variables and hence lesser scores in the variables Mathematical Problem Solving Process Skills, Mathematics Aptitude, Mathematical Creativity, Mathematics Interest, and Achievement Motivation in Mathematics compared to OA.

The positive critical ratio in the case of Mathematics Anxiety indicates that UA have greater mean score and hence are higher in Mathematics Anxiety compared to OA.

Findings

1. When mean scores of each of the psychological variables for the groups UA, NA and OA are compared, significant differences in mean scores (at 0.01 level) were obtained for all the psychological

variables. The differences is more for cognitive variables viz., Mathematics Problems Solving Process Skills, Mathematics Aptitude, Mathematical Creativity, compared to the affective variables, viz., Mathematics Interest, Achievement Motivation in Mathematics, Mathematics Anxiety.

2. When mean scores of the psychological variables of groups UA and NA are compared significant differences in mean scores (at 0.01 level) were observed for the variables Mathematics Problems Solving Process Skills, Mathematics Interest and Achievement Motivation in Mathematics. These groups differ significantly in the mean scores of Mathematics Anxiety at 0.05 level. The mean scores of the variables Mathematics Problems Solving Process Skills, Mathematics Interest and Achievement Motivation in Mathematics are higher for the group NA than for the group UA. But for Mathematics Anxiety the group UA has higher mean score than the group NA.

3. For the variables Mathematics Aptitude and Mathematical Creativity the two groups UA and NA do not much differ in the mean scores. Hence the two groups can be considered as belonging to same population for these variables. For the other variables differences in mean scores are statistically significant.

4. Significant difference in mean scores exists between the group pairs NA and OA, and UA and OA for all the Psychological Variables under study. For all the psychological variables listed below the mean scores of OA is greater than that of UA and NA.

i) Mathematics Problems Solving Process Skills

ii) Mathematical Creativity

iii) Mathematical Aptitude

iv) Mathematics Interest

v) Achievement Motivation in Mathematics

5. Mathematics Anxiety of OA is less than that of UA and NA.

4.4. RELATION OF PSYCHOLOGICAL VARIABLES WITH ACHIEVEMENT IN MATHEMATICS

Even though the main objective of the study is to find out the predictor variables witch could discriminate between the three Discrepant Achievement groups, the investigator wished to estimate the extent of relationship of the predictor variables with Achievement in Mathematics, one of the criterion variables. As such, the extent and nature of relationship between each predictor variables and Achievement in Mathematics has been worked out for the sample (N=992) using the Pearson's Product Moment Coefficient of Correlation (r) technique.

The investigator could use Pearson's Product Moment Coefficient of Correlation 'r' as all the variables under study are continuous and of the interval type by their measurement. Besides, in using 'r', the basic assumptions to be met are,

i) The distribution of the criterion (dependent) variable should be normal or at least not badly skewed. (This was understood by studying the distribution graphically and by estimating measures of skewness and kurtosis in the previous section).

ii) The relationship between the two variables is rectilinear. (This was understood by preparing scatter diagrams in the case of each psychological variable with Achievement in Mathematics)

iii) The condition of equal scattering (homoscedasticity). (This was assumed as a large sample was used for the study)

As all the assumptions are satisfied, the investigator proceeded with the computation of Pearson's 'r'. The value of 'r' obtained in the case of each psychological variable is described below in terms of

i) Statistical significance of the coefficient (by Fisher's t- test)

ii) The size of 'r'

iii) Direction of 'r'

iv) 99 percent confidence of 'r'

v) Shared variance, which a variable has in common with the variable associated, and

vi) The coefficient of predictive efficiency, E.

Details of these are presented in Table 16.

TABLE 16

Coefficient of Correlation and Other Details of Psychological Variables with Achievement in Mathematics

Sl. No.	Psychological Variables	Correlation Coefficient 'r'	Fisher's t	Standard Error of Estimate (SEr)	99% Confidence Interval	Shared Variance	Predictive Efficiency of 'r' (E)
1.	Achievement Motivation in Mathematics	0.32**	10.45	0.03	(0.24, 0.40)	9.90	0.05
2.	Mathematics Aptitude	0.67**	28.28	0.02	(0.62, 0.71)	44.60	0.26
3.	Mathematical Creativity	0.67**	28.44	0.02	(0.63, 0.71)	44.90	0.26
4.	Mathematics Interest	0.36**	12.12	0.03	(0.28, 0.44)	12.90	0.07
5.	Mathematics Anxiety	-0.30**	-9.72	0.03	(_0.37, 0.22)	8.70	0.04
6.	Mathematical Problem Solving Process Skills	0.76**	36.99	0.01	(0.73, 0.80)	57.90	0.35

Note: ** indicates significance at 0.01 level ($P \leq 0.01$)

Discussion of Results

From Table 16 it can be seen that the coefficient of correlation obtained between each of the psychological variables and Achievement in Mathematics are significant (at 0.01 level), as the t-value exceed 2.58, the limit set up for significance at 0.01 level. The significant 'r' is indicative of a true relationship and hence it can be understood that there exists real relationship between each of the psychological variables and Achievement in Mathematics.

The psychological variables in the order of the extent of relationship are presented below.

i) Mathematics Problems Solving Process Skills (0.76)

ii) Mathematical Creativity (0.67)

iii) Mathematical Aptitude (0.67)

iv) Mathematics Interest (0.36)

v) Achievement Motivation in Mathematics (0.32)

vi) Mathematics Anxiety (-0.30)

The magnitude of 'r' reveals that the relationship between Problem Solving Process Skills and Achievement in Mathematics is high. The relation of the variables Mathematical Creativity and Mathematics Aptitude with Achievement in Mathematics are substantial and the relations of the remaining variables with Achievement in Mathematics are low.

It was also found that the relations of the psychological variables Mathematical Problem Solving Process Skills, Mathematics Aptitude, Mathematical Creativity, Mathematics Interest, and Achievement Motivation in Mathematics with Achievement in Mathematics are positive. This suggests that an increase in these variables is accompanied by a corresponding increase in Achievement in Mathematics. The variable Mathematical Problem Solving Process Skills has a high positive relation with Achievement in Mathematics. This suggests that an increase in this variable corresponds to high increase in Mathematics Achievement. Also an increase in Mathematical

Creativity and Mathematics Aptitude is accompanied by a substantial increase in Mathematics Achievement. Two variables, Achievement Motivation in Mathematics and Mathematics Interest have low but positive relation with Achievement in Mathematics. That is, an increase in these variables corresponds to a low increase in Mathematics Achievement. The relation of Mathematics Achievement and Mathematics Anxiety is negative and low. That is, an increase in Mathematics Anxiety is followed by a corresponding decrease in Mathematics Achievement.

Ninety nine percent confidence interval of 'r' estimated between each of the psychological variables and Achievement in Mathematics is presented in Table 16. These suggest that the population 'r' would lie between the given limits for each of the variables, the probability being 0.99.

Table 16 also shows the shared variance indicating the percentage variance of the criterion variable Achievement in Mathematics accounted by variation in each of the predictor variables. The shared variances estimated vary between 8.70 (for Mathematics Anxiety) and 58.10 (for Mathematics Problem Solving Process Skills).

The coefficient of predictive efficiency, E (in terms of 'r'), of the variables varies from 0.04 to 0.35, which indicates that the efficiency of the psychological variables in predicting Achievement in Mathematics ranges from 4.00 percent to 35.00 percent. The psychological variables in the order of the magnitude of predictive efficiency are listed below.

i)	Mathematics Problems Solving Process Skills	(0.35)
ii)	Mathematical Creativity	(0.26)
iii)	Mathematical Aptitude	(0.26)
iv)	Mathematics Interest	(0.07)
v)	Achievement Motivation in Mathematics	(0.05)

Findings

All the psychological variables under study have significant correlation with Achievement in Mathematics at 0.01 level. The variables given below are positively correlated with Achievement in Mathematics.

i) Mathematics Problems Solving Process Skills

ii) Mathematical Creativity

iii) Mathematical Aptitude

iv) Mathematics Interest and

v) Achievement Motivation in Mathematics

The variable Mathematics Anxiety is negatively correlated with Achievement in Mathematics.

Findings of the present study suggest that all the select psychological variables are significantly related to Achievement in Mathematics. This findings are in consistent with the findings of the previous studies suggesting that Achievement in Mathematics is related to Problem Solving Skills (Kumar, 1984; Caballus and Estaban, 1988; Saljo and Wyndhamn 1990), to Creativity (Sreelatha, 1984; Tuli, 1985; Gakhar 1985; Padhi 1995; Resmi 1997; Jyothi 1997; Mumthas, 2001;

Nasser and Birenbaum 2005), to Aptitude (Budev, 1990; Okamoto and Kitao, 1992; Vijayakumari, 1993; Meeker *et al.*, 1995; Nijenhuis *et al.*, 2000; Nainitha, 2000), to Interest (Lalithamma, 1973; Schiefele and Csihszenlimihalyi 1994; Antony 2000; Mumthas 2001), to Achievement Motivation (Reynolds and Herbert, 1992; Anthony, 2000; Mumthas, 2001; Bouffard and Couture, 2003; Smith, 2003; DeJung *et al.*, 2004), and to Anxiety (Soamsundaram, 1980; Coleman, 1992; Hadfield *et al.*, 1992; Roy and Roy, 1994; Bandalos *et al.*, 1995; Xin, 1999; Mumthas 2001).

Some of the findings of the present study contradicted the findings in previous studies such as Mathematics Achievement is not related to Creativity (Dhaliwal and Saina, 1975; Gakhar and Sood, 2003), to Aptitude (Ghuman, 1976), to Achievement Motivation (Rajput, 1984) and to Anxiety (Miller, 1991; Minimol, 2000).

4.5. DEPENDENCY OF PSYCHOLOGICAL VARIABLES WITH DISCREPANT ACHIEVEMENT

To test whether Under-and Over-achievement is dependent on the select psychological variables, the non-parametric Chi-square (χ^2) test of independence was applied (computer analysis) with the assumption that Discrepant Achievement and each of the psychological variables under study are independent.

In order to calculate χ^2-values for the dependency of the psychological variables with Discrepant Achievement, data was arranged in the form of 3 x 3 contingency tables (given in Appendix XIV). For this each psychological variable was considered in three levels viz., High-, Average-, and Low- ('σ' distance from mean as the criterion for classification) and Discrepant Achievement as UA, NA, and OA (classification procedure described earlier).

Whenever a χ^2 value indicated significant dependency of the psychological variable with Discrepant Achievement, 'C' coefficient of contingency was estimated to know the extent of relation or dependency of the variables. The estimated values and the 'C' coefficients are given in Table 17.

TABLE 17

Chi-Square Values and the 'C' Coefficient for the ependency of the Psychological Variables with Discrepant Achievement

Sl. No.	Psychological Variables	χ^2 Value	'C' Coefficient	Maximum 'C'
1.	Achievement Motivation in Mathematics	49.69**	0.22	
2.	Mathematics Aptitude	162.95**	0.38	
3.	Mathematical Creativity	235.09**	0.44	0.82
4.	Mathematics Interest	54.06**	0.23	
5.	Mathematic Anxiety	76.63**	0.27	
6.	Mathematical Problem Solving Process Skills	255.28**	0.45	

Note: ** $P \leq 0.01$

Discussion of Results

The value of χ^2 obtained for the variable Achievement Motivation with Discrepant Achievement is 49.70 (Table 17), which far exceeds 13.28, the tabled value of χ^2 at 0.01level of significance and for four degrees of freedom. This results in the rejection of the null hypothesis "Achievement Motivation in Mathematics and Achievement in

Mathematics are independent" which in turn implies the significant association of the two variables. That is Achievement Motivation in Mathematics and Discrepant Achievement are significantly related or associated.

As the relation was found to be significant, to get an idea of the extent of relationship, 'C' coefficient of contingency was estimated in terms of χ^2. The value of 'C' was found to be 0.22 (Table 17), whereas the maximum value of 'C' for a 3 x 3 contingency table being 0.82.

For the variable Mathematics Aptitude, the χ^2 value obtained is 162.95 which is highly greater than 13.28, the tabled value of χ^2 at 0.01 level of significance and for four degrees of freedom. This suggests significant association of the variable Mathematics Aptitude with Discrepant Achievement in Mathematics.

'C' coefficient, the index of association between the variables, was found as 0.38, where the maximum 'C' obtainable is 0.82.

The χ^2 value obtained for the variable Mathematical Creativity is 235.09. This value far exceeds 13.28, the required value of χ^2 for significance at 0.01 level and for four degrees of freedom. This suggests that the relationship between Mathematical Creativity and Discrepant Achievement is significant at 0.01 level.

'C' coefficient calculated to find the extent of dependency is 0.44 and the maximum 'C' possible is 0.82.

Discrepant Achievement has significant association with Mathematics Interest as the χ^2 value (54.06) is greater than the needed value of χ^2 (13.28) for four degrees of freedom, the level of significance being 0.01.

The χ^2 value obtained for Mathematic Anxiety is 76.63 associated with four degrees of freedom. This value is greater than the tabled value of χ^2 at 0.01 level (13.28). This suggests the significant association of Mathematics Anxiety with Discrepant Achievement in Mathematics.

The 'C' coefficient obtained is 0.27 and the maximum 'C' obtainable is 0.82.

The χ^2 value obtained for the dependency of the variable Mathematical Problem Solving Process Skills with Discrepant Achievement is 255.28 which is far greater than 13.28, the χ^2 value needed for significance at 0.01 level with four degrees of freedom. This implies that the variable Mathematical Problem Solving Process Skills is significantly associated with Discrepant Achievement in Mathematics.

The 'C' coefficient calculated to know the extent of association between the variables is 0.45 and the maximum 'C' obtainable is 0.82.

Discrepant Achievement is found to have significant association with all the psychological variables selected for the study. The variables in the order of the 'C' coefficient of contingency suggesting the extent of relationship are presented below:

i) Mathematics Problems Solving Process Skills (0.45)

ii) Mathematical Creativity (0.44)

iii) Mathematical Aptitude (0.38)

iv) Mathematics Anxiety (0.27)

v)	Mathematics Interest	(0.23)
vi)	Achievement Motivation in Mathematics	(0.22)

Findings

Discrepant Achievement is found to have significant association with all the psychological variables selected for the study. The variables in the order of the 'C' coefficient of contingency, suggesting the extent of relationship are presented below,

i)	Mathematics Problems Solving Process Skills	(0.45)
ii)	Mathematical Creativity	(0.44)
iii)	Mathematical Aptitude	(0.38)
iv)	Mathematics Anxiety	(0.27)
v)	Mathematics Interest	(0.23)
vi)	Achievement Motivation in Mathematics	(0.22)

4.6. IDENTIFICATION OF THE PSYCHOLOGICAL VARIABLES FOR WHICH UA, NA AND OA DIFFER

Discriminant function analysis (Direct Method- Computer Analysis) was done in the study to identify the variables for which the groups UA, NA and OA differ. This method was also used to develop three linear functions for predicting group membership of new cases whose group membership is undetermined.

4.6.1. Analysis of Group Difference

As a preliminary step to discriminant analysis, difference among the groups UA, NA and OA in each of the predictor variables was examined by estimating Wilk's Lambda and F-values (The same was tested earlier by One-way ANOVA). These values along with means and standard deviations of the predictor variables for the three groups UA, NA OA and for the total sample are presented in Table 18.

TABLE 18

Univariate Statistics of Predictor Variables

Sl. No.	Predictor Variables	Group UA		Group NA		Group OA		Total Sample		Wilk's Lambda (λ)	F-ratio
		Mean	S.D.	Mean	S.D	Mean	S.D.	Mean	S.D.		
1	Achievement Motivation in Mathematics	86.69	10.87	89.33	11.53	96.50	10.75	90.00	11.67	0.94	32.11**
2.	Mathematics Aptitude	19.25	5.20	19.62	5.05	28.01	6.61	20.81	6.12	0.76	158.63**
3.	Mathematical Creativity	35.66	14.57	35.81	17.95	63.67	21.02	39.94	20.54	0.77	151.38**
4.	Mathematics Interest	8.20	4.75	9.32	4.55	12.83	5.16	9.67	4.33	0.92	43.52**
5.	Mathematics Anxiety	94.40	12.97	91.77	14.07	83.17	16.88	90.89	14.74	0.99	27.25**
6.	Mathematical Problem Solving Process Skills	11.65	3.96	41.73	4.96	24.01	5.40	15.64	6.11	0.64	279.67**

Note: **$P \leq 0.01$

Discussion of Results

A comparison of the group means of the predictor variables for groups UA, NA and OA suggests that group OA has higher mean scores than groups UA and NA for the following five variables.

i) Achievement Motivation in Mathematics

ii) Mathematics Aptitude

iii) Mathematical Creativity

iv) Mathematics Interest

v) Mathematical Problem Solving Process Skills

In the case of Mathematics Anxiety, the mean score of OA is less than that of UA and NA. This suggests that OA have comparatively less Mathematics Anxiety than UA and NA.

When tested for significance using the univariate statistic, Wilk's Lambda, the values of Lambda obtained for all variables suggest a significant difference in the mean scores of the three groups for the variables Mathematical Problem Solving Process Skills (0.64), Mathematics Aptitude (0.76) and Mathematical Creativity (0.77). The values of λ for the other variables Mathematics Anxiety (0.99), Achievement Motivation in Mathematics (0.94) and Mathematics Interest (0.92) are almost equal to 1.00 suggesting that the three groups do not differ much in the mean scores of these variables.

When tested for significance of mean difference using F-test, the values obtained for (2, 982) degrees of freedom indicate significant difference in the mean scores of all the variables at 0.01 level of significance as all the F- values exceed 4.61, the tabled value of F. This suggests that the three groups UA, NA and OA differ significantly in the mean scores of all the six variables (The results are in concurrence with that of ANOVA).

Even though Wilk's Lambda indicate a significant mean difference among the groups UA, NA and OA in the case of Mathematical Problem Solving Process Skills, Mathematics Aptitude and Mathematical Creativity only, the F-values obtained suggest that the three groups UA, NA and OA are significantly different in the mean scores of all the variables under study.

As the F-values suggest that the means of all the psychological variables differ significantly among the groups UA, NA and OA, pair-wise group difference of each variable was tested for means of 'F' test (Even though the same was done by means of two tailed 't'-test and discussed under section 4.3.1)

4.6.1.1. Pair-wise Group Difference of the Psychological Variables

Wilk's Lambda and F-values for the three group pairs such as UA and NA, NA and OA, and UA and OA together with all the groups taken are presented in Table 19.

TABLE 19
Univariate Statistics of Psychological Variables for Different Group Pairs

Sl. No.	Predictor Variables	UA and NA df (1,842)		UA and OA df (1,298)		NA and OA df (1,838)		UA ,NA and OA df (2,982)	
		Mean	S.D.	Mean	S.D	Mean	S.D.	Mean	S.D.
1	Achievement Motivation in Mathematics	0.99	6.67**	0.83	61.73**	0.95	48.24**	0.94	32.11**
2.	Mathematics Aptitude	0.99	0.64	0.65	163.25**	0.74	299.17**	0.76	158.63**
3.	Mathematical Creativity	0.99	0.01	0.62	180.61**	0.75	275.54**	0.77	151.38**
4.	Mathematics Interest	0.99	7.43**	0.82	65.84**	0.92	69.61**	0.92	43.52**
5.	Mathematics Anxiety	0.99	4.49*	0.88	41.95**	0.95	42.35**	0.99	27.25**
6.	Mathematical Problem Solving Process Skills	0.94	52.22**	0.37	514.49**	0.67	412.84**	0.64	279.67**

Note ** $P \leq 0.01$
* $P < 0.05$

The results given in Table 19 are described below

4.6.1.1.1. Comparison of Psychological Variables between UA and NA

When tested for significance of the difference in mean scores of the psychological variables between groups UA and NA using Wilk's Lambda, the values of λ obtained for all the variables except for Mathematical Problem Solving Process Skills are almost equal to 1.00 suggesting that the two groups do not differ significantly in the mean scores of these variables. But the value of λ obtained for Mathematical

Problem Solving Process Skills (0.94) suggests that there is difference in the mean scores of this variable between groups UA and NA.

But when tested for significance using F-values, the value obtained for (1,842) degrees of freedom indicate significant difference in the mean scores of Mathematical Problem Solving Process Skills, Mathematics Interest and Achievement Motivation in Mathematics at 0.01 level of significance. For the variable Mathematics Anxiety, significant difference in mean scores exist at 0.05 level of significance for (1,842) degrees of freedom. But for the variables Mathematical Creativity and Mathematics Aptitude the two groups do not differ significantly.

4.6.1.1.2. Comparison of Psychological Variables between UA and OA.

When the difference in mean scores of the psychological variables of the groups UA and OA were tested using Wilk's Lambda, the values of λ suggests that there exists significant difference in the mean scores of all the psychological variables.

It was also found that the F-values obtained for all the psychological variables between groups UA and OA are greater than 6.63, the table value of F with (1,838) degrees of freedom. This suggests that the mean scores of all the variables are significantly different between the groups UA and OA.

The variables in the order of the extent of difference between means are presented below.

i) Mathematics Problem Solving Process Skills
ii) Mathematical Creativity
iii) Mathematics Aptitude
iv) Mathematics Anxiety
v) Mathematics Interest
vi) Achievement Motivation in Mathematics

4.6.1.1.3. Comparison of Psychological Variables between NA and OA

The difference in the mean scores of all the psychological variables between NA and OA were also tested for significance using Wilk's Lambda and F-values. The estimated values of Wilk's Lambda suggest that significant difference exists in the mean scores of all the psychological variables.

When mean differences was tested for significance using F-test, the values obtained for (1,838) degrees of freedom indicate significant difference in the mean scores of all the variables at 0.01 level of significance as all the F-values exceed 6.63, the tabled value of F. This suggests that the two groups NA and OA differ significantly in the mean scores of all the six variables.

The variables in the order of the extent of difference between means are presented below.

i) Mathematics Problems Solving Process Skills
ii) Mathematical Aptitude
iii) Mathematical Creativity
iv) Mathematics Interest
v) Achievement Motivation in Mathematics
vi) Mathematics Anxiety

Hence the null hypothesis that "all the group means are equal" is rejected both by the F-test and Wilk's lambda in the case of two-group comparison of pairs NA with OA and UA with OA. But between group pair UA and NA, significant difference was found in the case of four variables only.

These findings are in par with the findings obtained by 't'-test described under Section 4.3.1 of this chapter.

4.6.2. Interdependencies Among the Predictor Variables

Interdependencies among the predictor variables affect most multivariate analyses and hence a correlation matrix of the predictor variables by averaging the correlation matrices of the three groups UA, NA and OA was estimated to examine interdependencies. This matrix is presented as Table 20.

TABLE 20

Within- Groups Correlation Matrix

Sl. No.	Psychological variables	1	2	3	4	5	6
1.	Achievement Motivation in Mathematics	1					
2.	Mathematical Aptitude	0.17	1				
3.	Mathematical Creativity	0.25	0.54	1			
4.	Mathematics Interest	0.25	0.19	0.26	1		
5.	Mathematics Anxiety	-0.01	-0.09	-0.10	-0.01	1	
6.	Mathematics Problems Solving Process Skills	0.15	0.64	0.57	0.20	-0.12	1

Discussion of Results

Above Table 20 reveals that the value of correlation coefficients (r's) ranges from 0.01 to 0.64 with r's greater than 0.40 in three cases only. Since low relationships were observed for majority of the variables indicating not much interdependency, the relative importance of the variables in discriminating the three groups UA, NA and OA were assessed by discriminant analysis.

As there are three groups the discriminant analysis yielded two discriminant functions as the linear combination of the six select psychological variables, which help assign cases to groups UA, NA and OA in Mathematics.

4.6.3. Discriminant Functions

As all the predictor variables were found to be significantly different between the three groups, UA, NA and OA by 'F' test, linear combination of these variables viz., Mathematics Problem Solving Process Skills, Mathematics Aptitude, Mathematical Creativity, Achievement Motivation in Mathematics, Mathematics Interest and Mathematics Anxiety, were formed so that two indices are obtained. Such combination of variables is formed by estimating weights, which result in the best separation between groups UA, NA and OA. The calculated weights of the variables, that is unstandardized Discriminant Function coefficients corresponding to the two functions are given in Table 21.

TABLE 21
Unstandardized Canonical
Discriminate Function Coefficients

Sl. No.	Psychological variables	Function 1	Function 2
1.	Achievement Motivation in Mathematics	0.01	-0.02
2.	Mathematical Aptitude	0.02	0.15
	Mathematical Creativity	0.01	0.05
4.	Mathematics Interest	0.03	-0.03
5.	Mathematics Anxiety	-0.01	0.00
6.	Mathematics Problems Solving Process Skills	0.16	0.21
7	Constant	-3.18	0.23

Discussion of Results

From Table 21 the first and the second linear discriminant functions formed on the basis of unstandardized canonical discriminant function coefficients are

$D_1 = 0.01\ X_1 + 0.02\ X_2 + 0.01\ X_3 + 0.03\ X_4 - 0.01\ X_5 + 0.16\ X_6\ -3.18$

and

$D_2 = 0.02\ X_1 + 0.15\ X_2 + 0.05\ X_3 - 0.03\ X_4 + 0.00\ X_5 + 0.21\ X_6 + 0.231$,

Where X_1, X_2.....X_6 are the individual scores obtained for the six psychological variables. Using these equations the discriminant scores of each student can be calculated and is assigned to the most likely group (UA, NA or OA) based on the discriminant score.

The relative importance of the variables on each function is expressed by the coefficients of X_1, $X_2 \ldots X_6$ in the functions. But the magnitude of the unstandardized coefficients is not a good index of relative importance, when the variables differ in the units in which they are measured. Hence standardized scores were calculated and the corresponding standardized canonical discriminent function coefficients are presented in Table 22.

TABLE 22

Standardized Canonical Discriminant Function Coefficients

Sl. No.	Psychological variables	Function 1	Function 2
1.	Achievement Motivation in Mathematics	0.13	-0.22
2.	Mathematical Aptitude	0.08	0.78
3.	Mathematical Creativity	0.11	0.82
4.	Mathematics Interest	0.14	-0.13
5.	Mathematics Anxiety	-0.18	0.03
6.	Mathematics Problems Solving Process Skills	0.76	-1.02

Discussion of Results

The first and the second discriminant functions in terms of the standardized function coefficients are

$D_1 = 0.13\ Z_1 + 0.08\ Z_2 + 0.11\ Z_3 + 0.14\ Z_4 - 0.18\ Z_5 + 0.76\ Z_6$ and

$D_2 = -0.22 Z_1 + 0.78\ Z_2 + 0.82\ Z_3 - 0.13\ Z_4 + 0.03\ Z_5 - 1.02\ Z_6$, where Z_1, $Z_2 \ldots Z_6$ are the respective standard scores of the variables X_1, $X_2 \ldots X_6$.

The two functions will account for significant variation in the six variables. The variable that best defines Function 1 (Table 22) is "Mathematical Problem Solving Process Skills" as this variable has high positive coefficient (0.76) in the function. This means that high values of Mathematics Problem Solving Process Skills will result in high values of the function. The coefficient corresponding to Mathematics Aptitude (0.08) is smaller, indicating that the contribution of this variable to the function is very little. The other variables having positive coefficients are Mathematics Interest (0.14), Achievement Motivation in Mathematics (0.13) and Mathematical Creativity (0.11). The negative sign in the case of Mathematics Anxiety (-0.18) indicates that this variable decreases the function value.

In the case of Function 2, the high positive coefficients in the function are Mathematical Creativity (0.82) and Mathematics Aptitude (0.78), indicating that high values of these variables will result in high values of the function. The negative sign together with a high value (-1.02) for the variable Mathematics Problem Solving Process Skills indicates that this variable will decreases the function value. Again negative signs in the case of Achievement Motivation in Mathematics (-0.22) and Mathematics Interest (-0.13) indicate that these variables also decrease the function value. In the case of Mathematics Anxiety, the coefficient is 0.33, indicating that the high values of this variable will contribute to high function value.

4.6.3.1. Discriminant Functions Evaluated at Group Centroids

Group centroids show the relative position of each group viz., UA, NA and OA, according to the two functions. Group centroids on the two functions (Function 1 and Function 2) for the three groups are given in Table 23

TABLE 23

Group Centroids of the Discriminant Functions for UA, NA and OA

Group	Function 1	Function 2
Group UA	-0.80	0.53
Group NA	-0.22	-0.15
Group OA	1.83	0.16

The big difference between the group centroids of UA, NA and OA on Function 1 (Table 23) indicates that it efficiently separates OA from UA and NA. An examination of group centroids on Function 2 indicates that this function separates UA from NA and OA but not so effective as in the case of the first function.

4.6.3.2. Significance of the Discriminant Functions

The eigen value, an indicator of the effectiveness of the function, percentage of variance, cumulative percent, canonical correlation, which is a measure of the degree of association between the discriminant scores and the groups, Wilk's Lambda (λ) and chi-square value, the related statistics which are the indicatives of the significance of each of the functions are presented in Table 24.

TABLE 24

Statistical indicators of the Discriminant Functions

Function	Eigen value	Percent of variance	Cumulative percent	Canonical correlation	Wilk's Lambda	Chi-square	Degrees of freedom
1	0.63	91.07	9.07	0.62	0.58	541.77**	12
2	0.06	8.93	100.00	0.24	0.94	59.25**	5

Note ** $P \leq 0.01$

Discussion of Results

From the Table 24, for the first Discriminant Function 1, the eigen value is 0.63 indicating that the function derived is an effective one for discriminating OA from UA and NA. The percentage of variance 91.07 indicates that the first function explained about 91.07 percent of the variance. The value of the canonical correlation (0.62) indicates that the discriminant scores and the group variables are substantially related. Further the chi-square value (541.08) suggests that the function is significant enough to discriminate OA from UA and NA. Again the value of Wilk's Lambda suggests that this function represents a significant difference between UA, NA and OA. For the second discriminat function, the eigen value is only 0.06 suggesting that this function is less effective. The percentage of variance indicates that the second function accounted for only 8.03 percent of the variance. The value of canonical correlation (0.24) indicates that the discriminant scores have a low relationship with the group variables. But the chi-square value of this function (59.25) suggests that the second function is also statistically significant at 0.01 level to distinguish UA from NA and OA as the χ^2 value exceeds 15.01, the tabled value of χ^2 at 0.01 level with 5 degrees of freedom. But the value of Wilk's Lambda suggests that the second discriminant function cannot significantly differentiate between UA, NA and OA.

4.6.3.3. Classification of the Cases

The discimrinant analysis was also used to classify the total sample of 992 students according to their predicted membership in the three groups namely UA, NA and OA based on their scores in the six predictor variables under study. The cases that were correctly classified and misclassified in to three groups, UA, NA and OA using the discriminant functions were also found out.

The number and percentage of pupils correctly classified and misclassified as belonging to groups UA, NA and OA using the discriminant analysis are given in Table 25 named as "Confusion Matrix" (Johnson and Wichern, 2002).

TABLE 25

Confusion Matrix

Actual Group	No. of Cases	Predicted Group Membership		
		UA	NA	OA
UA	152	20 (13.20%)	130(85.50%)	2(1.30%)
NA	692	9 (1.30%)	640 (92.50%)	43 (6.50%)
OA	148	0 (0.00%)	57 (38.50%)	91 (61.50%)

Percentage of grouped cases correctly classified: 75.71.

Discussion of Result

From Table 25, it can be seen that under the group UA with 152 cases only 20 (13.20percent) were correctly classified as belonging to this group and 132 cases were misclassified, of which 130 cases (85.50 percent) were classified as NA by the discriminant analysis. This may be of an overlapping of UA on NA indicating that both the groups have similar characteristics on the select psychological variables. Under the group NA, 640 (92.50 percent) cases were correctly classified as belonging to this group and 52 cases were misclassified by the discriminant analysis. Among OA with 148 cases, 91 cases (61.50 percent) were correctly classified, while 57 cases were misclassified.

The percentage of cases correctly classified by the function is 75.71 percent and the rate of misclassification is 24.49 percent. This means that the Discriminant Functions framed are efficient enough to discriminate UA, NA and OA with 75.71 percentage of correct classification. Again it can be seen that NA are the most accurately classified with 92.50 percent of the cases correct, OA the next with 61.50 percent and UA the least with 13.20 percent.

4.6.3.4. Classification with Criterion Variables

As the 'Confusion Matrix' showed an overlapping of different groups, especially UA and NA, the investigator in order to verify the correctness of prior classification of the sample into UA, NA and OA, again classified the sample of 992 cases using discriminant analysis classification with the criterion variables as the discriminating variables. The result is presented in Table 26.

TABLE 26
Classification of the Sample with the Criterion Variables as Discriminating Variables

Actual Group	No. of Cases	Predicted Group Membership		
		UA	NA	OA
UA	152	143 (94.10%)	9 (5.90%)	0 (0.00%)
NA	692	1 (0.10%)	686 (99.10%)	5 (0.70%)
OA	148	0 (0.00%)	4 (2.70%)	144 (97.30%)

Percentage of grouped cases correctly classified: 98.08.

Discussion of Results

From Table 26 it can be seen that under group UA with 152 cases, 143 cases (94.10 percent) were correctly classified as belonging to group UA and 9 cases (5.90 percent) were misclassified. Under Group NA with 692 cases, 686 (99.10 percent) cases were correctly classified as belonging to NA while 6 cases were misclassified. Under group OA with 148 cases, 144 cases (97.30 percent) were correctly classified as belonging to Group OA and 4 cases (2.7 0percent) were misclassified.

Thus percentage of cases correctly classified by discriminant analysis classification with Achievement in Mathematics and Intelligence as discriminating variables is 98.08 percent and the rate of misclassification is 1.92 percent.

Thus the investigator could find that the rating of correct classification by Discriminant Function with predictor variables as discriminates has only a slight variation of 22.67 percent from the correct classification rate with criterion variables as discriminants. That is, the classification done with the

Predictor variables as discriminants almost agree with the classification done with criterion variables as discriminants. This further suggests the effectiveness of the Discriminant Functions derived with discriminants as predictor variables.

4.6.3.5. Correlation between Discriminating variables and Canonical Discriminant Functions

The contribution of a variable to the discriminant function was further assessed by estimating correlation between the values of the function and the values of each variable. The so estimated pooled within groups correlation between discriminating variables and canonical discriminant functions in the order of magnitude of correlations are presented in Table 27.

TABLE 27
Pooled Within Groups
Correlation Between Discriminating
Variables and Canonical Discriminant Functions

Sl. No.	Discriminating Variables	Function 1	Function 2
1.	Mathematics problem	0.95*	-0.12
2	Solving Process Skills	00.70*	0.50
3	Mathematics Aptitude	0.67*	0.57
4	Mathematics interest	0.37*	-0.03
5.	Achievement Motivation in Mathematics	0.32*	-0.07
6	Mathematics Anxiety	-0.30*	0.02

* denote large absolute correlation between each variable and a discriminant function.

Discussion of Results

Table 27 suggests that all the six discriminating variables have significant correlation with Function 1 and hence are significant contributors on Function1. This suggests that these six variables are capable of discriminating the three groups UA, NA and OA using Function 1. But for Function 2 none of the variables have significant correlation and hence cannot be said as contributors to Function 2.

Further it is seen that the variable Mathematical Problem Solving Process Skills has the highest relation (0.95) with Discriminant Function 1 and this means that the variable contributes much to the Function 1. The other contributors in the order of magnitude of correlation with the Discriminant Functions are:

1. Mathematics Aptitude (0.70)
2. Mathematical Creativity (0.67)
3. Mathematics Interest (0.37)
4. Achievement Motivation in Mathematics (0.32)

Table 27 also reveals that for Function 1, the correlation of Mathematics Anxiety with Function 1 is negative. This negative sign of the coefficient of correlation for Mathematics Anxiety suggests that it negatively affects the dscriminant scores.

4.6.4. Classification Function Coefficients

Classification function offers the opportunity for classifying new cases into one of the three groups viz., UA, NA and OA. For this Fisher's linear discriminat function coefficients were calculated for the three groups. The three sets of coefficients obtained are presented as Table 28.

TABLE 28

Fisher's Linear Discriminant Function Coefficients

Sl. No.	Predictor Variables	UA	NA	OA
1	Achievement Motivation in Mathematics	0.67	0.69	0.71
2	Mathematics Aptitude	0.60	0.51	0.59
3	Mathematical creativity	-0.08	-0.12	-0.08
4	Mathematics Interest	-0.11	-0.07	-0.02
5	Mathematics Anxiety	-0.48	0.47	0.45
6	Mathematical Problem Solving Process Skills	0.20	0.43	0.68
	Constant	-58.57	-58.65	-68.27

Discussion of Results

Table 28 gives three sets of coefficients for the groups UA, NA and OA. The coefficients for each group can be used for assigning new cases to one of the three groups. A case is assigned to the group for which it has the largest discriminant score calculated using Fisher's discriminant function coefficients and the scores on the select psychological variables.

Using the three sets of coefficients (Table 28) three classification functions D1 for UA, D2 for NA andD2 for OA are formed. These are:

$$D_1 = 0.67\,X_1 + 0.60X_2 - 0.08X_3 + 0.11X_4 - 0.49\,X\,5 + 0.20\,X_6 - 58.57$$

$$D_2 = 0.69\,X_1 + 0.51X_2 - 0.12X_3 + 0.07X4 + 0.47 + X_4 + 0.43X_5 - 58.65$$

$$D_3 = 0.71\,X_1 + 0.59X_2 - 0.08\,X_3 - 0.02\,X_4 + 0.45\,X_5 - 0.68\quad X_6 - 68.27,$$

Where X_1, X_2 X_3, ... X_6 are the scores of the individual on the psychological variables in the order given in Table 28.

When the scores of the psychological variables X_1, X_2 ... X_6 for a new individual is known, but group membership unknown, that individual can be assigned to a group for which he/she has the largest score on the classification function.

Findings

Discriminant function analysis derived two Discriminant Functions to classify the sample into three groups. With these two functions, the correct classification rate was found to be 75.71 percent and the percent of incorrect classification was 24.29 percent. Even though the two functions derived were statistically significant, the first function derived was more efficient than the second one. The findings indicated that the three groups of students differed on the combination of the selected predictor variables. Among the set of variables, the variable Mathematical Problem Solving Process Skills is the most important variable in discriminating the students as Under-, Normal- and Over- achievers in Mathematics. The variables in the order of their relative importance are given below.

i) Mathematics Problem Solving Process Skills

ii) Mathematics Aptitude

iii) Mathematical Creativity

iv) Mathematics Interest

v) Achievement Motivation in Mathematics

vi) Mathematics Anxiety

These findings are similar to that of one-way analysis variance presented in section 4.3)

The discriminant analysis also yielded two classification functions to classify students as Under-, Normal- and Over- achievers in Mathematics on the basis of scores on the select predictor variables.

4.7. SUMMARY OF FINDINGS

The findings evolved from the statistical analyses are summarized and presented below:

1. Classification of the sample in to Under-achievers, Normal-achievers and Over-achievers revealed that among secondary school pupils, 15.32 percent are Under- achievers, 69.76 percent Normal- achievers and 14.92 are Over-achievers in Mathematics.

2. When One-way analysis of variance was used for comparison of the three groups it was found that the mean scores of all the psychological variables are significantly different between Under-, Normal- and Over-achievers in Mathematics. The variables in the order of the magnitude of F ratios are:

i)	Mathematics Problem Solving Process Skills	(279.67)
ii)	Mathematics Aptitude	(158.63)
iii)	Mathematical Creativity	(151.38)
iv)	Mathematics Interest	(43.52)
v)	Achievement Motivation in Mathematics	(32.11)
vi)	Mathematics Anxiety	(27.25)

3. Two tailed 't' test when used to test the significance of mean difference in the psychological variables of the three group pairs Under- and Normal- achievers, Normal- and Over-achievers, and Under- and Over-achievers it was found that group difference exists between Normal- and Over-achievers, and Under- and Over-achievers for all the psychological variables selected for the study.

   But groups Under- and Normal-achievers differ significantly in the case of three variables only viz.,

i) Mathematics Problem Solving Process Skills

ii) Mathematics Interest and

iii) Achievement Motivation in Mathematics

4. Pearson's Product Moment Coefficient of Correlation 'r' when estimated between the psychological variables and Achievement in Mathematics revealed that all the psychological variables have significant correlation (at 0.01 level) with Achievement in Mathematics. The variables in the order of correlation are,

i) Mathematics Problem Solving Process Skills (0.76)

ii) Mathematics Creativity (0.65)

iii) Mathematics Aptitude (0.67)

iv) Mathematics Interest (0.36)

v) Achievement Motivation in Mathematics (0.32)

and

vi) Mathematics Anxiety (-0.30)

The only variable having significant and negative correlation with Achievement in Mathematics is Mathematics Anxiety.

5. When chi-square test was used to test the dependency of the psychological variables with Discrepant Achievement in Mathematics all the psychological variables were found to have significant association with Under-, Normal- and Over-achievement in Mathematics.

6. Discriminant function analysis done between UA, NA and OA in terms of the six psychological predictor variables yielded two discriminant functions viz.,

$$D_1 = 0.13Z_1 + 0.84Z_2 + 0.11\,Z_3 + 0.14Z_4 - 0.18Z_5 + 0.76Z_6 \text{ and}$$

$$D_2 = -0.22Z_1 + 0.78Z_2 + 0.82Z_3 - 0.13Z_4 + 0.03Z_5 - 1.02Z_6$$

where Z_1, Z_2 ....Z_6 are the respective standard scores of the predictor variables X_1, X_2.... X_6. These functions were found to be efficient enough to discriminate Under-, Normal- and Over-achievers in Mathematics with correct classification rate as 75.71 percent. But the Correlation between discriminating variables and the second discriminant function indicate that the second function is not efficient enough to discriminate UA, NA and OA.

Three functions were also formed to assign new cases into any of the three groups UA, NA and OA on the basis of values on the six psychological variables. The three classification functions are,

$$D_1 = 0.67X_1 + 0.60X_2 - 0.08X_3 - 0.11X_4 - 0.48X_5 + 0.197X_6 - 58.57$$

$$D_2 = 0.69X_1 + 0.51X_2 - 0.11X_3 - 0.07X_4 + 0.47X_5 \_ 0.43X_6 - 58.65 \text{ and}$$

$$D_3 = 0.71X_1 + 0.59X_2 - 0.08X_3 - 0.02X_4 + 0.45X_5 + 0.68\,X_6 - 68.265,$$

Where X_1, X_2, ...X_6 are the raw scores for the selected psychological variables viz., Achievement Motivation in Mathematics, Mathematics Aptitude, Mathematical Creativity, Mathematics Interest, Mathematics Anxiety and Mathematical Problem Solving Process Skills respectively.

4.8. TENABILITY OF HYPOTHESES

1. The first hypothesis states "The three groups of pupils Under-, Normal- and Over- achievers in Mathematics will differ significantly for each of the select psychological variables".

   The result of One-way Analysis of Variance indicated that the three groups Under-, Normal- and Over-achievers are significantly different for each of the selected psychological variable. Thus the first hypothesis is fully substantiated.

2. The second hypothesis states, "Each of the select psychological variable will be significantly related to Achievement in Mathematics".

   Coefficient of correlation 'r' obtained between each of the psychological variable and Achievement in Mathematics revealed that all the psychological variables have significant correlation with Achievement in Mathematics. Hence the second hypothesis is fully substantiated.

3. The third hypothesis states, "Discrepant Achievement in Mathematics (classified as Under-, Normal- and Over-achievers) is dependent on each of the select psychological variables".

   The chi-square values estimated by the chi-square test of independence indicated that Discrepant Achievement in Mathematics is dependent on the six selected psychological variables. Thus the third hypothesis also is fully validated.

4. The fourth hypothesis states, "Discrepant Achievement in Mathematics can be significantly predicted in terms of a select set of psychological variables".

   By discriminant analysis, the investigator could derive three classification functions as D_1, D_2 and D_3, which can be used effectively to predict group membership as UA, NA and OA to the extent of 76 percent correct classification.

   Thus the fourth hypothesis is almost validated.

Thus the four hypotheses set for the study are found to be substantiated.

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CHAPTER V

SUMMARY, CONCLUSIONS AND SUGGESTIONS

Educational implications of the findings of the study are listed in this chapter by providing a summary of the findings.

Findings derived by this study are to be viewed in the light of the objectives of the study, which are listed below.

1. To find out the incidence rates of Under-, Normal- and Over-achievement in Mathematics among standard IX pupils.

2. To compare the mean scores of each of the select psychological variables between Under-, Normal- and Over-achievers in Mathematics and to know the variables for which the three groups are significantly different.

3. To estimate the extent of relationship of each of the select psychological variables with Achievement in Mathematics.

4. To test the dependency of the select Psychological variables with Discrepant Achievement classified as Under-, Normal- and Over-achievement.

5. To identify a Discriminant Function in terms of psychological variables to predict group membership as Under-, Normal-, and Over-achievers.

MAJOR FINDINGS OF THE STUDY

1. Classification of the sample into Under-, Normal-, and Over-achievers revealed that there are fifteen percent Under-achievers, Seventy percent Normal-achievers and fifteen percent Over-

achievers in Mathematics among secondary school pupils.

2. One-way analysis of variance which used for comparing the mean scores of the psychological variables between Under-, Normal-, and Over-achievers in Mathematics revealed that significant mean difference exists in the case of all the psychological variables indicating that all the psychological variables have significant effect on Discrepant Achievement. The variables in the order of the magnitude of the F-ratios are:

   i) Mathematical Problem Solving Process Skills (279.68)

   ii) Mathematics Aptitude (158.63)

   iii) Mathematical Creativity (151.38)

   iv) Mathematics Interest (43.52)

   v) Achievement Motivation (32.11)

   vi) Mathematics Anxiety (27.25)

3. Two-tailed test of significance of difference between means of large independent samples when used for pair-wise group comparisons indicated:

   i) Significant group difference in the case of all the variables between Under- and Over-achievers and between Normal- and Over-achievers.

   ii) Significant group differences in the case of four variables only (Except Mathematical Creativity and Mathematics

Aptitude) between Under-achievers and Normal-achievers.

4. Estimation of the coefficients of correlation (Pearson's rs') between each of the psychological variables and Achievement in Mathematics found that all the variables have significant relationship (at 0.01 level) with Achievement in Mathematics. These variables in the order of the index of correlation are as follows.

i) Mathematical Problem Solving Process Skills

$r = 0.76$ ($p \leq 1$) $CI_{0.99} = (0.65, 0.78)$

Shared Variance = 58.10 Predictive Efficiency, E = 0.35

ii) Mathematical Creativity

$r = 0.67$ ($p \leq 0.01$) $CI_{0.99} = (0.63, 0.71)$

Shared variance = 44.90 Predictive efficiency, E = 0.26

iii) Mathematics Aptitude

$r = 0.67$ ($p \leq 0.01$) $CI_{0.99} = (0.62, 0.71)$

Shared variance = 44.60 Predictive efficiency, E = 0.26

iv) Mathematics Interest

$r = 0.36$ ($p \leq 0.01$) $CI_{0.99} = (0.28, 0.44)$

Shared Variance = 12.90 Predictive efficiency, E = 0.07

v) Achievement Motivation in Mathematics

$r = 0.32$ ($p \leq 0.01$) $CI_{0.99} = (0.02, 0.39)$

Shared Variance = 9.90 Predictive efficiency, E = 0.05

vi) Mathematics Anxiety

$r = -0.30$ $CI_{0.99} = (-0.22, -0.37)$

Shared Variance = 8.70 Predictive efficiency, E = 0.04

5. Chi-square test of independence was used to test the dependency of Under-, Normal- and Over-achievement with the select psychological variables. It was found that Discrepant (which is classified as Under, Normal and Over-achievement in Mathematics) have significant association with all the psychological variables. The variables in the order of the extent of association estimated by 'C' coefficient of contingency are,

i) Mathematical Problem Solving Process Skills (χ^2 = 255.28,C = 0.45)

ii) Mathematical Creativity (χ^2 = 235.00, C = 0.44)

iii) Mathematics Aptitude (χ^2= 162.95, C = 0.38)

iv) Mathematics Anxiety (χ^2= 76.63, C = 0.27)

v) Achievement interest (χ^2= 54.06, C = 0.23)

vi) Mathematics Anxiety (χ^2=49.69, C = 0.22)

5. (i) Discriminant Analysis (Direct Method) was used to derive linear functions that could efficiently discriminate Under-, Normal-, and Over-achievers. Accordingly two Discriminant Functions were derived and these are, classify pupils to Under-,

Normal- and Over-achievers with 75.71 percent of correct classification, are,

$D_1 = 0.13\ Z_1 + 0.84\ Z_2 + 0.11\ Z_3 + 0.14\ Z_4 - 0.18\ Z_5 + 0.76\ Z_6$ and

$D_2 = -0.22\ Z_1 + 0.78\ Z_2 + 0.82\ Z_3 - 0.13\ Z_4 + 0.03\ Z_5 -1.02\ Z_6$

Where Z_1, Z_2,....Z_6 are the respective standard scores of the six predictor variables viz.,

i) Achievement Motivation in Mathematics
ii) Mathematics Aptitude
iii) Mathematical Creativity
iv) Mathematics Interest
v) Mathematics Anxiety
vi) Mathematical Problem Solving Process Skills.

i) The first Discriminent Function (D_1) explained about 91.07 percentage of the variance and the second (D_2) accounted for only 8.93 percent.

ii) Correlation between discriminating variables and Discriminant Functions indicated that the first function is more efficient to classify students into three groups on the basis of the select psychological variables.

iii) The rating of correct classification by Discriminant Functions with predictor variables as discriminants has only a slight variation of 22.67 percent from the correct classification rate with criterion variables as discriminants. That is, the classification done with predictor variables as discriminants almost agrees with the classification done with criterion variables as discriminants.

iv) Discriminant analysis also yielded three classification functions to assign students to the three groups viz., Under-, Normal- and Over-achievers on the basis of scores obtained for the three functions. The three classification functions are,

$D_1 = 0.67\,X_1 + 0.60\,X_2 - 0.08\,X_3 - 0.11\,X_4 - 0.48\,X_5 + 0.20\,X_6 - 58.57$

$D_2 = 0.69\,X_1 + 0.51X_2 - 0.11X_3 - 0.07\,X_4 + 0.47\,X_5 + 0.43\,X_6 - 58.65$ and

$D_3 = 0.71\,X_1 + 0.58\,X_2 - 0.08\,X_3 - 0.02\,X_4 + 0.45\,X_5 + 0.68\,X_6 - 68.27$,

Where X_1, X_2 ...X_6 are the raw scores for the six psychological variables of the study viz.,

i) Achievement Motivation in Mathematics

ii) Mathematical Aptitude

iii) Mathematical Creativity

iv) Mathematics Interest

v) Mathematics Anxiety

vi) Mathematical Problem Solving Process Skills.

CONCLUSIONS

Findings of the study using different statistical techniques, enabled the investigator to conclude as follows:

The selected predictor psychological variables are capable of classifying pupils as Under-, Normal-, and Over-achievers in Mathematics. That is, Under-, Normal- and Over-achievers can be discriminated on the basis of the select psychological variables.

EDUCATIONAL IMPLICATIONS

By the study it was found that all the selected psychological variables viz., Mathematical Problem Solving Process Skills, Mathematical Creativity, Mathematics Aptitude, Mathematics Interest, Achievement Motivation in Mathematics and Mathematics Anxiety are capable of discriminating between Under-, Normal-, and Over-achievers in Mathematics. This finding of the study helped the investigator to point out some of its implications in the field of education.

15 percent of the sample is Under-achievers, 15 percent are Over-achievers and 70 percent are Normal-achievers, indicating that the incidence of Under-achievement is serious and not negligible.

By the findings, it seems that topmost priority is to be given to reduce the rate of Under-achievement to a negligible level. Academic Under-achievement is an evil of the educational system and should be eliminated if the system is to be successful and fruitful to the society. Under-achievers are capable persons but not achieving up to the expected level. Eliminating or reducing Under-achievement requires sincere and intensive planned efforts on the parts of both teachers and parents.

Further, the six psychological predictor variables of the study were found to have significant effect on the Under/Over–achievement of students and that a combination of these variables (explained by a linear function) could discriminate significantly between Under-achievers, Normal-achievers and Over-achievers. When Canonical Correlation was estimated for each of the six variables with the Discriminant Function the correlation was found to be very high (0.95), positive and significant for Problem Solving Process Skills where as the correlation for Mathematics Anxiety was very low and negative (0.30). These findings imply the role of teachers in fostering the Problem Solving Ability of students and in reducing the Anxiety of students to an appreciable level.

A problem is best defined as a perplexing question or situation. It is not simply a question or situation- it must be perplexing implies that the question or situation should be of interest to the solver. Therefore problem solving qualifies as the ultimate justification for teaching Mathematics. Yet it is the hardest to teach and often the most neglected part of the Mathematics curriculum. Knowledge, basic skills and understandings are important components of Mathematical learning but ultimately a student learns Mathematics in order to solve a great variety of problems. Thus to boost the ability of problem solving, teachers should know what is a real problem? How is it different from an exercise? What are the ways by which this ability can be taught and upgraded?

A problem is different from an exercise in that, exercises are employed in Mathematics teaching to provide practice in learning skills or as applications of understandings. Problems, unlike exercises, require the student to use synthesis or insight. To solve a problem the student must draw upon previously learned items of knowledge, skills and understandings and use in new situation. Therefore, to teach for problem solving ability, teacher should know such characteristic of a problem which also includes that there will be several different ways of solving a problem. A teacher if concentrates on this characteristic, simultaneously it will nurture the creativity of students in doing with Mathematics, which is another predictor of Mathematics Achievement.

Thus to develop problem solving ability in the students and thereby to raise student achievement, teachers must

i) Have a collection of problems and keep it categorizing as applications, abstract problems, open search, projects, proofs etc.

ii) To learn to solve problems, students must have an opportunity to solve problems. Therefore assign problems for solving depending on the level of student.

iii) Teacher should device a reward system for students and develop some basic problem-solving approaches for students.

iv) The teacher should see that reward system is not punishment. If students who solve problems quickly are often 'rewarded' with additional work, which will extinguish any desire to succeed.

Along with these, teachers should take the following measures for the all-round development of Mathematical ability of students which will in a way reduce the level of Under-achievement and boost that of Over-achievement.

1) Develop extensive interest to learn and work with Mathematics. Elements of novelty, usefulness and intellectual curiosity are the primary stimuli for arousing interest.

2) Promote peer group learning. Handling of materials, learning through activity, project work and experimentation should be permitted when ever possible. Ask pupils to do field works, assignments etc as group activity.

3) Appreciate your child for every good deed, for every good questions and answers.

4) Motivate pupils to aim High Achievement with high thinking.

5) Encourage children to try and do challenging activities. Give them mathematical puzzles, which could be solved after some

brainstorming.

6) By means of observation and tests identify pupils with high Problem Solving Skills. Make such pupils as leaders and implement co-operative learning strategy.

7) Guide and inspire pupils towards independent learning and working. Homework should be given in the subject, which develops the problem solving skills of students. Some reward or praise should be bestowed upon the successful problem solvers.

8) Value creative talents. He should encourage pupils towards unusual solutions. They must be encouraged to pose new questions everyday, for; an inquiry mind is highly creative.

9) In today's competitive atmosphere, smart work is appreciated than hard work. Create awareness and suitable environments among students to realize this.

10) Stress should be given to develop speed and accuracy while solving mathematical concepts and relations and use of short cut methods should be practised in classrooms.

11) Understanding the utilitarian value of learning Mathematics should be given top priority at every unit of instruction.

12) Listen every child with your heart, not with mind, what the child says. This will reduce the anxiety and tension in

students.

13) Identify all Under-achievers and make them members of Mathematics club, participate them in quizzes etc.

14) If a child is found to be an Under-achiever, this should be informed to his/her parents and their co-operation can be requested. Parents should see that their wards are utilizing their study time effectively. Parents should restrict them from unnecessarily watching TV's or any other entertainments.

15) Parents should understand the capability of their children is and their achievement is in accordance with their ability level. If not they should find reasons for the same and should take measures for improving their children's academic achievement.

SUGGESTIONS FOR FURTHER RESEARCH

The experiences the investigator had with the conduct of the present study and the findings derived made the investigator to suggest the following areas for further research.

1) A longitudinal study on the causal factors of Under-achievement among secondary school pupils.

2) Study on the cognitive and affective factor structures of Under-, Normal-, and Over-achieves in Mathematics.

3) Study on the characteristics of High Intelligent- and Low

Intelligent- Under-, Normal-, and Over-achievers in Mathematics.

4) Replicate the study with Socio-familial variables as predictor variables.

5) Develop a comprehensive training program for reducing Under-achievement.

6) A comparative study of the problem solving ability of High intelligent-under-achievers and High Intelligent-Over-achievers.

7) A study on the association of instructional strategies used by teachers and the academic Achievement of pupils.

8) A study of the psychological variables contributing to Over/Under-achievement in Mathematics.

9) A study of the personality characteristic of Over-achievers, Normal-achievers and Under-achievers.

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APPENDICES

APPENDIX I

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

ACHIEVEMENT TEST IN MATHEMATICS (Draft)

Dr. V. Sumangala
Professor in Education
University of Calicut

Nicemol Sebastian
Research Scholar
Dept. of Education

Instructions:

1. This test is for measuring achievement level of pupils in Mathematics. This test contains 50 objective type questions. Write answers to the test in the separate answer sheet provided along with the test.
2. For each question four possible answers are given as a, b, c and d. Out of which only one is the correct answer.
3. In the answer sheet, against each question number four letters a, b, c and d are given. Put an 'X' mark on the letter corresponding to the correct answer for each question
4. If you want to change the answer already marked, darken the incorrect answer and again mark the correct answer with 'X'mark.
5. Start making the answers only when the teachers says 'start'.
6. Answer the questions within the allotted time.

Time: 60 mts.

1. Which is a simple equation?

a. $x+10 = 3$ b. $5x+4=y$ c. $y=x^2$ d. $3x^2+4x = 5$

2. Which is the truth set of a pair of inconsistent equations?

a. infinite set b. null set c. disjoint set d. singleton set

3. Which postulate is applicable only to rightangled triangle?

a. S. A. S. b. S.S.S. c. R.H.S. d. S.A.A.

4. Which is a zero polynomial?

a. $0x^2+0x+0$ b. $0x^2+x+0$ c. $0x^3+0x^2+0x+3$ d. $0x^2+x^3+0x+1$

5. Which is an undefined term?

a. line b. plane c. point d. line segment

6. Which rule of congruency is applied in MN≅NM.

a. low of symmetry b. transitive property

c. identity property d. closure property

7. The point (-3, 4) is in which quadrant.

a. 2nd b. 3rd c. 4th d. 1st

8. The sum of the angles of a triangle is ____

a. 90^0 b. 270^0 c. 180^0 d. 360^0

9. The graph of which of the following equations represents the y axis.

a. $x=0$ b. $y=0$ c. $y=k$ d. $x=k$

10. Which is the standard form of the polynomial $9x^3-8x+2$

a. $9x^3+0x^2-8x+2$ b. $9x^3-8x+2$ c. $9x^3+8x-2$ d. $-9x^3+8x-2$

11. If the measure of the sides of a cuboid are x, y, and z what is the sum of the measures of all the edges.

a. $x+y+z$ b. $2x+2y+2z$ c. $4x+4y+4z$ d. $3x+3y+3z$

12. If two liens intersect at a point and the measure of one angle is x^0, what is the measure of its adjacent angle.

a. x b. 90-x c. 90+x d. 180-x

13. A={1,2,3} B={2,4,5} what is the reason for P={(1,4), (2,3), (5,3)} is not a relation from A to B.

a. P is not a subset of AxB b. P is not a subset of BxA

c. A is not a set of first elements c. B is not a set of first elements.

14. Which is not true for 0.8^{*}.

a. real number b. rational number

c. irrational number d. occurring decimal

15. If 'W' represents whole numbers and 'N' represents natural numbers, W-N=__

a. R b. Q c. W d. {0}

16. If A={0,1,2} B={2,4} which is not a relation from B to A.

a. {(2,1), (4,2)} b. {(2,2)} c. {(2,0), (4,0)} d. {(1,2), (2,4)}

17. Which among the following is not a polynomial.

a. $\sqrt{x} - 1$ b. x^2-1 c. $3x+\frac{1}{2}$ d. $5x+\sqrt{2}$

18. What is the degree of the polynomial obtained when a 5th degree polynomial is multiplied by a 3rd degree polynomial.

a. 8 b. 15 c. 5 d. 3

19. $\Delta PQR \sim \Delta ABC$. If $\angle P=40^0$, $\angle Q=60^0$ what is the measure of $\angle C$?

a. 40^0 b. 80^0 c. 60^0 d. 100^0

20. In parallelogram ABCD, if $\angle A = 70^0$ what is the measure of $\angle B$

a. 70^0 b. 20^0 c. 160^0 d. 100^0

21. In ΔABC and ΔPQR, if ABC $\leftrightarrow$RPQ is a congruency, which of the statement is not true.

a. $BC \cong RQ$ b. $AB \cong RP$ c. $\angle A \cong \angle R$ d. $\angle C \cong \angle Q$

22. If sinA=4/5, what is the value of cos A

A. 5/4 b. 3/5 c. 5/3 d. 4/9

23. Which is not included in a number line

a. π b. $1/\pi$ c. $1/\sqrt{3}$ d. $\sqrt{-9}$

24. The graph of which of the following equations contain the point (-2, -1)

a. x+y=3 b.-x-y=3 c. x_-y=1 d. x+y=1

25. Which is similar to cot A.sinA

a. sinA b. cosA c. tan A d. secA

26. If cos B = $\sqrt{3}/2$ what is the measure of B?

a. 30^0 b. 60^0 c. 90^0 d. 0^0

27. Which among the following is most appropriate to the sum of two irrational numbers.

    a. is a rational number   b. is an irrational number

    c. is a counting number   d. need not be an irrational number

28. What is the length of one side of a cube whose volume is $84cm^3$?

    a. 16cm   b. 8cm   c. 12cm   d. 4cm

29. If one angle of a linear pair is 70^0, what is the measure of the other angle?

    a. 110^0 b. 20^0 c. 35^0 d. 290^0

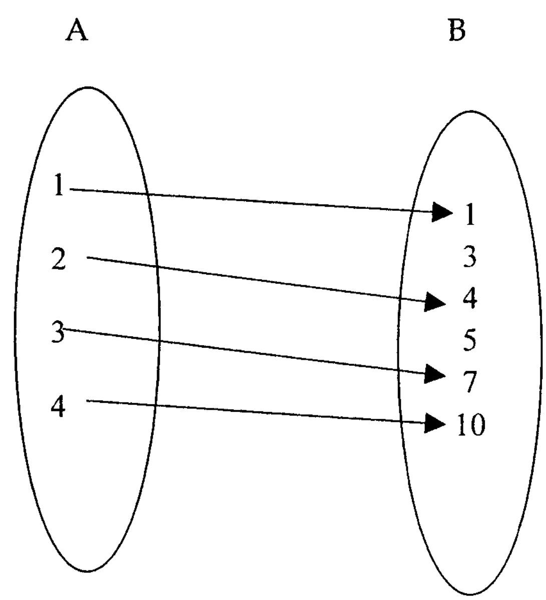
30. Find the range of the relation $\{(x,x^2) / x$ an irrational number, $x < 10\}$

    a. {2,3,5,7}   b. {1,3,5,7}   c. {4,9,25,49}   d. {1,9,25,49}

31. Find the lateral surface area of a cuboid whose height is 15cm, the length and breadth of the base are 14cm and 6cm respectively.

    a. $300cm^2$ b. $600cm^2$ c. $768cm^2$ d. $1260cm^2$

32. Write the relation given in the following arrow diagram in rule method



    a. $\{(x,y)/x\in A, y\in B, y=x+2\}$ b. $\{(x,y)/x\in A, y\in B, x<y\}$

    c. $((x,y)/x\in A, y\in B, y\geq x\}$ c. $((x,y)/x\in A, y\in B, y=3x-2)$

33. If $A\cap B = \phi$, $n(A)$, $n(B) = 2$, what is $n(A\cup B)$?

    a. 0   b. 5   c. 3   d. 7

34. Which among the following is not a point on the graph of the equation 3x-4y=12.

a. (0,-3) b. (4,0) c. (4,8) d.(8, 3)

35. What is the coefficient of a^2 in the expansion of $(a^2+1/a-1)^2$?

a. -1 b. 1 c. 2 d. -2

36. What is the coefficient of m in the expansion of $(4m+2)^3$?

a. 24 b. 48 c. 96 d. 8

37. What is the total surface area of a cylinder whose height of 80cm and curved surface area is $5600\pi cm^2$?

a. $9800\pi cm^2$ b. $8050\pi cm^2$ c. $448000\pi cm^2$ d. $224000\pi cm^2$

38 What is the volume of a cylinder whose base lengths are 13cm, 14cm and 15cm.

a. $1680cm^3$ b. $2008cm^3$ c. $840cm^3$ d. $3900cm^3$

39. If the number of lateral faces of a prism is 5, what is the number of corners?

a. 5 b. 10 c. 15 d. 7

40. What is the x coordinate of a point on the graph of the equation 3x-26=8, whose y coordinates is 2?

a. 2 b. 4 c. 8 d. 1

41. What is the equation equivalent to (x/3)+(y/5) = 1

a. 3y-5x=15 b. 3y+5x=15

c. x+3y = 5 d. 5x-3y = 15

42. The midpoints of the sides of ΔABC are, P, Q and R. If the area of ΔABC is $40cm^2$, what is the area of ΔPQR?

a. $10cm^2$ b. $20cm^2$ c. $80cm^2$ d. $\sqrt{40}cm^2$

43. What is the height of a tree when the angle of elevation while looking at the sun is 45^0 and the length of the shade is 15m

a. 15m b. $15\sqrt{3}$m c. $15\sqrt{2}$m d. $15/\sqrt{2}$m

44. A={0,5,7,9,14}, B={2,3,4,5}. A relation from A to B is given in rows and columns. Write the relation in the rule method.

a. $\{(x,y)/x\in B, y\in A, y=x^2-2\}$ b. $\{(x,y)/x\in A, y\in B, y=x+1\}$

c. $\{(x,y)/x\in B, y\in A, y<x\}$ d. $\{(x,y)/ x\in A, y\in B, y=x^{2+}2\}$

45. Write the standard form of the equation 2y-3x+8=0

a. 2y=3x-8 b. y = (3x-8)/2 c. y = 3x+8 d. (3x+8)/2

46. $\Delta ABC \sim \Delta PQR$. The area of the triangles are in the ration 16:9. If BC=24cm. What is the length of QR.

a. 18cm b. 25cm c. 32cm d. 8cm

47. If $\Delta ABC \sim \Delta PQR$, 2AB = 3DE and BC = 12cm. What is the measure of EF?

a. 6 b. 24 c. 18 d. 8

48. If $5x+3y = 39$ and $3x+5y = 33$. What is the value of $x+y$?

a. 9 b. 6 c. 72 d. 36

49. If $a+(1/a) = 5$. What is $a^3+(1/a^3)$

a. 125 b. 110 c. 120 d. 115

50. Simplify $2\,(p+q)^2+(p-q+r)^2 - (p+q-r)^2$

a. $2(p+q)^2$ b. $2(p^2+q^2+2pr)$ c. $(p+r)^2$ d. $(p+r)^2 + (q+r)^2$

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APPENDIX II

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

ACHIEVEMENT TEST IN MATHEMATICS

Dr. V. Sumangala
Professor in Education
University of Calicut

Nicemol Sebastian
Research Scholar
Dept. of Education

Instructions:

1. This test is for measuring achievement level of pupils in Mathematics. This test contains 25 objective type questions. Write answers to the test in the separate answer sheet provided along with the test.
2. For each question four possible answers are given as a, b, c and d. Out of which only one is the correct answer.
3. In the answer sheet, against each question number four letters a, b, c and d are given. Put an 'X' mark on the letter corresponding to the correct answer for each question
4. If you want to change the answer already marked, darken the incorrect answer and again mark the correct answer with 'X'mark.
5. Start making the answers only when the teachers says 'start'.
6. Answer the questions within the allotted time.

Time: 40 mts.

18

1. Which is a simple equation?

a. $x+10 = 3$ b. $5x+4=y$ c. $y=x^2$ d. $3x^2+4x = 5$

2. Which is a zero polynomial?

a. $0x^2+0x+0$ b. $0x^2+x+0$ c. $0x^3 +0x^2+0x+3$ d. $0x^2+x^3+0x+1$

3. Which is an undefined term?

a. line b. plane c. point d. line segment

4. Which rule of congruency is applied in MN≅NM.

a. low of symmetry b. transitive property

c. identity property d. closure property

5. The graph of which of the following equations represents the y axis.

a. $x=0$ b. $y=0$ c. $y=k$ d. $x=k$

6. If the measure of the sides of a cuboid are x, y, and z what is the sum of the measures of all the edges.

a. $x+y+z$ b. $2x+2y+2z$ c. $4x+4y+4z$ d. $3x+3y+3z$

7. If two liens intersect at a point and the measure of one angle is x^0, what is the measure of its adjacent angle.

a. x b. 90-x c. 90+x d. 180-x

8. A={1,2,3} B={2,4,5} what is the reason for P={(1,4), (2,3), (5,3)} is not a relation from A to B.

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c. A is not a set of first elements c. B is not a set of first elements.

9. Which is not true for 0.8^{*}.

a. real number b. rational number

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10. If 'W' represents whole numbers and 'N' represents natural numbers, W-N=__

a. R b. Q c. W d. {0}

11. What is the degree of the polynomial obtained when a 5th degree polynomial is multiplied by a 3rd degree polynomial?

a. 8 b. 15 c. 5 d. 3

12. Δ PQR~ΔABC. If ∠P=40^0, ∠Q=60^0 what is the measure of ∠C?

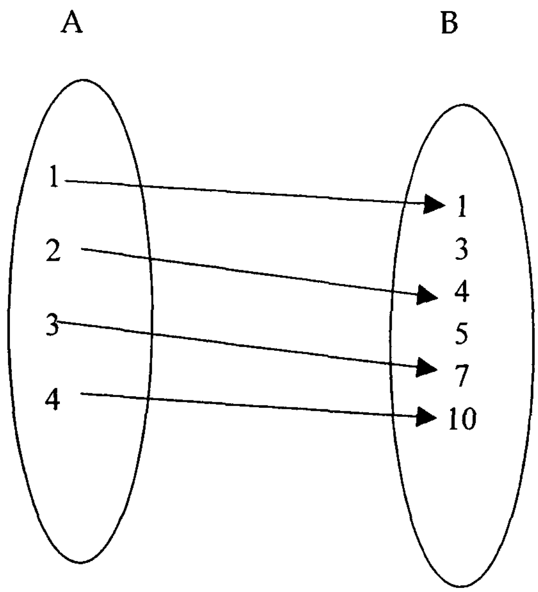
a. 40^0 b. 80^0 c. 60^0 d. 100^0

13. In ΔABC and ΔPQR, if $ABC \leftrightarrow RPQ$ is a congruency, which of the statement is not true.
    a. $BC \cong RQ$ b. $AB \cong RP$ c. $\angle A \cong \angle R$ d. $\angle C \cong \angle Q$

14. If $\sin A = 4/5$, what is the value of cos A
    A. 5/4 b. 3/5 c. 5/3 d. 4/9

15. Find the range of the relation $\{(x,x^2)\ /x$ an irrational number, $x < 10\}$
    a. {2,3,5,7} b. {1,3,5,7} c. {4,9,25,49} d. {1,9,25,49}

16. Write the relation given in the following arrow diagram in rule method



a. $\{(x,y)/x \in A,\ y \in B,\ y=x+2\}$
b. $\{(x,y)/x \in A,\ y \in B,\ x<y\}$
c. $((x,y)/x \in A,\ y \in B,\ y \geq x\}$
c. $((x,y)/x \in A,\ y \in B,\ y=3x-2)$

17. Which among the following is not a point on the graph of the equation $3x-4y=12$.
    a. (0,-3) b. (4,0) c. (4,8) d.(8, 3)

18. What is the coefficient of m in the expansion of $(4m+2)^3$?
    a. 24 b. 48 c. 96 d. 8

19. What is the total surface area of a cylinder whose height of 80cm and curved surface area is $5600\pi cm^2$?
    a. $9800\pi cm^2$ b. $8050\pi cm^2$ c. $448000\pi cm^2$ d. $224000\pi cm^2$

20. If the number of lateral faces of a prism is 5, what is the number of corners?
    a. 5 b. 10 c. 15 d. 7

21. What is the equation equivalent to $(x/3)+(y/5) = 1$

a. $3y-5x=15$ b. $3y+5x=15$ c. $x+3y = 5$ d. $5x-3y = 15$

22. What is the height of a tree when the angle of elevation while looking at the sun is 45^0 and the length of the shade is 15m

a. 15m b. $15\sqrt{3}$m c. $15\sqrt{2}$m d. $15/\sqrt{2}$m

23. Write the standard form of the equation $2y-3x+8=0$

a. $2y=3x-8$ b. $y = (3x-8)/2$ c. $y = 3x+8$ d. $(3x+8)/2$

24. $\Delta ABC \sim \Delta PQR$. The area of the triangles are in the ration 16:9. If BC=24cm. What is the length of QR.

a. 18cm b. 25cm c. 32cm d. 8cm

25. If $a+(1/a) = 5$. What is $a^3+(1/a^3)$

a. 125 b. 110 c. 120 d. 115

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APPENDIX III

ACHIEVEMENT TEST IN MATHEMATICS

RESPONSE SHEET

Name: Name of School:
Standard: Boy/Girl :

No.	A	B	C	D
1.	○	○	○	○
2.	○	○	○	○
3.	○	○	○	○
4.	○	○	○	○
5.	○	○	○	○
6.	○	○	○	○
7.	○	○	○	○
8.	○	○	○	○
9.	○	○	○	○
10.	○	○	○	○
11.	○	○	○	○
12.	○	○	○	○
13.	○	○	○	○
14.	○	○	○	○
15.	○	○	○	○
16.	○	○	○	○
17.	○	○	○	○
18.	○	○	○	○
19.	○	○	○	○
20.	○	○	○	○
21.	○	○	○	○
22.	○	○	○	○
23.	○	○	○	○
24.	○	○	○	○
25.	○	○	○	○

APPENDIX IV

ACHIEVEMENT TEST IN MATHEMATICS

SCORING KEY

Question No.	Answer
1	A
2	A
3	D
4	C
5	A
6	C
7	D
8	C
9	C
10	D
11	A
12	D
13	A
14	B
15	C
16	D
17	C
18	B
19	B
20	B
21	B
22	A
23	B
24	D
25	B

APPENDIX V

TEST OF INTELLIGENCE

Dr.V. Sumangala
Professor in Education
University of Calicut

Sholy Joseph
Research Scholar
Department of Education

This test is meant for measuring your intelligence. The test contains 38 questions in three sections.
(Test I 14, Test II 13, Test III 11).

Questions under Test I (iii) and Test I (iv) should be answered in separate sheets of paper.

Test I (i)

1. Balu moved from his home to the seashore to see the sun set. After walking a short difference he turned to his left and walked a little. Again he turned to left and walked. But he could not see sun set. Here the problem is that
   A. He was walking towards the east.
   B. He was walking towards the south
   C. He was walking towards the north.
   D. He was walking towards east-west direction.

2. When a competitive test was conducted for two classes all the students became successful. A reward had been declared for the better one. The criteria for deciding the class eligible for the reward are.
   A. The class in which the top scorer studied
   B. The class, which contain the highest number of full scorers.
   C. The average of the marks.
   D. The class, which contains the highest number of successful students.

3. State that 11 plus 2 is 1. In which situation does this statement become true.
   A. In relation to time
   B. In relation to negative numbers
   C. In relation to money
   D. Never possible

4. Containers of different height and shape are placed on a table. Which of these contains the largest quantity of water.
   A. The container, which has the top most height.
   B. The container, which has the top most basement area.
   C. The container, which has the top most circumference of the base.
   D. The container, which has the top most volume.

Test I (ii)

1. I have got 14 coins of Rs. 5/- with the denominations of 25 ps and 50ps. The equation to find out the number of 25ps and 50ps coins is ____?
   (x = the number of 25ps coins, y = 50ps coins)
   - A. 25x+50y=5
   - B. x + y=14, 25x 50y=5
   - C. x+y=14, 25x+50y=5
   - D. x+y=14, 25x+50y=500

2. When 1 is added to the double of a particular number and the same number is subtracted from the product we get nine. The algebraic equation for the statement is
   - A. $x^2+1-x=9$
   - B. 2x+1-x=9
   - C. 2(x+1)-x=9
   - D. $2^2+1-x=9$

Test I (iii)

Instruction: Answer in detail the following questions in separate sheets

1. 8 adults and 2 children have to cross a river. There is only one boat in which either 2 children or one adult can sail at a time. How can they cross the river?
2. You have got two measuring jars of 3 liters and 8 liters. By using those jars how can you take one liter of oil?

Test I (iv)

For the following questions only one answer is correct. Find out the correct answer and write the procedure how you got the answer.

1. Bill is taller than Tom.
2. Peter is taller than Sam.
3. Peter is shorter than Tom.
4. Bill is shorter than Mike.
5. Sam is taller than Jack.

Who is tallest?

A. Bill B. Sam C. Mike D. Peter

3. A. B C D & E are five rivers. A is smaller than B and longer than E. C is the longest river. D is smaller than B and longer than A. Which of those is the smallest river?

   A. B B. C C. D D. E

4. A cricket ball is lighter than a hockey ball. Volleyball is lighter than a football. A hockey ball is lighter than a football, but heavier than tennis ball. Which of these the heaviest?

A) Hockey ball B) Cricket ball C) Volleyball D) Football

Test I (V)

In each of the following questions there is a relationship between the first two words. The third and fourth words have the same relationship. Find out the correct relationship.

1.Lecturer is to learner as [a. The teacher b. A film] is to [a. The viewer b. The actor]

A. Teacher is to viewer
B. Film is to viewer
C. Teacher is actor
D. Film is to actor

2. Eye is to tear as [a. Mouth, b. Nose] is to [a. The check. b. Saliva]

A. Mouth is to cheek
B. Nose is to mouth
C. Mouth is to saliva
D. Nose is to saliva.

3. Sugar is to energy as [a. Five b. Force] is to [a. Heat b. Log.]

A. Fire is to heat
B. Force is to heat
C. Fire is to log
D. Force is to log.

Test II (i)

For each of the following questions there is a relationship between the first two terms. The third and fourth terms also have the same relationship. Find out the missing terms.

1. Grapes: Wine:: Wheat:_______
A. Corn flour B. Field C. Corn D. Bread.

2. Factory: Product:: School:_____
A. Teacher B. Student C. Education D. Building

3. LXM: 12X13:: VXW:_______
A. 21X22 B. 24X26 C. 9X11 D. 22X23.

Test II (ii)

Four words or letters are given for each of the following questions. Three of them are interrelated. Find out the one, which is quite different from the other three.

1. A silver B. Sink C. Lead D. Iron
2. A. PM B. CM C. DM D. MP
3. A. Parallalogram B. Triangle C. Square D. Rectangle

Test II (iii)

Find out the missing

1. 2, 6, 12, 20, 30 _____ 56, ____
   A. 40 B. 42 C. 45 D. 44

2. 5, 11, 17, ______ 29, 35, _________
   A. 19 B. 42 C. 23 D. 25

Test II (iv)

Find out the missing items in the following matrix.

1. $\begin{bmatrix} 2\ 4\ 14 \\ 3\ 5\ 22 \\ ?\ 6\ 32 \end{bmatrix}$
   A. 10 B. 12 C. 16 D. 49

Test II (v)

Each of the following questions are life situations. Write your response to them.

1. Don't sleep under trees during night: The reason is _____
   A. The tree may fall down.
   B. The tree may contain wild creatures.
   C. The expels carbon decide which is harmful to us.
   D. The tree expel oxygen during night.

2. Anil is interested in helping poor people because
   A. He likes praise of others
   B. He considers it as his duty.
   C. To get the support of people when he becomes an MLA.
   D. To become famous.

3. The inevitable factor for success in life ______?
   A. Education
   B. Money
   C. Sincerity and hard work
   D. High political influence

4. Children should not smoke because
   A. It is a bad habit.
   B. It is the advice of elders.
   C. It is an unnecessary expenditure
   D. It is injurious to health.

Test III (i)

For the following questions to find the answers consider more than one factor. Choose the correct answer from those given under the question

1. The sound of one gun fired from a place takes two minutes to reach another place. How much time will it take for sound of fire guns fixed from the same place to reach the same another place.
   A. 10 minutes B. 2 minutes C. 5 minutes D.4minutes

Test III (ii)

To find answers to the following questions one or more factors are needed. Choose the correct answer from the given options.

1. What is the total number of people in a line if 'A' is the seventh person from both ends of the line?
   A. 12 B. 13 C. 14 D. 7

2. Hitha was in the habit of visiting Ebin every Sunday evening. The first day she came at 4.30. Then she came at 5.20, 6.30 and 8.00. After that what time did she come?
   A. 9.00 B. 9.30 C. 9.40 D. 9.50

3. Alense and Jesny have got Rs. 100/- and Rs. 60/- respectively. How much money should Alense give Jensy for the equal distribution of the amount between them.
   A. Rs. 40/- B. Rs. 20/- C. Rs. 30/- D. Rs. 10/-

4. The cost of a camera including its case is Rs. 5000/-. The cost of the camera is Rs. 4500/- higher than the case. What is the cost of the case?
   A. Rs. 4500/- B. Rs. 5000/- C. Rs. 250/- D. Rs. 500/-

5. The population of Ernakulam city become double in every 20 years. In 1940 it was 4000. In which year did the population become half the population of 1960.

A. 1950 B. 1940 C. 1920 D. 1980

Test III (iii)

Some of the following statements are true and others false. The first line contains a clue for the solution of the given problem. The second line contains the actual problem. Find out the relationship between the two words in the first line. Apply this relationship in the second line.

1.Paintings are made by skillful persons.

Novel is to author as painting is to _______

A. Creativity B. Artist C. Colour D. Canvas.

2. Gandhinagar is famous for gems.

Bangalore is to Karnataka as Gandhinagar is to ____.

A. India B. Guarajat C. Delihi D. Kerala.

3. Star doesn't shine.

Sea is to ship as stars is to

A. Sky B. Clouds C. Night D. Telescope.

4. Millilitre is the basic unit of measuring jar.

Kilogram is to gram as milliliter is to ______.

A. CC B. Matter C. Litre D. Volume

5. Thunder makes sound

If lightning is visible, thunder is ____

A. Shocking B. Audible C. Cloudy D. Dangerous.

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APPENDIX VI

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

TEST OF MATHEMATICAL CREATIVITY (Draft)

Dr. V. Sumangala
Professor in Education
University of Calicut

Nicemol Sebastian
Research Scholar
Dept. of Education

Instruction:

This is a test for measuring your creativity in Mathematics.

There are seven questions in this test. To each question, write as many answers as possible within the time limit specified.

Your answers will not be grouped as right or wrong. Instead they will be categorized as relevant to the questions/ diversified/ unusual/ very unusual and will be scored accordingly.

Diverse and unusual answers represent the creativity. Therefore, the scores of creativity is determined in accordance with such answers.

Let your answers be unusual, novel and diverse.

1. A clock marked with Arabic numerical fell down and broke into two pieces. If the sum of the numbers in the two pieces is to be equal, which are the possible ways in which the clock had broken?

   8 mts.

2. Using exponents of ten and four fundamental operations express one lakh in different ways.

   4 mts.

3. Using the same digit six times only, represent as many counting numbers as possible.

   Eg; (5/5) + (5/5) + (5/5) =3

   5 mts.

4. Write as many numbers as possible using the digits 1, 2, 3 and 4 and the four fundamental operations.

   4 mts.

5. If the digits of a number are interchanged, then the square will also interchange. Write such numbers

8 mts.

6. Write different pairs of numbers which give the same answer to two different operations eg: 4-2=2, 4/2 = 2

5mts

7. In a shop there are 5, 1kg, 5kg, 10kg, 20kg and 50kg weights. Which are the possible ways 80kg rice can be weighed using thee weights?

5 mts

8. Represent the number 64 in different ways

3mts

9. Write as many equations as possible equivalent to the equation x/3=5

5 mts.

10. In what different ways can the numbers 16, 24, 32 and 40 be related?

4mts

11. Draw 8 circles arranged in different patterns.

6 mts.

12. Write down different sets of numbers such that their median is 7.

4 mts.

13. A portion of a calendar is given. Chose different groups of numbers having the same sum from this.

2	3	4
9	10	11
16	17	18
23	24	25

8mts

14. If $(a+b)^2=100$, what are the possible values that a and b can take?

3 mts.

15. Using the numbers 1, 2, 3 and the four fundamental operations write as many relations as possible to get the answer as 11.

Eg: 3x3+2=11 4mts.

APPENDIX VII

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

TEST OF MATHEMATICAL CREATIVITY

Dr. V. Sumangala
Professor in Education
University of Calicut

Nicemol Sebastian
Research Scholar
Dept. of Education

Instruction:

This is a test for measuring your creativity in Mathematics.

There are seven questions in this test. To each question, write as many answers as possible within the time limit specified.

Your answers will not be grouped as right or wrong. Instead they will be categorized as relevant to the questions/ diversified/ unusual/ very unusual and will be scored accordingly.

Diverse and unusual answers represents the creativity. Therefore, the scores of creativity is determined in accordance with such answers.

Let your answers be unusual, novel and diverse.

1. Using exponents of ten and four fundamental operations express one lakh in different ways. 4 mts.

2. Write different pairs of numbers which give the same answer to two different operations eg: 4-2=2, 4/2 = 2 4mts

3. Represent the number 64 in different ways. 5mts

4. In what different ways can the numbers 16, 24, 32 and 40 be related?

   4mts

5. Show how eight circles can be arranged in different patterns. 6mts

6. A portion of a calendar is given. Chose different groups of numbers having the same sum from this.

2	3	4
9	10	11
16	17	18
23	24	25

8mts

7. Using the numbers 1, 2, 3 and the four fundamental operations write as many relations as possible to get the answer as 11.

   Eg: 3x3+2=11

4mts.

APPENDIX VIII

DEPARTMENT OF EDUCATION 2000
UNIVERSITY OF CALICUT

TEST OF MATHEMATICAL PROBLEM SOLVING PROCESS SKILLS

Dr. V. Sumangala
Reader in Education
University of Calicut

Mr. Anil Kumar, A.K.,
M.Ed. Student,
Department of Education

Time: 1 hour

Instructions:

This is a mathematical test. The aim of this test is to find out your ability in processing for solving mathematical problems. There are five sections to this test. The questions in each section has four answers as A, B, C and D. Among these, one will be the correct answer. Answer the questions after reading carefully. Indicate the correct answer by putting 'X' mark on the letter given against the questions in the response sheet provided along with this test booklet.

If you feel your response marked is wrong, draw a O over the marked letter and put a 'X' over the correct one.

Start answering only when the examiner says 'start' and stop when he says 'stop'. The question paper and the response sheet should be returned to the examiner after writing the answers. Please don't write anything on the test booklet.

Eg: How many I cm square bricks are needed to fill a rectangular box with 5 cm width, 5 cm length?

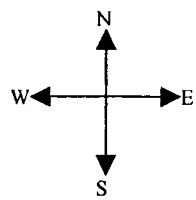
A) 10 B) 25 C) 125 D) 5
Ans. A B ~~C~~ D

TEST – 1

1) When a competitive examination was held in two classes. It was found that all students passed. A prize was arranged to be given to the class which secure better results. Here the winner class is to be decided on the basis of
   A) The class in which the top scorer studies
   B) The class in which there are more number of students who have scores full marks.
   C) By finding the average of the student's marks of both classes.
   D) The prize should be equally divided between the two classes.

2) A father decided to give his eldest son half of his property; to the second son half of the remaining and to the youngest one the rest. The father is supposed to give the third son:
   A) One forth of his property
   B) Half of his property
   C) One third of his property
   D) One eighth of his property

3) Balu started to walk from his home towards the sea to view the sunset. After some time he turned to his left and walked. Then again he turned to his left and walked. But he coundn't see the sunset. The problem here is
   A) He was walling in the East Direction
   B) He was walking in the South Direction
   C) He was walking in the North Direction
   D) He was walking the East-West Direction



4) "I say that when who is added to eleven it will be done". In which context is this right?
   A) Time
   B) In the case of negative numbers
   C) Money
   D) It was said just for its sake.

5) The time is midnight. It is raining heavily and too cold. The question is whether it will be a sunny climate after 72 hours?
   A) It will be soon
   B) It will be night
   C) If not raining at sunny climate
   D) It can't be said based on the given facts.

6) A teacher placed a cylinder shaped vessel and a square prism vessel which have different heights on the table and asked. "Which vessel will contain more water?
   A) Vessel which has more height
   B) Vessel which has more base area
   C) Vessel which has more base perimeter
   D) Vessel which has more volume.

Test II

1) The age of Lakshmi is 5 more than thrice the age of her daughter Bindhu. Fifteen years hence the age of Lakshmi will be twice the age of Bindhu. Which of the following equations can be used to find out Lakshmi's present age?
   [Assumed that Lakshmi's age as X and Bindhu's as Y]
   A) $3x+15y = y$
      $15 + x = 2y$
   B) $3x+5 = y$
      $2y + 15 = x$
   C) $3y + 5 = x$
      $x + 15 = 2y$
   D) $3y + 5 = x$
      $2y + 15 = x$

2) "One more than twice a number decreased by the number is nine". The translated form of this sentence in to its algebraic equivalent is,

A) $X^2 + 1 - x = 9$ B) $2x + 1 - x = 9$
C) $2(x+1) - x = 9$ D) $2^2+1- x = 9$

3) I have a certain number of 25 and 50 Ps coins. Altogether I have 14 coins worth Rs. 5. Which equation of the following will help you to find out how many 25 Ps. And how many 50 Ps. I have.

[x=number of 25 Ps. Y = number of 50 Ps]

A) $25x + 50y = 5$
$x+y=14$

B) $x+y = 14$
$25x.50y=5$

C) $x+y = 14$
$25x+50y = 5$

D) $x+y = 14$
$25x+50y = 500$

4) A wire 30 inches long is to be cut in two pieces. Twice the length of the first piece must be equal to three times the length of the second piece. The equation to find out the length of each piece is _____

[x = length of the first piece y = length of the second piece]

A) $2x = 3y$
$x+y = 30$

B) $2x+3y = 30$
$x+y = 30$

C) $2x=3y$

D) none of these

5) 40 men can do a job in 15 days. Which of the following operations will help you to find out how many days are required for 30 men to do the same job?

A) $\frac{15x40}{30}$ B) $\frac{30x15}{40}$

C) $\frac{40x30}{30}$ D) None of these

6) There are two numbers such that the first number is 4 less than twice the second number; four times the first number is 2 more than 6 times the second number. Which among the following equations will help you to find the numbers?

[First number = x Second number =y]

A) $x =2y - 4$
$6y = 4x +2$

B) $x = y + 4$
$x = 6y +2$

C) $2y + x = 4$
$6y = 4x - 2$

D) $x = 2y - 4$
$4x = 6y +2$

7) 4 chairs and 2 tables cost Rs. 1900, 3 chairs and 5 tables cost Rs. 3000. Which among the following equations can be used to find the cost of a chair and that of a table?

[Cost of a chair = P cost of a table = Q]

A) $4Q+2P = 1900$
$3Q + 5P = 3000$

B) $4P + 5P = 1900$
$3Q + 2Q = 3000$

C) $4P + 2Q = 1900$
$3P + 5Q = 3000$

C) None of these

8) A soap measures 5cm x 4cm x 1.5cm. How will you find how many such soaps a cardboard box can contain which measures 55cm x 48cm x 15cm.

A) $\frac{5x4x1.5}{55x48x15}$ B) $\frac{5xx4xx1.5x}{55x48x15}$

C) $\frac{55x48x1.5}{5x4x15}$ D) $\frac{55+48+1.5}{5+4+15}$

TEST III

1)Part of a problem reads. "How much interest compounded quarterly does a bank pay on Rs. 3000/- kept in a savings account for one year". Is any additional information needed to solve this problem?

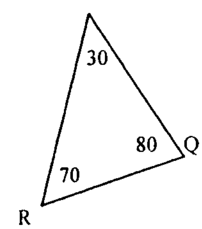
A) No additional information
B) When the money will be withdrawn
C) The purpose of the savings
D) The interest rate

2) Which of the following is not associated with the given triangle?

A) PR > PQ B) PQ = RQ
C) PR > RQ D) PQ > RQ

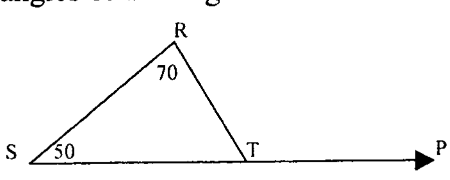
3) One of the question which is to be answered by Ramu was like this. "The measures of the sides of a right angled triangle are 4, 5, and 9. Calculate its area? Ramu didn't get the correct answer. Because ___0_

A) May be doesn't know the equation
B) The given measures are not the sides of a right angled triangle.
C) Measures of angles are not given
D) It is not mentioned in the question which sides measures are given.



4) Which theorem can be used to find the angle measure of $\angle$RTP without measuring it?

A) The sum of the measures of the three angles of a triangle is 180^0
B) Exterior angle theorem
C) Supplement postulate
D) Linear pair



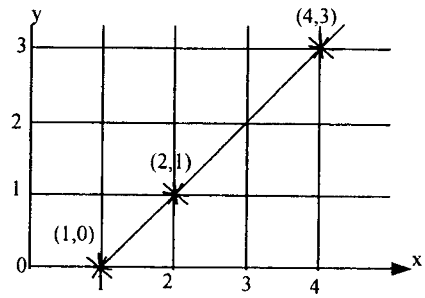
5) The place value of various digits of a five digit number is as follows. Place value of 7 is less than the place value of 4. Place value of 2 is less than of 3 and greater than that of 4. If place value 4 is ten and sum of digits in the number is 16 what is the number?

A) 32047 B) 23047 C) 32407 D) 70423

6) Which one of the following is correct according to the given graph?

A) x = y   B) x = y + 1

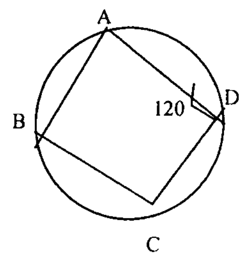
C) y = x + 1   D) $x = y^2$



7 If 3x=2y, 2y=z which letter has more value?

A) x B) y C) z D) Every letter has equal value

8) Which theorem can be used to find the measure of ∠ABC



A) The opposite angles of a rectangle are supplementary

B) The sum of the measures of all angels of a quadrilateral is 360^0

C) The opposite angles of a cyclic quadrilateral are supplementary.

D) The given data are not sufficient to find the measure of ∠ABC.

9) Which of the following operation will always give an even number

A) Even number x odd number   B) Even number + Odd number

C) Odd number x Odd number   D) Even number/Even number

10) A jar contains black balls and white balls. If there are 10 balls in the jar, which one of the following doesn't indicate the proportion of the black and white balls.

A) 1:10   B) 7:3 C) 1:1 D) 9:1

11) If n is an odd number which of the following will be an odd number?

1. n+n   II n+n+n   III nxnxn

A) only I   B) Only II   C) III and I   D) II and III

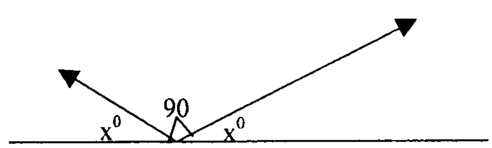
12) Which equation will you use to find out the value X?

A) $180^0=90^0+2x^0$

B) $180^0=90^0+x^2$

C) $90^0+x^0=180^0$

D) None of these



TEST IV

See the proofs below and locate the step in which error begins

I) If $\sqrt{x} = 3$ $\sqrt{y} = 3$ then

i. $\sqrt{x} + \sqrt{y} = \sqrt{x+y} = 3 + 3 = 7$

ii. $x + y = 7^2$

iii. $x+y = 49$

iv. $3^2+4^2 = 49$

v. $9+16 = 49$

$25 = 49$

A) Step 1 is wrong   B) Step 2 is wrong

C) Step 3 is wrong   D) Step 4 is wrong

2) We know that $\sqrt{a} . \sqrt{a} = \sqrt{ab}$

i. a = -1 b = -1

ii. $\sqrt{-1} x \sqrt{-1} = \sqrt{-1x-1} = \sqrt{1} = 1$

We know that $\sqrt{a} . \sqrt{a}$ =a

iii. $\sqrt{-1} x \sqrt{-1}$ = -1

iv. ∴ 1 = -1

A) Step 1 is wrong B) Step 2 is wrong
C) Step 3 is wrong D) Step 4 is wrong

3) x = y then

i. x + x = y+x

ii. 2x = yx

If x = y = 3 then

iii. 2x 3 = 3 x 3

6 = 9

A) Step 2 is wrong B) Step 3 is wrong
C) Step 1 is wrong D) Assumption that x = y is false

4) If p=q then

i. 2p = 2q

ii. 2p x p = 2q x q

iii. $3p^2 = 2pq$

iv. $\frac{3p^2}{p} = \frac{2pq}{p}$

v. 3p = 2q

If p = q = 2 then

iv. 3 x 2 = 2 x 2

6 = 4

A) step 2 is wrong B) Step 3 is wrong
C) Step 4 is wrong D) Step 5 is wrong

TEST V

Hint Answer the questions given below after understanding the relationship between equations/ numbers given in each question. Figures are given with an intention to explain the questions to you. Don't try to find out the answers by drawing figures.

1) $\frac{1}{1x2} = \frac{1}{2}$

$\frac{1}{1x2} + \frac{1}{2x3} = \frac{2}{3}$

$\frac{1}{1x2} + \frac{1}{2x3} + \frac{1}{3x4} = \frac{3}{4}$

$\frac{1}{1x2} + \frac{1}{2x3} + \frac{1}{3x4} + \frac{1}{4x5} = \frac{4}{5}$

$\frac{1}{1x2}+\frac{1}{2x3}+\frac{1}{3x4}+\frac{1}{4x5}+\frac{1}{5x6} \qquad = \frac{5}{6}$

.... =

.... =

.... =

$\frac{1}{1x2}+\frac{1}{2x3}+\frac{1}{3x4}$ .... $+\frac{n}{n(n+1)} \quad = \underline{\qquad\qquad}$

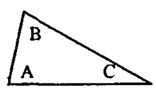
A) $\frac{n}{(n+1)}$ B) $\frac{6}{7}$ C) $\frac{(n+1)}{n}$ D) $\frac{(n+2)}{n}$

2)

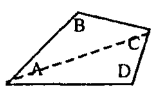
No. of base edges of a prism	**No. of faces**	**No. of edges**	**No. of vertices**
3	5	9	6
4	6	12	8
5	7	15	10
6	8	18	12
n	--	--	--

A) 2n, 3n, (n+1) B) (n+2), 3n.2n C) 3n, 2n (n+3) D) None of these

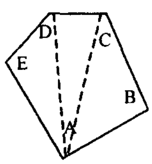
3)



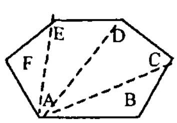
3 side 1 triangle = 1 x 180 = 180
∠A + ∠B + ∠C



4 side 2 triangle = 2 x 180 = 360
∠A + ∠B + ∠C+ ∠D



5 side 3 triangle
∠A + ∠B + ∠C+ ∠D+∠E = 3 x 180 = 540



6 side 4 triangle
∠A + ∠B + ∠C+ ∠D+∠E+∠F = 4 x 180 = 720

n side ∠A + ∠B + ∠C+.................

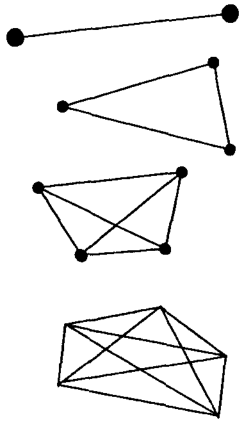
A) n x 180 B) n + 720 C) (n+2) 180 D) (n-2) 180

4)

Row	Item	Sum
1	1	1
2	1+3	4
3	1+3+5	9
4	1+3+5+7	16
...	....	
...	....	
...	....	
n	1+3+5+....	...

A) n(n+1) B) $\frac{n}{(n+1)}$ C) n^2 D) None of these

5)



2. points determine a maximum of 1 line

3. points determine a maximum of 3 lines

4. points determine a maximum of 6 lines

5. points determine a maximum of 10 lines

6. points determine a maximum of 15 lines.

Then 8 points will determine how many lines in maximum?

A) 21 B) 28 C) 32 D) 20

6) 1, 4, 9, 16, 25, …….

A) 36 B) 28 C) 50 D) 43

7) If 1=1, 2=3, 3=5 4 = 7 Then5 = ………….

A)6 B) 8 C) 7 D) 9

8)

$1^3 = 1$

$1^3+2^3 = 9$

$1^3+2^3+3^3 = 36$

$1^3+2^3+3^3+4^3 = 100$

$1^3+2^3+3^3+4^3+5^3 = 225$

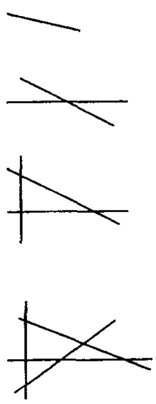
$1^3+2^3+3^3+4^3+5^3+6^3+7^3 =$ …………………………..

a) 784 B) 441 C) 625 D) 1000

9) 1, 1, 2, 3, 5, 8, 13, …………………..

A) 29 B) 36 C) 21 D) 41

10.



1 line 2 segments

2 lines 4 segments

3 lines 7 segments

4 lines 11 segments

6 lines ___ segments

A) 22 B) 16 C) 18 D) 37

APPENDIX IX(i-v)

DEPARTMENT OF EDUCATION
UNIVERSITY OF CALICUT 1993

TEST OF MATHEAMTICS APTITUDE

Dr. V. Sumangala
Reader in Education
University of Calicut

Mrs. Malini P. M.
Research Scholar
Dept. of Education

General Instructions

This test is to examine your aptitude in Mathematics. It is different from your class tests. This includes five different tests, with separate instructions to each test. Each test should be completed within the given time. Find out the correct answer of each item and mark the corresponding alphabet of that answer, in the separate answer sheet given with the test. Do the questions correctly and quickly.

If you find that you have incorrectly marked the response, you can cancel the earlier one marked and can mark again the right answer by an 'X' mark inside the circle meant for that.

** please turn the page only after getting instruction to do so **

Appendix IX(i)

TEST 1 NUMERICAL ABILITY

Instructions:

Problems in Mathematics, based on the rules you have learned are given here. To each item, four possible answers are given of which are in the correct answer. Identify the correct answer and mark it against each item by putting an X mark in the given answer sheet.

Ex: 87+128+55= _____
Ans: A. 370 B. 270 C. 26 D. 380

The correct answer for the above question is 270. It is i8ndicated by the letter B. Therefore, in the answer sheet put an 'X' mark on the circle below the letter B.

A	B	C	D
0	X	0	0

Time: 10 mts

** start answering only when told to do so **

1. 0.1+0.011+0.1010 = _____
   A. 0.2120 B. 0.1220 C. 0.1202 D. 0.2102
2. 32.6/12.6 - _______ = 25
   A. 20 B. 20.1 C. 20.2 D. 22
3. $\frac{3}{4} - 1\frac{1}{4} + 2\frac{5}{4} =$ _______
   A. $\frac{9}{4}$ B. $\frac{7}{4}$ C. $\frac{11}{4}$ D. $\frac{5}{4}$
4. The smallest four digit number
   A. $\frac{9}{4}$ B. 1024 C. 1042 D. 1204
5. 2.25 ÷ ________ = 1.5
   A. 3.5 B. 0.5 C. 1.5 D. 0.25
6. $\left(\frac{3}{4} \div \frac{9}{4}\right) x \frac{27}{4} =$ _________
   A. $\frac{3}{4}$ B. $\frac{9}{4}$ C. $\frac{4}{3}$ D. $\frac{4}{9}$
7. 0.002 x _____ = 200
   A. 100 B. 1000 C. 10000 D. 100000
8. (_______ ÷ 8) – 8 = 0
   A. 80 B. 8 C. 64 D. 48
9. $5^3 - 5^2 =$ ________
   A. 100 B. 5 C. 25 D. 50

10. The equivalent percentage of $\frac{1}{20}$

A. 5% B. 10% C. 20% D. 40%

11. 0.65 x _______ = 0.6565

A. 101 B. 0.101 C. 1.10 D. 1.0

12. The average of the first five multiples of 3

A. 6 B. 9 C. 30 D. 45

13. A train running by a speed of 45 km/hour. What is the distance traveled by the train in 6 seconds?

A. 72m B. 60m C. 75m D. 70m

14. A five digit number 258 * 4 can be divided by 9 with remainder zero. What is the number in the place*

A. 1 B. 6 C. 7 D. 8

15. In a mixture of 25 litres, wine and water are in the ratio 3:2. How much water should be added to make the ratio of wine and water equal?

A. 10 l B. 5 l C. 15 l D. 11 l

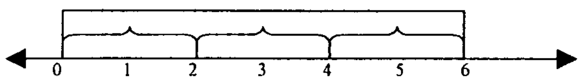
Appendix IX(ii)

TEST 2 NUMERICAL (MATHEMATICAL) REASONING

** Start answering only when told to do so **

1. In a class there are 'r' rows of desks with d desk in each row and each student occupies one desk. On a day when all the students are present, 3 desks were found vacant. Then the number of students in the class are
   A) rd – 3 B) r+d-3 D. (r/d)-3

2. Look at the following picture



The best explanation to denote S is
A. 2 x 3 B. 2 + 3 C. 3 x 2 D. 3 + 3

3. When the radius of a circle is reduced by half, its area is
   A. reduced to half B. Doubled
   C. Reduced to one fourth D. Not changed

4. In a class, when 5 tests of 25 marks each were given, John obtained an average of 15 marks for the first four tests, if he were to obtain the overall average of 16 marks how many marks should John obtain in the firth test?
   A) 15 B. 16 C. 17 D. 20

5. All the houses in a lane are marked with even numbers commencing from 56 and ending with 140. How many houses are there in the lane?
   A. 70 B. 43 C. 42 D. 84

6. If Suresh is sitting in the fifteenth position in a row of boys of a class, when viewed either from the left side or right side, then the number of boys in the class is
   A. 30 B. 31 C. 29 D. 28

7. Father told his son "when you were born, I was your present age". If father's present age is 36, what was the age of the son 5 years ago?
   A. 18 B. 13 C. 15 D. 23

8. Marks obtained by 5 students A, B, C, D, E in 5 examinations are given below:

97

	I	II	III	IV	V
A	69	71	75	75	79
B	84	79	69	79	80
C	64	67	74	74	79
D	53	54	61	60	62
E	56	58	62	63	68

The mark obtrained by which student showed regular progress?

A. C B. D C. E D. A

9. A train running at 30m/sec speed crosses a 600m platform in 30 seconds. What is the length of the train?

A. 120m B. 150m C. 900m D. 300m

10. What is the total length of all edges of a cube having a volume of 1 cubic cm.

A. 1/16 cm B. 16cm C. 1/12cm D. 12cm

Appendix IX(iii)

TEST 3

ABILITY TO USE SYMBOLS

Instructions

The conventional symbols of fundamental operations are replaced by some new symbols. Understand the new symbols and do the operations asked.

Time: 5mts

**start answering only when told to do **

Answer the following if '0' indicates the operation addition '+' multiplication and '*' division.

1. (608) + 7 + 2	100	42	28	196
2. (6*3) x8	10	25	16	63
3. 12+(14*7) 0 2 + 4	40	20	22	64
4. (13+5) * 5 0 25	115	350	35	38
5. (18*6) + (24*2)+12	27	48	168	3

Appendix IX(iv)

TEST 4

SPATIAL ABILITY

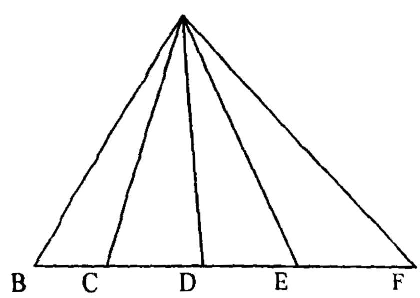
Instructions:

This section contains 8 questions. Answer them within the time given.

Time: 6 mts.

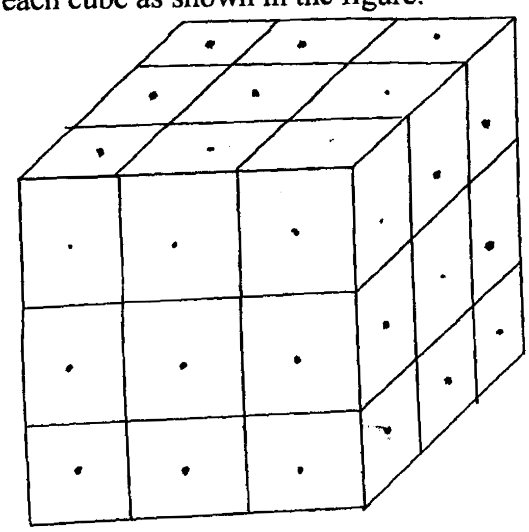
** Start answering only when told to do **

1. What is the total number of triangles in the given picture?



A. 10 B. 8 C. 12 D. 9

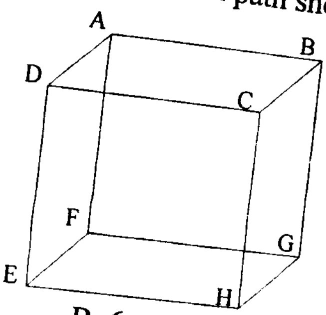
2. A wooden solid cube is divided into 27 small equal cubes and dots are placed on the faces of each cube as shown in the figure.



2. What is the number of cubes on which there is one dot.
A. 4 B. 6 C. 8 D. 10

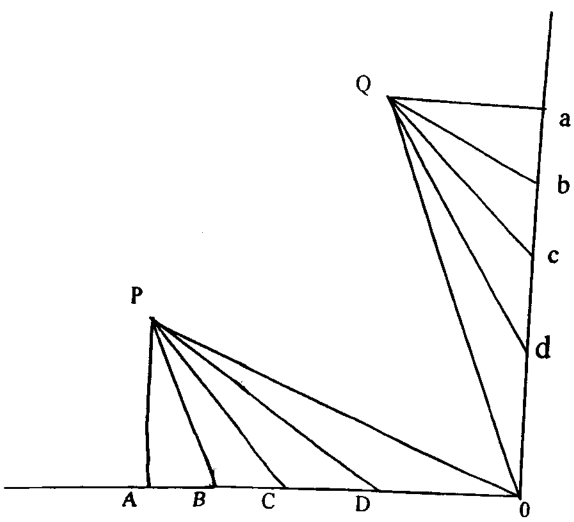
3. What is the number of cubes on which there are two dots?
A. 4 B. 8 C. 12 D. 16

5. In the cube ABCDEFGH, how many paths are there to reach H from A, passing through the 8 vertices (Each path should be through each vertex only once)?



A. 8 B. 6 C. 4 D. 2

6.

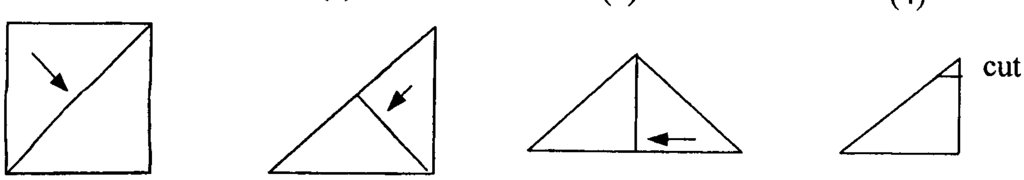


In the above figure, what is the shortest distance from P to Q?

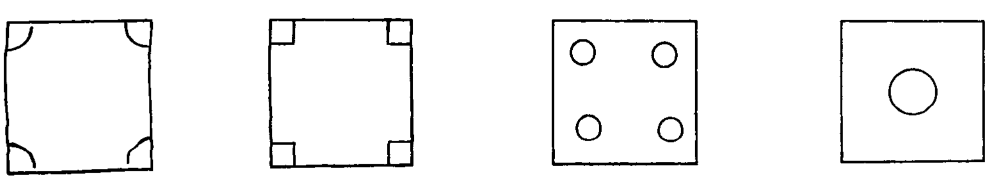
A. POQ B. PAOQ C.PAOaQ D. POAQ

7. A square paper is folded consecutively as shown in the picture, and is cut in the position marked 'cut' in the fourth picture. When it is unfolded, what will be the shape of the paper?

(1) (2) (3) (4)



1 2 3 4



A B C D

8. A cube is to be painted. Two adjacent faces should not be of the same colour. The number of minimum colours required to paint the cube is

A. 6 B. 3 C. 4 D. 5

15

Appendix IX(iv)

TEST 4

SPATIAL ABILITY

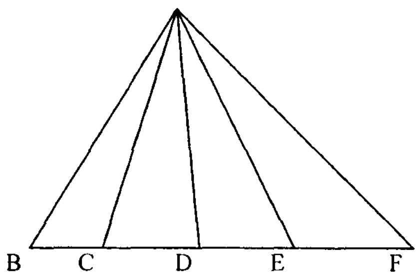
Instructions:

This section contains 8 questions. Answer them within the time given.

Time: 6 mts.

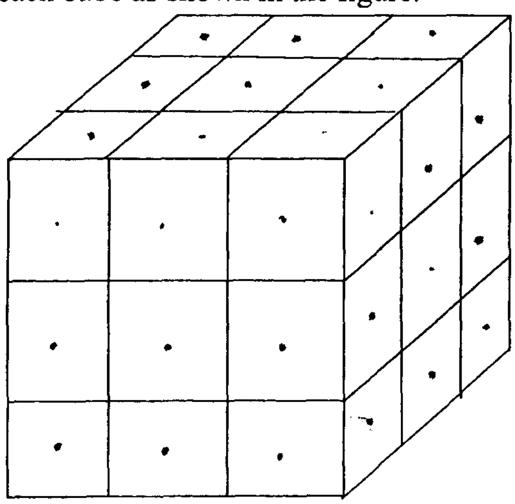
** Start answering only when told to do **

1. What is the total number of triangles in the given picture?



A. 10 B. 8 C. 12 D. 9

2. A wooden solid cube is divided into 27 small equal cubes and dots are placed on the faces of each cube as shown in the figure.



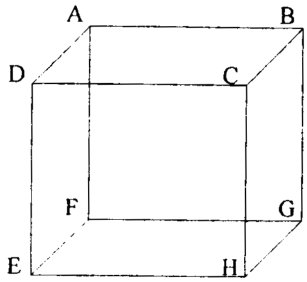
2. What is the number of cubes on which there is one dot.

A. 4 B. 6 C. 8 D. 10

3. What is the number of cubes on which there are two dots?

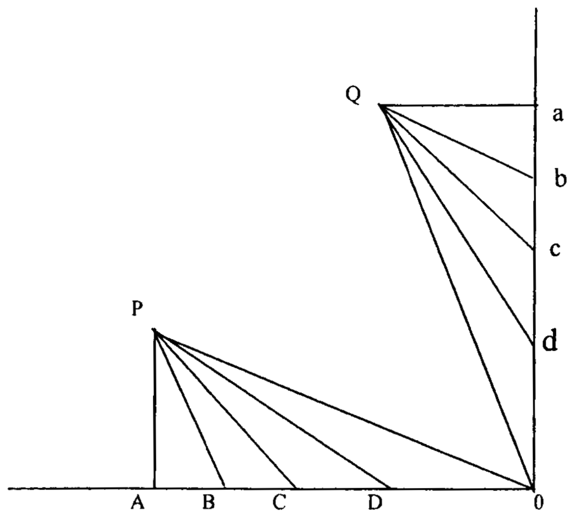
A. 4 B. 8 C. 12 D. 16

5. In the cube ABCDEFGH, how many paths are there to reach H from A, passing through the 8 vertices (Each path should be through each vertex only once)?



A. 8 B. 6 C. 4 D. 2

6.

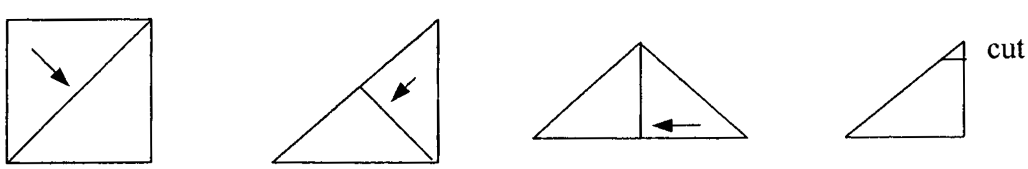


In the above figure, what is the shortest distance from P to Q?

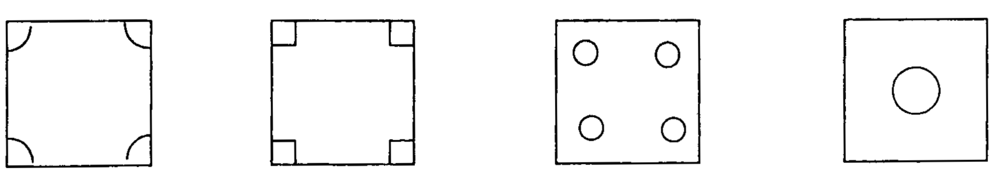
A. POQ B. PAOQ C.PAOaQ D. POAQ

7. A square paper is folded consecutively as shown in the picture, and is cut in the position marked 'cut' in the fourth picture. When it is unfolded, what will be the shape of the paper?

(1) (2) (3) (4)



1 2 3 4



A B C D

8. A cube is to be painted. Two adjacent faces should not be of the same colour. The number of minimum colours required to paint the cube is

A. 6 B. 3 C. 4 D. 5

APPENDIX X

DEPARTMENT OF EDUCATION
UNIVERSITY OF CALICUT

SCALE OF MATHEMATICS ANXIETY

Dr. V. Sumangala
Reader in Education
University of Calicut
Education

Mrs. Malini, P.M.
Research Scholar
Department of

The problem felt by you while learning mathematics are given here in the form of statements. Read each statement and mark your response in either of the forms 'Strongly Agree' (SA), 'Agree' (A), 'Undecided' (U), 'Disagree' (D), or 'Strongly Disagree' (SD). For this, you are given a separate answer sheet with five circles labelled as SA, A, U, D, SD against each statement number.

If your response to a statement is 'Strongly Agree', put an 'X'mark on the circle below SA; if the response is 'Agree', 'Undecided', 'Disagree', or 'Strongly Disagree', put ' X ' mark on circles below A, U, D or SD respectively.

Eg: Mathematics is tough to me than other subjects

SA	A	U	D	SD
O	O	O	O	O

In this example, the X mark is on D. this means that the student who answered disagrees to the statement.

1. While doing mathematical problems, if I feel that the teacher is caring me then it will be difficult for me to proceed with.
2. When the mathematics teacher starts asking questions, I will feel worry because of anxiety.
3. I feel upset if I do not follow reading mathematics lessons.
4. Often I cannot do a problem in time because of the feeling that I have gone wrong somewhere.
5. I make mistakes even when answering to questions which are thorough to me.
6. While drawing mathematical figures the thought that the measures taken by me may not be correct usually disturbs me.
7. I am ready to do mathematics problems in the blackboard even if I feel that I may go wrong.
8. In mathematics classes I like to sit in the back row so as to avoid the teacher.
9. I am unable to do mathematics examination well even if I study well.

10. I do not feel difficult on my attempts to keep better in mathematics.
11. Even after many revised studies I am anxious at examinations whether I could do exam well.
12. Even if I have severe doubts I do not try to solve it for I fear that I may be viewed a poor student.
13. The thought that I may go wrong prevents me from doing mathematics problems independently.
14. I am satisfied if the teacher does all the problems on the blackboard so that I can copy down.
15. Even petty mathematical calculations done at shopping times becomes difficult for me when done in the classroom.
16. I copy from the books of my neighbor student because of the fear that the teacher may scold me if I go wrong.
17. I find it difficult to answer questions in mathematics classes even when the answer is known to me.
18. I keep myself aloof from opportunities involving transactions of given and take because of the fear that I may go wrong in calculations.
19. On the way of mathematics exam I usually have physical ailments like fever, stomach upset etc.
20. I do not participate in quiz programmes because of the fear that I may not be able to answer correctly.
21. While solving each new problem the fear whether I will be able to do it as in the earlier classes usually upsets me.
22. The anxiety I have before the commencement of mathematics exam does not bother me when the exam starts.
23. I always score lower marks in mathematics exam because of anxiety
24. Because of my ambition to score full marks in the exam nothing hinders me in the way.
25. I cannot write even to the expected level in mathematics exam if I am not prepared against anxiety.
26. I am anxious that it will be difficult for me to pass competitive exams in future if I have no sound knowledge in mathematics.
27. I do not get upset even if I have to do several times to get correct answer for mathematics problems.
28. The anxiety of exams won't affect my studies in mathematics.
29. I forget the formulae at the time of exams due to anxiety even if I study well.

APPENDIX XI

DEPARTMENT OF EDUCATION 2000
UNIVERSITY OF CALICUT

MATHEMATICS INTEREST INVENTORY

Dr. V. Sumangala
Reader in Education
University of Calicut

Vijayakumari K.
Research Scholar
Department of
Education

Instruction:
This is to find how far secondary school students are interested in activities related to Mathematics. 32 sets of activities that you would like to do usually are given under three options A, B and C. You are free to indicate your choice/ preference by choosing any one activity of the three options. Mark your preferences with a cross mark (X) under the column heading, A. B and C in the separate response sheet provided.

1. A. Keeping a collection of coins of different countries
   B. Collecting pictures of geometrical shapes.
   C. Collecting various types of stamps.

2. A. Reading children's publications like Poompata, Balarama etc.
   B. Reading magazines on Mathematics.
   C. Reading books on Science fictions.

3. Listening radio programme on
   A. Mathematics
   B. Hindi lesson
   C. Non formal education.

4. Discuss with others about
   A. Current political issues.
   B. Modern scientific inventions
   C. The scope of modern mathematics.

5. Learning
   A. Rules of different games.
   B. The working of machines.
   C. Mathematical games.

6. In magazines and other publications
   A. Attempt word puzzles
   B. Find out answers to mathematical puzzles
   C. Colour pictures.

7. On holidays
    A. Watch films
    B. Play games
    C. Do mathematical problems.

8. A. Helping parents in preparing the family budget
    B. Purchasing the household things
    C. Helping in household chores

9. A. Observing birds
    B. Identifying geometrical figures present in nature.
    C. Observing the sky.

10. A. Experimenting with instruments.
    B. Making different patterns using geometrical figures.
    C. Making card board models of different countries.

11. In the school, help in conducting
    A. Sports meet
    B. Mathematics exhibition
    C. Arts festival

12. Taking part in
    A. Literacy meetings
    B. Mathematical club
    C. Political meetings

13. Preparing a chart of
    A. Mathematical formula
    B. The contributions of renowned scientists.
    C. Famous writers and their works

14. To discuss with friends about
    A. The ways and means of making the learning of Mathematics interesting.
    B. Health issues
    C. The environmental issues.

15. A. Making a library on literary works.
    B. Making a library of mathematics
    C. Making a library of history

16. Helping the brother/ sister in learning
    A. Languages
    B. Mathematics
    C. Science

17. To see
    A. Sports meet
    B. Cultural programme
    C. Mathematical exhibitions

18. Delivering a speech on
    A. Political issues
    B. The utility of Mathematics
    C. The benefit of Science.

19. A Understanding the working of machines by visiting a factory
    B. Understanding the relationship between production and distribution in a factory.
    C. Finding out the use of the factory products to the society.

20. Taking part in
    A. Mathematics quiz
    B. Science quiz
    C. Quiz on history

21. Daily learn
    A. Science
    B. Mathematics
    C. Social Science

22. Understanding the usage of
    A. Language dictionary
    B. Mathematical dictionary
    C. Science dictionary

23. Doing higher studies in
    A. Science
    B. Literature
    C. Mathematics

24. A. Solving difficult mathematical problems
    B. Conducting scientific experiments
    C. Locating countries and places in the world map

25. Listening the description regarding
    A. The progress of Science
    B. The cultural progress of humanity
    C. The contribution of Mathematics to the modern world.

26. A. Observing the procedure of conducting scientific experiments
    B. Studying the use of mathematical instruments with precision
    C. Observing the methods and ways of different body exercises.

27. Reading the biography of
    A. The famous mathematician Srinvasa Ramanuja
    B. The greater leader Mahatma Gandhi
    C. The poet Rabindranath Tagore

28. Reading books on
    A. Ancient Indian Mathematics
    B. Astronomy
    C. Plants and Animals

29. Obtaining a job on
    A. Teaching
    B. Construction and operation of machines
    C. Operating computers

30. During holidays learn
    A. Typewriting
    B. Computer
    C. Cycling

31. Learning
    A. The scientific names of the common plants found in nature.
    B. The scientific names of the things in common use (eg: Salt, Washing soda, etc).
    C. Recognize mathematical forms in the household things.

32. Being a member of
    A. Literary association
    B. Sports Club.
    C. Mathematics club.

*****

APPENDIX XII

DEPARTMENT OF EDUCATION 2000
UNIVERSITY OF CALICUT

SCALE OF ACHIEVEMENT MOTIVATION IN MATHEMATICS

Dr. V. Sumangala
Reader in Education
University of Calicut
Education

Vijayakumari K.
Research Scholar
Department of

Instruction:

This is to measure secondary school pupils striving to attain expected goals by learning Mathematics. This has 42 statements and each statement can have 3 ways of responses viz., Always (A), Sometimes (B) and Never (C). Mark your responses (A,B or C) with a cross mark 'X' in the circle against each item number under the column heading A, B and C in the separate sheet given. All statements are to be responded.

1. I like to do mathematical problems which others cannot do.
2. I will learn difficult portions in Mathematics, even if it is time consuming.
3. I insist on learning mathematical lessons taught in the class on that day itself.
4. I do copy home work in Mathematics from others.
5. I spend more time to learn Mathematics
6. Everyday I put off my mathematics learning for the next day.
7. I workout problems in Mathematics text book which are not done in the class.
8. I am adamant in completing the work assigned by my mathematics teacher within specified time.
9. It is obligatory that I shall get good marks in Mathematics examinations.
10. All my friends are good at Mathematics
11. When I fail to understand what I learn in Mathematics I think that, I need not learn any Mathematics at all.
12. I am satisfied by my excellence in Mathematics.
13. I feel satisfaction when I am successful in completing difficult mathematical tasks.
14. I proudly show my mathematical ability in front of my peers.
15. I get depressed when others comment on my poor standard in Mathematics.
16. I have only inadequate opportunity for better mathematics learning.
17. I desire to be accepted in my mathematics class.

18. When I am successful in working out one problem, I tend to do the next immediately.
19. I respect those who perform well in Mathematics.
20. I want, I should be the No.1 in Mathematics learning.
21. Others should consider me as a model in Mathematics learning.
22. Eventhough I am the top scorer in the class, I study Mathematics very carefully.
23. Leadership in all mathematical activities will be on me.
24. I am sure that I will succeed in life through mathematics learning
25. I like to sit in backbench in the mathematics class without being noticed by anyone.
26. I wish to have higher studies in Mathematics as much as possible.
27. I work hard to defeat bright students in Mathematics competitions
28. I like to compete with students who are good at Mathematics.
29. I don't take part in competitions related to Mathematics because of the fear of under performance when compared to others.
30. I take part and win prizes in mathematical competitions
31. I volunteer myself first when Mathematics teacher asks to do the problem in the blackboard
32. I like to know more about Mathematics related matters which are not in the syllabus.
33. I get motivated in learning Mathematics by the small bits of appreciations.
34. I utilize the opportunities maximum to enrich my mathematical knowledge.
35. I work hard to maintain my first place in Mathematics in the class.
36. Eventhough I study a small portion in Mathematics, I insist to make it thoroughly.
37. My achievement in Mathematics is the result of my hardwork.
38. I doubt whether my learning style is enough to achieve high grades in Mathematics
39. I wish my friends clarify their doubts in Mathematics by asking me.
40. I want to be the only person who can answer all the questions of my Mathematics teacher.
41. I desire the teaches to ask me to help those who are poor in Mathematics
42. I want to be the leader in all the mathematical activities.

APPENDIX XIII

DETAILS OF SCHOOLS SELECTED

Sl. No.	Name of School	Type of School	Type of Management	Locality	Boys	Girls	Total
1.	St. Joseph's Boys H.S., Kozhikode	Single	Private	Urban	40	-	40
2.	Silver Hills H.S. Paroppady	Co-educational	Private	Urban	18	31	49
3.	NGO Quarters G.H.S.	Co-educational	Government	Urban	29	22	51
4.	J.D.T. Islam H.S. Marikkunnu	Co-educational	Private	Urban	32	30	62
5.	Govt. Girls H.S. Nadakkavu	Single	Government	Urban	-	50	50
6.	G.B.H.S. Koyilandy	Single	Government	Rural	56	-	56
7.	G.H.S. Parambil	Co-educational	Government	Urban	31	32	63
8.	C.M.C. G.H.S. Elathoor	Single	Private	Rural -	-	49	49
9.	A.K.K.R.B.H.S. Chelannur	Single	Private	Rural	50	-	50
10.	M.G.M.H.S. Puthuppady	Co-educational	Private	Rural	24	26	50
11.	G.H.S. Puthoor	Co-educational	Government	Rural	20	38	58
12.	A.K.K.R.G.H.S. Chelannur	Single	Private	Rural	20	28	48
13.	S.H.H.S. Thiruvampady	Co-educational	Private	Rural	20	30	50
14.	St. George H.S. Kulathuvayal	Co-educational	Private	Rural	25	24	49
15.	G.R.E.C.H.S. Chethamangalam	Co-educational	Government	Rural	30	28	58
16.	G.H.S. Mavoor	Co-educational	Government	Rural	30	27	57
17.	Ilahiya H.S. Kappad	Co-educational	Private	Rural	26	25	51
18.	St. Joseph's H.S. Kodenchery	Co-educational	Private	Rural	20	30	50
19.	Perambra H.S.S.	Co-educational	Private	Rural	27	24	51

APPENDIX XIV

CONTINGENCY TABLES

(Mathematics Achievement X Psychological Variables)

1. Achievement Motivation in Mathematics

Groups	Low	Average	High	Total
Under-	36 25.6	104 103.0	12 23.4	152
Normal-	21 116.5	478 468.8	93 106.7	692
Over-	10 24.9	90 100.2	48 22.8	148
Total	**167**	**672**	**153**	**992**

2. Mathematics Aptitude

Groups	Low	Average	High	Total
Under-	26 21.5	112 103.9	14 26.7	152
Normal-	113 97.7	498 473.0	81 121.4	692
Over-	1 20.9	68 101.2	79 26.0	148
Total	**140**	**678**	**174**	**992**

3. Mathematical Creativity

Groups	Low	Average	High	Total
Under-	14 23.3	130 101.9	8 26.8	152
Normal-	134 106.0	480 463.9	78 122.1	692
Over-	4 22.7	55 99.2	89 26.1	148
Total	**152**	**665**	**175**	**992**

4. Mathematics Interest

Groups	Low	Average	High	Total
Under-	42 30.0	89 89.2	21 32.5	152
Normal-	145 138.1	418 406.0	129 147.9	692
Over-	11 29.5	75 86.8	62 31.6	148
Total	**198**	**582**	**212**	**992**

5. Mathematics Anxiety

Groups	Low	Average	High	Total
Under-	19 27.6	103 102.0	30 22.4	152
Normal-	97 125.6	491 464.6	104 101.8	692
Over-	64 26.9	72 99.4	12 21.8	148
Total	**180**	**666**	**146**	**992**

6. Mathematical Problem Solving Process Solving Skills

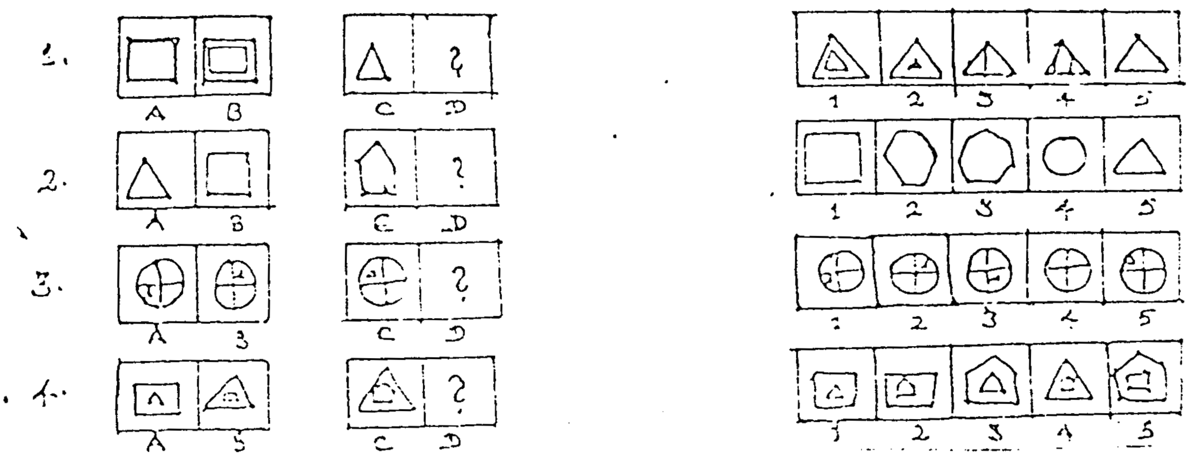
Groups	Low	Average	High	Total
Under	30 20.2	111 107.6	11 24.2	152
Normal-	102 92.1	531 489.7	59 110.2	692
Over-	0 19.7	60 104.7	88 23.6	148
Total	**132**	**702**	**155**	**992**

TEST 5 - ABSTRACT REASONING

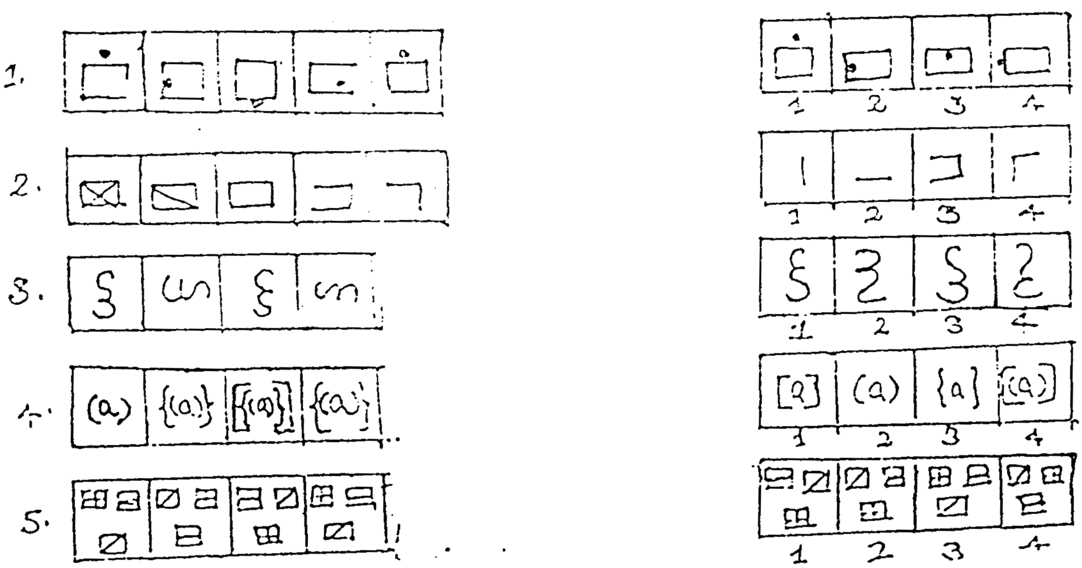
Time: 8 mts

** Start answering only when told to do **

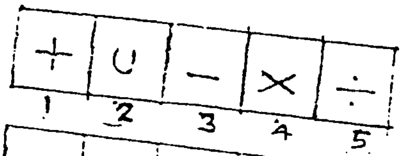
I. Pictures A and B has a particular relationship. Select D from the answer figures such as C and D has the same relationship as A to B.

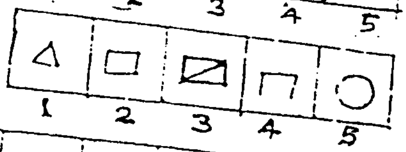


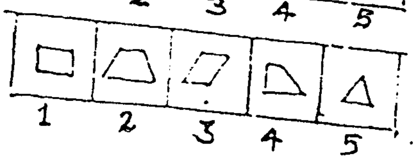
II. The following pictures are in a particular order. Select the answer figure which follows the same order.

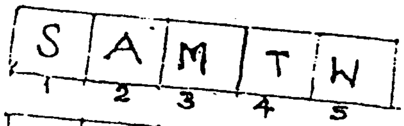


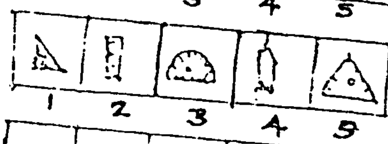
III. In the following five figure series, four belongs to one category and one stands out. Find the different one.

1 

2 

3 

4. 

5. 

6.