SOME PSYCHOLOGICAL VARIABLES CONTRIBUTING TO MATHEMATICAL GIFTEDNESS OF SECONDARY SCHOOL PUPILS OF KERALA

VIJAYAKUMARI K.

Thesis submitted for the Degree of
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IN EDUCATION

DEPARTMENT OF EDUCATION
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DECLARATION

I, Vijayakumari, K., do hereby declare that this thesis, "SOME PSYCHOLOGICAL VARIABLES CONTRIBUTING TO MATHEMATICAL GIFTEDNESS OF SECONDARY SCHOOL PUPILS OF KERALA" has not been submitted for the award of a Degree, Diploma, Title or Recognition before.

C.U. Campus,
20.12.2000.

VIJAYAKUMARI. K.

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Dr. V. SUMANGALA
Reader
Department of Education
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CERTIFICATE

I, Dr. V. Sumangala, do hereby certify that this dissertation entitled, "SOME PSYCHOLOGICAL VARIABLES CONTRIBUTING TO MATHEMATICAL GIFTEDNESS OF SECONDARY SCHOOL PUPILS OF KERALA" is a record of bonafide study and research carried out by VIJAYAKUMARI, K. under my supervision and guidance.

20.12.2000.

C.U. Campus,
20.12.2000.

Dr. V. Sumangala
(Supervising Teacher)

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CHAPTER I

INTRODUCTION

INTRODUCTION – NEED AND SIGNIFICANCE OF THE STUDY – STATEMENT OF THE PROBLEM – DEFINITION OF KEY TERMS – OBJECTIVES – HYPOTHESES – METHODOLOGY – LIMITATIONS OF THE STUDY – ORGANISATION OF THE REPORT

The new millenium is endowed with a whole host of advances in all fields of human endeavour which have cumulative impact on the social, economic and cultural dimensions of the society. The development in science and technology, especially in the latter part of the last century, made the society to be cognizant that in the present milieu, knowledge is the only way to societal development.

As a nation, we have to set a task of making knowledge ourselves as it is the power of knowledge that will enable India to seize the opportunities and face the challenges of the 21st century. The only way we can fulfil this task is when individuals strive for both knowledge and excellence, which is possible only through goal oriented education.

In the words of Piaget, "The principal goal of education is to create men and women who are capable of doing new things, not simply repeating what other generations have done" (Renzulli,[1] 1999). Any educational system with primary focus on the prosperity of nation should concentrate on individual development which can be made possible if and only if every child receives opportunity for maximum development of his/her potentialities. Here lies the significance of special education which aims to meet the needs of children who are different from normal ones like gifted, physically and mentally handicapped. Gifted or talented, the target group of the study, are exceptional children deviating from the norm or average by having superior abilities to the extent demanding variety of special educational opportunities to meet their psychological needs.

India has her own share of gifted and talented people to the world but the sorriest side is that their needs and potentials are not adequately met or nurtured. While there is wide spread agreement that children with intellectual disability or a learning disability need special education with special strategies, a similar consensus is absent in the case of gifted and talented students.

The problems of suppressed potentials, which are often hidden, will affect not only the individuals concerned but the society we live in and depend on. Gallagher[2] (1975) who studied in depth about gifted children opined that, " failure to help the handicapped child reach his potential is a personal tragedy for him and his family, failure to help the gifted child reach his potential is a societal tragedy, the extent of which is difficult to measure, but which is surely great".

It has been pointed out that there are mainly two purposes of providing special education to gifted. The first is to provide young people with opportunities for maximum cognitive development and fulfillment through the expansion and expression of one or a combination of performance areas where superior potential may be present. The second purpose is to increase society's reservoir of persons who will help solve the problems of contemporary civilization by becoming producers of knowledge and art rather than mere consumers of existing information.

While it is true that some gifted children do develop their full potential without the help of special learning atmosphere, it is not always so in most cases. A congenial atmosphere for the gifted and talented is necessary in a democratic society which respects a democratic, humanistic system of education.

A child is considered gifted when his superior ability contributes greatly to the welfare of the society and so social and cultural values of the time determine the meaning of giftedness. For example, while our present society emphasizes Mathematics and Science, Ancient Greeks held the orator and the artist in high esteem. The Romans gave esteem respect to the soldier and the administrator. The more complex the social issues, the higher should be the degree of giftedness.

A gifted child is potentially an awesomely powerful force. He can mould civilization or destroy it. The creative energies of gifted children need to be activated and guided in the initial stage itself, or else they can be lost or prove dangerous. Here lies the master role of educators and teachers. A delay in identification and provision of enrichment programmes can even lead to a retardation in the abilities of such students.

Identification is, however the most difficult aspect in working with the gifted and talented, there being no accepted single definition of giftedness. The literature of giftedness is loaded with theory and not with concise results of investigation. A perusal of the theoretical works on giftedness and talent will pave the way for a clear understanding of the area.

Excellence always fascinate people and they may keep watch on both the performance and performer cutely. Study of such individuals who deviate from the normal in the positive direction, has been going on for centuries, the result being the concept of giftedness varying accross years. Theory as well as research in this area are growing at an astounding rate, and the various domains of exceptions in the realm of giftedness are also increasing.

Theoretically the study of giftedness is related to the psychology of individual difference and has focussed on the constructs of intelligence, creativity and motivation. The study of giftedness encompasses both adults and children and the development of talents in many domains - the academic areas, performing arts, etc. It involves the investigation of both cognitive and affective variables and its research lexicon is formed by retrospective as well as prospective studies.

At the practical level, it is primarily concerned with results related to education and upbringing of gifted children. The corpus of research in the field has been largely related to schooling and to family contexts that develop gifts and talents in children and youth.

Although broadened definitions of giftedness in the area of visual arts and music have emerged, the most extensive body of research available for review concentrates on intellectual giftedness.

Eminent researchers in the area put forward different definitions of giftedness with different points of view and each seems to have high value in the context in which it has defined.

Definitions and Approaches of Giftedness

The concept of giftedness itself is a very complex one and the theorists, researchers and practitioners are puzzled with the complexity to arrive at a comprehensive definition.

A hawk's view on the literature of giftedness reveals that the definition of giftedness vary from the conservative ones such as Terman's use of the top one percent of general intellectual ability to Witty's liberal conceptualization. Witty[3] (1952) is of the view that "Giftedness is displayed by a child whose performance in a potentially valuable line of human activity is consistently remarkable". These conceptualizations again were diverse, with some concentrating primarily on the psychological aspects of giftedness and others relying on social contexts also.

In general four main groups of definitions of giftedness can be seen as Trait oriented model, Cognitive component model, Achievement oriented model and Socio-cultural model. While the first two refer to psychological constructs, the third focuses on achievement and accomplishment and the last takes an environmental view.

Trait oriented model considers giftedness to be a relatively stable personal trait, not dependent on the environment, historical period or socio-economic conditions. In cognitive component model, the quality of information processing is more important than the quantifiable results of testing. Achievement is considered as an observable out put of giftedness in the Achievement oriented model. The socio-cultural or psycho-social model takes the pragmatic position that giftedness is defined and determined in the context of the concern for extra-ordinary abilities and the available programmes.

Eventhough these four approaches are valuable in defining giftedness, the first and third categories predominate the field because of the concreteness and consistency in defining giftedness.

Another classification of the definitions of gifted is due to Feldhusen and Jarwan[4] (1993) who saw definition of giftedness into six categories which are not strictly exclusive. The six categories are Psychometric definitions, Trait definitions, Youth definitions, Educationally oriented definitions, Special talent definitions and the Multidimensional definitions.

Psychometric definitions focus on attaining high scores in intelligence tests; Trait definition concentrate on the psychological characteristics of able children; Youth definitions focus on social needs or by what society values; Educationally oriented definitions put forward statements about the need for special provisions; Special talent definitions emphasize talents in specific domains such as Mathematics, the arts and science and the Multi dimensional definitions crosses several categories like intellectual, creative, artistic, etc.

According to Renzulli[1] (1999), there are two types of Giftedness - lesson learning or 'schoolhouse' giftedness and creative productive giftedness.

'Schoolhouse giftedness' is the kind most easily measured by standardised ability tests, which focus on analytic skills rather than creative or practical skills. Creative productive giftedness describes those aspects of human activity and involvement where a premium is placed on the development of original ideas, products, artistic expressions and areas of knowledge that are purposefully designed to have an impact on one or more target audiences. The learning situations for promoting this type of giftedness emphasize the use and application of knowledge and thinking processes in an integrated, inductive and real problem oriented manner. This concept of giftedness lead him to develop the three ring model of giftedness (1977) in which superior ability, motivation and creativity interact to define giftedness. The definition continues as gifted and talented children are those possessing or capable of developing this composit set of traits and applying them to any potentially valuable area of human performance.

Thus it can be seen that the approach of equating giftedness with high intelligence has changed and the modern concept of giftedness is incorporating other constructs also. For instance, in a longitudinal study, from 1921 onwards Terman[5] (1965) identified the gifted as youngsters who scored at or above 140 on Stanford-Binet Scale and Hollingworth[6] (1926) defined the intellectually gifted as the most intelligent one percent of juvenile population.

In 1972 in the report to American congress, Marland[7] defined the gifted as those who are identified by professionals for their outstanding abilities and capability for high performance. But Martinson[8] in 1973 found creativity - a superior ability in the performing arts-and other socially desirable achievements as characteristics of giftedness. Eventhough Swanson and Willis[9] in 1979 defined the academically gifted as those who scored the upper three percent in the measurement of general intelligence (as assessed by the commonly used individual assessment instruments), they suggested that those who are high in creative abilities and superior in special areas of human activities deemed desirable by the society must also be included in the group of gifted.

Feldhusen[10] in 1986 extended his earlier concept of giftedness by adding another psychological construct, motivation along with general intellectual ability. Monk et al.[11] (1986) extended Renzulli's three ring model of giftedness by incorporating a fourth dimension also viz., sociological environment.

Ross[12] (1993) in a report gave a multidimensional definition to the gifted. The report states, "these children and youth exhibit high performance capability in intellectual, creative or artistic areas, possess an unusual leadership capacity or excel in specific academic fields".

The scientific analysis of the concept of giftedness made, Kratochwil[13] (1993) to arrive at the conclusion that like education, giftedness also is a process and a product, for the development of which one needs the motivating components like thirst for knowledge and preserverance or dilegence. He also found that the extent to which giftedness develops is determined by the degree to which the three components of talent viz., above average abilities to learn, high motivation and high creativity exists.

Thus literature in the area of giftedness suggests that, gifted children are those who have high achievement in one or more academic areas like Mathematics, Science, Art etc, with high general intellectual ability, creative thinking, aptitude in particular subject, leadership or psychomotor ability.

Need and Significance of the Study

India after independence has made a number of education commissions and all these have vehemently emphasized the need for identification and development of special talents at a very younger age of education itself. The educational system of advanced countries like USA had realized this fact much earlier and hence had made provisions for identification and nurture of the talented in every field of human endeavour.

Kothari Commission[14] (1964-1966) which answers all the questions related to educational sphere of our country noted that "the genius in one field is generally poor in several others and in our examination system, a genius is more likely to fail or set up only a mediocre 'total' of marks than to come out at the top....., We should there fore, search separately for each special talent whether in Mathematics, Science, Literature, Fine arts, Sports or Technology". The importance of special education for talented is accepted not only by educationists but by the scientists, social leaders and educators also. Still they have not arrived at a specific conclusion as to "how to".

It is high time for a developing country like India to think on this line, otherwise we will be thrown away from the community of world countries. In an age of globalization, to cope up with the scientific and technological developments, India is in need of scientifically and mathematically talented persons which in turn throws light on the superiority of Mathematics, the back bone and key of all sciences, over any other discipline. The Report of National Advisory Committee on Mathematics Education of America

(NACOME)[15] has rightly qualified Mathematics as "a national resource and national concern".

History reveals that Mathematicians usually make their major contributions before the age of 35, particularly in their twenties. Such individuals should be helped to attain the heights of Mathematical knowledge in their early twenties, so that they can give their best to add to the reservoir of Mathematical information. An extremely rare talent, Mathematical Giftedness, is usually suppressed and over looked by the routine teacher who shuts the door against avenues of the development of child.

Studies on giftedness in India include those on an enrichment programme in Biology for talented youth (Vashishtha,[16] 1979), the social and academic problems of crative teenagers pursuing different curriculum (Roy,[16] 1982), need patterns, achievement and adjustment of mentally superior children (Singh,[16] 1983), the characteristics and problems of the intellectually gifted children (Sampath,[16] 1984), parents' attitude and personality types of gifted children (Khan,[16] 1986), adjustment problems of creative male and female children (Dhar,[16] 1987) and use of SOI model in the study of levels of giftedness (Khire,[17] 1997).

Mathematical Giftedness is well studied in the west (Helso,[18] 1971; Rodenstein,[18] 1981; Kissanne,[18] 1986; Weiner & Robinson,[18] 1986; Miller, 1990[19]) in contrast to the pitiable condition in India. It is true that in order to motivate mathematically talented students, attempts like Mathematics Olympiad are being conducted world wide - yet many who are really able do not get access to such programmes because of some or other reasons.

Also merit scholarships are available to bright students in some Indian schools. Navodaya Vidyalayas, as recommended by National Policy on Education (NPE, 1986)[20] are started in every districts for the education of bright children but the selection procedure includes only high achievers excluding many creative special talents in separate fields. An adequate and systematic attempt is not yet made for the identification and nurturing of talents.

In majority of the works on giftedness, gifted was identified using the single criteria, 'high intelligence'. Vernon[21] (1977) reached the conclusion that the relationship between general intelligence and scientific, mathematical and writing aptitudes is low which implies that the link between talent and intelligence is still open to question. Theory as well as research in the area suggested that high mental ability and creativity are a sure criteria for identifying gifted.

This directs us to the idea that mathematical ability and mathematical creativity may be some of the contributing factors to Mathematical Giftedness. But studies are very rare incorporating the two characteristics to identify Mathematical Giftedness. The present study is in such a context.

'Beat the iron when it is hot' and so we have to identify and nurture the talents at the school level itself especially at the secondary level, which is the crucial period in the academic development of the individual. More over, the investigator being a teacher educator in Mathematics, felt the need for providing special attention to the gifted, who are found to be neglected in our classrooms. The remedy lies in providing in-depth knowledge about the contributing variables to Mathematical Giftedness to the classroom teachers and to all those concerned with education of school children and hence the significance of the study.

1. 2. STATEMENT OF THE PROBLEM

The present study is entitled as "SOME PSYCHOLOGICAL VARIABLES CONTRIBUTING TO MATHEMATICAL GIFTEDNESS OF SECONDARY SCHOOL PUPILS OF KERALA".

1. 3. DEFINITION OF KEY TERMS

Operational definitions of the key terms involved in the title are provided below in order to understand the study.

1. 3. 1. Psychological Variables

The term 'psychological variables' stands for a set of cognitive (thinking related) variables and affective (feelings, emotions etc. related) variables.

1. 3. 2. Contributing

The term 'contributing' in the title stands synonymous to the statistical terms like correlating or having association with; capable of discriminating between two distinct groups; making the factor structures of the groups different etc.

As such the contributing variables of Mathematical Giftedness were identified by applying the following statistical treatment to the measures of the variables.

i. Two tailed 't' test

ii. χ^2 - test of Independence

iii. Discriminant Analysis

iv. Factor Analysis

1. 3. 3. Mathematical Giftedness

Eventhough in the modern concept, Mathematical Giftedness, a special talent found in few pupils, is defined by the simultaneous presence of one or more characteristics like High Intelligence, Creativity, Task commitment etc., for the present study, it is defined as the high presence of two characteristics viz., Mathematical Abilities and Mathematical Creativity.

Hence, pupils were identified as Mathematically Gifted, who scored seventy percent or above in Test of Mathematical Abilities and scored high (greater than $\overline{X} + \sigma$ in the test) in the Test of Mathematical creativity.

Pupils were therefore treated as Mathematically Non-gifted if their score in the Test of Mathematical Abilities is below 70 percent and/or the score in the Test of Mathematical Creativity is less than $\overline{X} + \sigma$ in the test.

1. 3. 4. Secondary School Pupils

Secondary School pupils stands for the students studying in standards VIII, IX and X of the secondary schools of Kerala.

1. 4. Objectives

As expounded by the statement of the problem, the major objective of the study was "To find out the psychological variable the presence or absence of which contribute significantly to Mathematical Giftedness".

In order to tackle this major objective, the following objectives were set forth as the testing or procedure implied in each will lead to the answering of the major objective.

i. To compare Mathematically Gifted and Non-gifted pupils for each of the select psychological variables and to decide the variables for which the two groups significantly differ and hence may contribute to Mathematical Giftedness.

ii. To test whether Mathematical Giftedness is dependent on the select psychological variables so that the dependent predictor variables can be considered as the contributing variables.

iii. To test whether Mathematically Gifted and Non-gifted pupils can be significantly discriminated by a linear combination of the select psychological variables and to decide the relative importance of such variables as contributors to Mathematical Giftedness.

iv. To derive the psychological factor structures of Mathematically Gifted and Non-gifted pupils and to decide the contributing variables by the presence or absence of the variables having highly significant factor loadings in the factor with the highest percent of variance or eigen value.

v. To compare the psychological factor structures of Mathematically Gifted and Non-gifted pupils in terms of

a. number of factors
b. presence or absence of the variables in the factors and
c. percent of variance accounted for by each factor and to decide whether the factor structures of the two groups are different or not.

1. 5. HYPOTHESES

The study was designed round the major hypothesis that each select predictor variable will be a significant contributor of Mathematical Giftedness. In this respect, the investigator set up the following hypotheses, the testing of each of which is analogous to the testing of the major hypothesis. These hypotheses are:

i. Mathematically Gifted and Non-gifted groups are significantly different in the case of each psychological variable selected.

ii. Mathematical giftedness is significantly dependent on each of the select psychological variables.

iii. Mathematically Gifted and Non-gifted groups can be significantly discriminated by means of a single linear function of the select psychological variables.

iv. The psychological factor structure of Mathematically Gifted and Non-gifted pupils are significantly different in terms of

   a. number of factors
   b. presence or absence of the variables in the factors and
   c. percent of variance accounted for by each factor.

1. 6. METHODOLOGY

A brief description is attempted below of the different aspects of methodology like the sample used, tools employed for collection of data and the statistical techniques used for analysis of the collected data.

1. 6. 1. Sample Used

Population of the study being secondary school pupils of Kerala; sample was drawn from 12 schools of the six major revenue districts viz., Thiruvananthapuram, Kollam, Thrissur, Malappuram, Kozhikode and Kannur. The final sample consisted of 564 (basal sample 600) standard IX pupils. Among this 45 were identified as Mathematically Gifted using the criteria stated in the operational definition of the term 'Mathematical Giftedness'.

1.6.2. Variables

The design of the study warranted two types of variables viz., criterion and predictor. The statement of the problem leads one to set Mathematical Giftedness as the criterion variable and the select psychological variables as predictors. Based on the operational definition of the term an individual is considered as Mathematically Gifted if he or she secures a score of 70 percent or above in the Test of Mathematical Abilities and score high (greater than $\overline{X} + \sigma$) in the Test of Mathematical Creativity.

The predictor variables are a set of psychological variables consisting of variables of both cognitive and affective domains. The select predictor variables are,

i. Problem Solving Ability in Mathematics
ii. Abstract Reasoning
iii. Achievement Motivation in Mathematics
iv. Mathematics Interest
v. Attitude towards Mathematics
vi. Self Concept in Mathematics
vii. Mathematics Anxiety
viii. Introversion
ix. Masculinity

1. 6. 3. Tools Used

The data needed for the study were collected using instruments both available and newly constructed and standardized by the investigator. The investigator prepared and standardized three tools. These are,

i. Test of Problem solving Ability in Mathematics
ii. Scale of Achievement Motivation in Mathematics and
iii. Mathematics Interest Inventory

The other tools employed for collection of data are:

i. Test of Mathematical Abilities (Sumangala & Malini, 1995)
ii. Test of Mathematical Creativity (Sumangala, 1993)
iii. Test of Abstract Reasoning (Sumangala & Malini, 1993)
iv. Scale of Attitude towards Mathematics (Sumangala and Sunny, 1987)
v. Scale of Self Concept in Mathematics (Sumangala & Malini, 1993)
vi. Scale of Mathematics Anxiety (Sumangala & Malini, 1993)
vii. The Kerala Introversion - Extraversion Scale (Nair, 1976)
viii. The Kerala Masculinity - Femininity scale (Nair, 1979)

1. 6. 4. Statistical Techniques Used for Analysis

The following statistical techniques were used to analyse the collected data in order to tackle the objectives/to test hypotheses set for the study.

1. Two tailed test of significance of difference between mean scores of large independent samples

2. Chi-square test of Independence.

3. Discriminant function analysis by direct method.

4. Factor analysis by Principal Component Model followed by Varimax rotation.

1. 7. SCOPE OF THE STUDY

The major focus of the present study was to find out the psychological variables which are the significant contributors of Mathematical Giftedness and to identify the psychological factor structures of Mathematically Gifted and Non-gifted which have significant place in many of the human endeavours. Details of the study so far attempted are adequate to convey the scope of the study. However an attempt is made here to examine the scope of the study.

In the study, the investigator selected the predictor psychological variables on the hope that each will be significantly related to Mathematical Giftedness and hence will be significant contributors of Mathematical Giftedness. The selection of variables was on the basis of readings on available research indications and theoretical literature in the area of Giftedness. The investigator therefore presumes that the findings of the study will be valid and generalisable.

By the study the investigator hoped that if a person has any or more such psychological traits or the psychological factors which contribute to Mathematical Giftedness, those can be traced out and through proper training giftedness can be nourished to an optimum level. Further, teachers can find out strategies for the development of such abilities (for example, Problem Solving Ability, Abstract Reasoning etc.) which contribute significantly to Mathematical Giftedness.

Again the discriminant function which the investigator derived in the study, is found as significant and effective to discriminate between Mathematically Gifted and Non-gifted, and hence can be utilized in the future for the identification of Mathematically Gifted pupils in terms of the contributing psychological variables.

Further, the findings of the study may add to the existing theoretical understanding of Mathematical Giftedness and may help reorganisation or modification of the existing model of giftedness.

Since this is a field of research which is not much explored in Indian situations, the present study may motivate other educational researchers to come forward, conduct studies and to make valuable contributions.

1. 8. LIMITATIONS OF THE STUDY

Eventhough utmost care was taken to make the study as valid and generalizable as possible, the study was done with certain limitations the prevention of which was inconvinient to the study. The following are the limitations of the study.

i. Mathematically Gifted pupils were identified using two criterion variables Mathematical Ability and Mathematical Creativity. Variables like task commitment, social environment etc are also found in the latest literature of giftedness as its major characteristics.

But these two were not taken into account as identification of gifted children based on four criterion variables simultaneously will be a laborious process and that the number of such children in the population will be very limited for the application of intended statistical techniques.

ii. For the study, Mathematically Gifted students are those who secured marks greater than or equal to 70 percent in the Test of Mathematical Abilities and at the same time who got high scores (greater than mean plus standard deviation) in Mathematical Creativity. The cut off point of Mathematical Ability score between Gifted and Non-gifted could be increased to 80 or 90 percent but not done fearing that the size of the gifted pupils will be very few.

iii. Many psychological, physiological and environmental factors may contribute to Mathematical Giftedness, but the present study focussed only on nine psychological variables of cognitive and affective domains. The number of predictor variables was restricted to nine as additional variable may make difficult and complex several ingredients of the study like availability of sufficient tools, collection of data in limited time, scoring and discussion of the results of statistical analyses.

iv. The population for the study is secondary school pupils of Kerala. But the sample was drawn from standard IX pupils on the assumption that standard IX pupils will represent students at secondary level.

v. Eventhough the population for the study is secondary school pupils of Kerala, the sample drawn was not a big proportion of the population (the size of the basal sample is 600), but represented six major revenue districts of Kerala. This was done as there were a number of tools to use (both for criterion and predictor variables) and many of these were time consuming to respond. The total time needed for the administration of all the tools including that for giving adequate instruction and the interval given after completing one tool is about six hours.

vi. The final sample size is 564 and among these 45 were identified as Mathematically Gifted so that the remaining 519 were treated as Non-gifted. Comparison of the two groups and hence identification of the contributing variables were done by means of sophisticated statistical techniques eventhough the group size differ much.

1.10. ORGANISATION OF THE REPORT

The study is reported under five chapters, viz., Introduction, Review of Literature, Methodology, Analysis, and Summary, Conclusion and Suggestions.

The first chapter narrates almost all the important aspects of the study viz.,

i. Need and significance of the study
ii. Statement of the problem
iii. Definition of key terms
iv. Objectives

v. Hypotheses

vi. Methodology

vii. Scope and Limitations

In the second chapter review of the studies and the respective findings in the area of Giftedness are summarized.

'Methodology', the third chapter gives a detailed picture of the design of the study. This chapter incorporates details on

i. Variables

ii. Objectives

iii. Hypotheses

iv. Tools used for the study

v. Sample selection

vi. Data collection procedure, scoring and consolidation of data

vii. Statistical techniques used.

Details incorporated in chapter IV; 'Analysis' are

i. Preliminary Analysis

ii. Identification of variables for which the two groups, MG and MNG differ significantly.

iii. Identification of a linear combination of the predictor variables

iv. Psychological factor structure of groups MG and MNG.

v. Comparison of the psychological factor structure of MG and MNG groups.

vi. Summary of the findings.

vii. Tenability of the hypotheses.

The last chapter of the report "Summary, conclusion and suggestions" gives a short compendium of the work, along with major findings, conclusions, educational implications and suggestions for further research.

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SOME PSYCHOLOGICAL VARIABLES CONTRIBUTING TO MATHEMATICAL GIFTEDNESS OF SECONDARY SCHOOL PUPILS OF KERALA

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CHAPTER II

REVIEW OF RELATED LITERATURE

STUDIES ON THE CHARACTERISTICS OF GIFTEDNESS

Theoretical and empirical works in the concerned area will be a great resource to the researchers, through which one can understand how researchers had approached the concept and what they had come up with. It provides ample stress and foundations to any type of research which is concerned to a specific area. So going through previous literature will be a treasure to bring out the research in a systematic and scientific manner.

The present study is in the area of Mathematical Giftedness, with a view to understand the contributing psychological factors of this phenomena. The investigator has, therefore gone through the studies conducted in the area of giftedness, as the area of Mathematical Giftedness is a less tackled one compared to the general giftedness.

The concept of giftedness has changed itself from the aristocratic connotation to the modern multidimensional approach. One of the most challenging facets of work with gifted is that of identification. Former means of identification of gifted children was by teacher nomination in which the actual definition of gifted becomes "those children who are doing well in school much better than their companions".

A new dimension was given to the concept of giftedness by the development of intelligence test (both verbal and non-verbal) by Binet and

Simon in 1905. Thus the prime identifying technique of teacher judgment has been replaced by standard tests of mental ability. Consequently to this the definitions of gifted changed as "those children who score high on IQ tests".

It is Guilford[1] (1950), the pioneer of researches on creativity - a divergent thinking ability, who put forward a new approach on the education of gifted. Many researchers were of the opinion that when IQ is considered as the sole criterion for the identification of giftedness, about 70 percent of the creative talented youth are missing (Getzels & Jackson,[2] 1962; Torrence,[3] 1962).

Renzulli[4] (1999), who contributed much to the theory and practice on giftedness, through his 25 years of research in the area evolved the three ring concept of giftedness involving three interacting constructs viz., intelligence, creativity, and task commitment as the necessary condition for giftedness.

Major works done in the area of giftedness are by western researchers and the education of the gifted is very advanced in those countries especially in America. Studies in the field of giftedness collected by the investigator whether western or eastern are presented under the heading "Studies on characteristics of Giftedness".

STUDIES ON THE CHARACTERISTICS OF GIFTEDNESS

The longitudinal study over a period of 40 years conducted by Terman[5] (1965) is a remarkable one in the field of giftedness. 1,528 children with IQ of 140 or above on Stanford-Binet test were studied in the years

1921, 1928, 1940 and in the middle of 1950's. This study revealed that gifted individuals are healthy, well-rounded, committed, responsible and likable persons. The study also observed that most of the gifted children maintained their positive profile through out their life.

According to Carroll[6] (1940), gifted children are characterized by high ability to see relations, make association and adapt abstract principles to concrete situation, originality, early development of self criticism, initiative and independence in thinking. They are superior in traits like desire to know, desire to excel and power to learn.

As reported by Barbe[7] (1965), Bristow, et al. (1951) observed high degree of insight into problems, the ability to generalize, ability to do mental tasks at a high degree of difficulty and the ability to do abstract thinking as the main characteristics of gifted children.

Cutts and Moseley[8] (1959), in their study identified the characteristics of bright children as ability to make generalizations, abstract thinking, insight into problems, reasoning, problem solving, speed of learning and completing intellectual tasks, creative ability, persistence, wide range of interests, memory and curiosity.

Terman and Oden[9] (1959), studied 209 gifted students and 262 non-gifted students (eleven to thirteen years old). Some of the findings of the study are:

i. Gifted children are more interested in school subjects which are most abstract and less interested in more 'practical' subjects than non-gifted children.

ii. The typical gifted child likes active games, plays with tools and machinery, likes the companionship of others and shows no abnormal fondness for study or for solitude.

iii. Gifted boys showed more masculine nature than non-gifted boys at all ages from eight to twelve years, after which there was little difference. Gifted girls tended to be more masculine than the non-gifted at ages eleven, twelve and thirteen.

An unusual interest in number relations was observed in pre-school gifted children by Martinson[10] (1961).

DeHaan[11] (1965), put forward the method of self selection for accelerated learning programs by candidates themselves with the key criterion as motivation of students which is assumed as an important determinant of achievement as ability is.

A study on the pupils of Hunter College Elementary School conducted by Wilson[12] (1965), revealed that general mental ability had a fair degree of relationship (0.45) to the science abilities. It was also found that gifted children tend to be especially interested in science and acquire unusual understanding in that area.

Silverblank[13] (1970) in a study to compare male high school seniors who are talented in mathematics with male high school seniors who are talented in English as to sense of responsibility, level of anxiety, and solidarity, found that no difference exists in the levels of responsibility between male high school seniors talented in Mathematics and those talented in English. No significant difference in the level of anxiety was observed between the two groups. It was also found that students, talented in English are higher in sociability than Mathematically talented.

Dodson[14] (1972) in a study to develop a description of 'insightful' mathematical problem solvers, found that a typical successful problem solver will be strong in Mathematics, score high on verbal and general reasoning tests, good at determining spatial relations, able to resist distractions to identify critical elements and disregard irrelevant elements and will be a divergent thinker. Such person will be having low debilitating anxiety, high facilitating anxiety and a positive attitude towards Mathematics.

Hitchfield[15] (1973) investigated the characteristics of able children on a sample of 125 boys and 113 girls selected based on three criterion - i) high attainment in reading and arithmetic ii) good score on the Goodenough Draw A Man test and iii) parent nomination. The study revealed that higher the children's IQs higher were their divergent thinking scores. The favorite subjects of the most intelligent boys were Mathematics, Art and Science where as girls liked Art, English and Mathematics.

Dunlap[16] (1975) reported some characteristics of gifted children as high ability to generalize, to see relationships, to make logical associations and a strong desire to excel. The gifted children were also found to be inaccurate in arithmetic.

The list of characteristics of exceptionally able children from the department of education and science , UK (Hoyle and Wilks,[17] 1975) include superior powers of reasoning, of dealing with abstractions, of generalizing from specific facts, of seeing into relations and imaginations.

Gifted children are superior in Mathematics particularly in Problem Solving.

L'Abate and Curtis[18] (1975) reported that gifted children have superior abilities and they learn at a faster pace and solve problems at a more mature level than their agemates do.

Krutetskii[19] (1976) reported that by a comparatively early age, mathematically gifted children may have developed characteristics of mental activity as an ability to generalize mathematical material, a flexibility of mental processes, a striving to find the easiest and most economical ways to solve problems, an ability to remember generalized relation and reasoning schemes, curtailment of reasoning process and the formation of mathematical perception of the environment.

Kopelman et al.[20] (1977) based on their experience with gifted secondary students, provided a comprehensive list of characteristics of gifted children. Gifted students are found to be stimulated by problem solving approaches to learning, readily able to induce, deduce and to connect related ideas and are strongly and sincerely motivated toward learning and achieving in science.

Vasantha[21] (1978) in a study on 70 boys and girls (who qualified the NCERT Science Talent Search Tests) found that 59 percent of the students have friends who want to be scientists. Physics and Mathematics were found to be the most preferred subjects and boys were interested in science but girls selected non science activities at their leisure time. Occupations with science bias and occupations where creative ability may find an expression were preferred by boys and girls.

In an attempt to compare the gifted with non-gifted children, Freeman[22] (1979) found that very high level of intellectual ability was seen with extra ordinary good memories, concentration, lively creative activities, excellent school progress and a wide range of interests.

Cropley[23] (1981) reported that gifted achievement depends on a combination of conventional abilities such as good memory, logical thinking, knowledge of facts, accuracy and creative abilities including generating ideas, recognizing alternative possibilities, seeing unexpected combination and having the courage to try the unusual (c.f. Cropley,1993).

The most obvious characteristic of the gifted in mathematics is a propensity toward quantitative relationships and the use of numbers. They have advanced mental abilities, unusual ability to solve mathematical problems and are capable of abstract thinking (Consuegra,[24] 1982).

John Hopkin University developed an accelerative Mathematics model in 1971 (Pratscher et al.[25], 1982) and the study of mathematically precocious youth (SMPY) focussed to develop a systematic method of identification of able mathematics resoners, to study the aspects of that ability and to provide appropriate instruction to foster that talent. The study revealed the need to provide opportunity for gifted mathematics reasoners to pursue the study of mathematics beyond the boundaries of the regular school day.

Winnie et al.,[26] (1982) found that gifted pupils score more highly on academic self-esteem but get undifferentiated in social and physical domains.

Sternberg and Davidson[27] (1983) in their studies found that the gifted person sees, perceives, notes or ascertain some relations or essential element that the average person does not. More intelligent subjects did better on 'insight' problems than average students. Again it was found that gifted students 'spontaneously combine and integrate' relevant data to solve problems. (c.f. Shaughnessy, 1993).

Nicholls and Miller (1984)[28] reported that high ability students often come to see themselves as competent and thereby have greater achievement motivation where as less able children often perceive themselves as low in ability and competence and suffer loss of achievement motivation.

Sampat[29] (1984) in a study on intellectually gifted children obtained that gifted children are profusely interested in reading on various subjects and interested in radio programmes and movies.

Stanley[30] (1984) linked motivation to gifted behaviour in the classroom by referring it to the 'academic hunger' of outstandingly able mathematics students.

Studies done by Van Tassel[31] (1985) revealed that academically talented children generally have high academic Self Concept and they show well developed and diversified interests that interweave with school subject preference and future study.

According to Whitmore[32] (1985) gifted behaviour is characterized by highly creative behaviour in production of ideas, things and solutions, aspiration of high standard of achievement and desire to excel.

In an year long research study of 'supernormal' children in China, Zi-Xiu[33] (1985), identified five characteristics of 'supernormal child viz., strong cognitive interests and intellectual curiosity, concentrated attention and good memory; keen perception and power of observation; quick thinking, good comprehension and creativity and confidence, competitiveness and persistence.

In a study conducted by Davidson[34] (1986) more intelligent students did better on 'insight' problems than average students and gifted children spontaneously selected and applied relevant information from insight problems.

Walter and Gardner[35] (1986) by studying famous musicians, exemplary mathematicians and artists found that "crystallizing experiences" dominated in music and prodigious achievement in mathematics but were less clear in the visual arts. By 'crystallizing experience' they means the phenomenon of blending or meshing of innate potential with a field of endeavour which is receptive to the particular skills and abilities of that individual.

Exceptionally able pupils selected for study by Zha[36] (1986) in China exhibited characteristics like curiosity, persistence and self-confidence

In a study on 143 intellectually gifted (IQ greater than 130) and intellectually average students, Barrington and Hendricks[37] (1988) found significant differences between average and gifted students in attitude toward being a scientist, usefulness of science and in knowledge of science.

Miller[38] (1990) put forward some characteristics and behaviours that may yield important clues in discovering high mathematical talent. These are:

1. An unusually keen awareness of and intense curiosity about numeric information.

2. An unusual quickness in learning, understanding and applying mathematical ideas.

3. A high ability to think and work abstractly and the ability to see mathematical patterns and relationships.

4. An unusual ability to think and work with mathematical problems in flexible, creative ways rather than in a stereotypic fashion.

5. An unusual ability to transfer learning to new, untaught mathematical situation.

He also provided a definition to Mathematically talented/ Mathematically gifted/highly able in Mathematics as students whose mathematics ability places them in the top two percent or three percent of the population.

Monson and Fukui[39] (1991) put forwarded some identifiable characteristics of gifted children for regular classroom teachers. The cognitive characteristics include ability to manipulate abstract symbol system and ability to generate original ideas and love to create. Intellectually gifted children are found to have high level of planning, problem solving and abstract thinking compared to their peers.

Muir and Coyle[40] (1991) examined group difference based on giftedness and achievement in acquisition and generalization of a strategy for solving verbal and figural analogies (N=162). Each of four groups differed significantly in analogy solving accuracy. The high achieving gifted were more spontaneously, frequently and successfully strategic, and were the only group to increase performance at distal transfer.

Corne'll *et al.*[41] (1992) compared the academic achievement, self-esteem and teacher ratings of 1,114 gifted 2nd and 3rd graders receiving one of 5 types of services for gifted - within regular classrooms, through pull-out resource rooms, ability grouping in separate classes, special schools or no program offerings. Relatively few differences in Self Concept was observed between the groups.

Lubinski and Humphreys[42] (1992) conducted a study on physical and medical correlates of mathematical giftedness and of socio-economic privileges. The sample of the study consisted of 497 male and 508 females (who are gifted) and 647 males and 485 females (with high economic status) in tenth grades. It was found that medical and physical well being to be more highly associated with mathematical giftedness than with socio-economic privileges.

Boyd[43] (1993) reviewing studies conducted in the area of giftedness summarized that, gifted adolescent males are performing much better in some aspects of mathematics than gifted girls. Contrary to earlier speculation that the better performance of males is a result of their higher spatial abilities, it was shown that spatial abilities make only a minor contribution to mathematical performance, but mathematical reasoning seems much stronger in the gifted boys.

Fredette and Hunter[44] (1993) reported a case study of a visually gifted eight year old child which illustrates the problems that may be encountered in determining giftedness that is manifested largely through visual process and products. The child's IQ was just below that required for admission to the gifted program in his school. Even though he was admitted to the gifted program after retesting, his unique needs were not satisfied by the educational district. The characteristics of the child's giftedness in ability, personality traits and creativity were explored and the authors conclude that being identified as gifted does not end the problem for this child, whose giftedness lies outside the areas generally nurtured.

Hoge and Renzulli[45] (1993) conducted a review in the area of giftedness to see whether the Self Concepts of gifted and non-gifted children differ and to explore the effects on Self Concept of labeling a child as gifted and placing the child in special programs. The authors arrived at the conclusion that studies indicate a generally higher academic Self Concept among gifted students.

Pyryt[46] (1993) re-examined Oden's (1968) comparison of the 100 most and 100 least successful men in the "Genetic Studies of Genius of L.M. Terman *et al.* (1925-59)" using three predictor variables - IQ, amount of acceleration (AOA) and educational attainment (EA). Results indicated that each of the three variables contributed to the discrimination between the two groups of students. EA was the major discriminator, with AOA and IQ making small contributions to group discrimination.

A qualitative research was conducted by Schack[47] (1993) to examine how a developmentally appropriate educational programme in the early years can affect the development of gifted children. The research was focused on a multi-age, multi-ability setting with partial implementation of a whole language program, a systematic writing process and with some flexibility in grouping of students. Eleven teachers and approximately 260 students in an upgraded primary school were involved in the study, with three first year and 30 second year students identified as gifted. The study found that gifted children followed a somewhat accelelerated curriculum. Teachers felt that there were definite social benefits to integrating the gifted and non-gifted students. The multi-age, multi-ability setting seemed to allow young students not identified as gifted to progress more rapidly than they might have in a traditional graded classroom, as they were exposed to higher level instruction. There was little evidence of the development of creative productivity or multiple intelligence other than linguistic and logical-mathematical.

In an attempt to revise the profiles of children with superior intellectual ability, Wilkinson[48] (1993) found that bright students excelled in complex reasoning but were not different from average students in their sequential reasoning and visual-spatial perception.

Caropreso and White[49] (1994) compared the analogical reasoning performance of 55 gifted students with 53 non-identified students and found that gifted students outperformed non-identified students on the geometric analogy task.

Gallagher and De-Lisi[50] (1994) in a study with 25 male and 22 female high school students of high mathematical ability found that females were likely to use conventional problem solving strategies and the use of conventional strategies is associated with negative mathematical attitude.

Interviews with teachers and teacher-completed questionnaires were used by Hunsaker[51] (1994) to examine the interplay between personal and official conceptions of giftedness. The data showed that teachers saw giftedness as greatly varied but having creativity as the common characteristic. While selecting for gifted programs they focussed on classroom performance than creativity.

Kranzler *et al.*[52] (1994) in their study found that gifted and non-gifted students differ not only in terms of the effectiveness of higher-order or metaprocess but also in terms of speed and efficiency of lower-order cognitive process.

Frame of reference theory (Developed by Marsh in 1990) which proclaims that students made both internal ability comparisons across academic domains and external ability comparisons relative to peers in determining academic self concept was validated by Williams and Montgomery[53] (1994) on a sample of 103 academically able high school students of age 13 to 15 years. Path analysis was used and the influence of both internal comparisons across academic areas and external ability comparisons relative to peers in determining student's self concepts was verified.

Shore *et al.*[54] (1994) reanalysed the initial data of Douer and Shore's study on the performance of 30 gifted children in solving water-jar problems by breaking an induced mental set. Gifted student's who failed to form the set made the most errors of any group and less accurate gifted children were found to be deficient in metacognitive knowledge. Gifted children was found to be not always outperforming others on cognitive tasks.

In a study, Cornell *et al.*[55] (1995) found that minority students identified for gifted programs scored significantly higher on achievement measures but not different in academic or social Self Concept. But white gifted program students scored significantly higher than non-gifted on achievement and academic and social Self Concepts.

Frasier et al.[56] (1995) identified ten attributes of giftedness in a study to explore the characteristics of giftedness in minority, language minority and economically disadvantaged student populations and to asses giftedness in these population. The study was conducted on a sample of 262 individuals and the attributes identified are communication skills, imagination, creativity, humour, enquiry, insight, interests, memory, motivation, problem solving and reasoning.

Hannath and Shore[57] (1995) in their study on learning disabled-gifted children found that the use of metacognitive skills and knowledge is a factor in high levels of performance demonstrated by the academically gifted.

Lea-wood[58] (1995) examined the self-esteem of gifted and non-gifted Australian adoelscent girls. Eightyone gifted and 77 non-gifted student's enrolled in year 7, 8 and 9 in post primary schools completed the School Form of Coopersmith Self-Esteem Inventory. It was found that non-gifted girls were higher in both total and social self-esteem than the gifted girls.

Luvisi[59] (1995) in the final report of a three year project in Kentucky to assist teachers in creating an innovative learning environment for gifted and talented primary aged children, emphasized on maintaining or increasing students self esteem and increasing their creative thinking, critical thinking and Problem Solving skills.

Diezmann and Watters[60] (1996) in a case study of nine year old Australian gifted student analyzed his behaviour in light of theoretical model of giftedness. The described characteristics of gifted include ability to analyze, synthesize and evaluate newly acquired information and decontextualization skills in constructing solution to new problems. The recommended pull-out model for the child includes expanding experiences, establishing a social environment, cognitive apprenticeship, development of affect, cooperative groups and knowledge creation.

In three experiments Jausovec[61] (1996) studied the differences in EEG alpha Activity between 30 gifted and 30 average individuals. Higher alpha power during information processing displayed by gifted individuals was found to be derived from the non-use of many brain areas not required for the problems at hand.

Jones and Day[62] (1996) compared research findings on heightened cognitive flexibility in academically gifted children and similar flexibility in social intelligence. It was proposed that social-cognitive flexibility is an important component of social-intelligence and speculated that a relationship exist between social problem solving and social giftedness.

In a survey to examine educational aspirations and perception of school climate among gifted students at the Maine School of Science and Mathematics, Plucker et al.[63] (1996) found that high ability secondary students attending Magnet School have higher aspirations, than those of general-ability sample. It was also found that Magnet school students appear to perceive a school climate that is supportive and fosters achievement and aspirations to a greater extent than do general ability student attending traditional high schools.

Khire[64] (1997) developed an SOI model to differentiate between type of giftedness and the very highly gifted from the gifted. Greater variety of number of SOI factors as relevant to the type of giftedness is used as a variable of type of giftedness in the model. The levels of giftedness are identified based on composite of 13 SOI scores and intra-individual variation.

Zental et al.[65] (1997) investigated the different characteristics of three boys with giftedness and found that giftedness did confer specific benefits related to talent (free reading, mental mathematics, social skills, memory, creativity) and to liking specific subject areas.

In a study to explore the relationship between Mathematics and English achievement between Mathematics and verbal Self Concept by Zhang et al.[66] (1997) it was found that statistically significant difference exists in the correlation between Mathematics and verbal Self Concept.

High correlation were found to exist between mathematics Self Concept and verbal Self Concept for gifted than for non-gifted students.

Modi et al.[67] (1998) in a paper presented at the Annual Meeting of the American Educational Research Association reported that the amount of independent reading, enrollment in academic programs, high educational aspirations and time spent on home work are associated with academic talent.

In a study conducted by Freeman[68] (1999) on 24 musically precocious boys aged 10 to 14, it was found that all participants has had a crystallizing experience, defined as a dramatic event in a persons life that makes inherent giftedness manifest and that it had improved their Self Concept.

Norman et al.[69] (1999) compared the highly (N = 74) and moderately (N = 163) gifted adolescents on Self Concept, emotional autonomy and anxiety. Results indicated no significant difference on Self Concept and adjustment.

As the result of 25 years work on giftedness Renzulli[4] (1999) developed the school wide enrichment model (SEM), the over all mission of which is to escalate the level and quality of learning experiences for any and all students capable of manifesting high levels of performance in any and all areas of curriculum.

To have a comprehensive picture, the major findings of the studies reviewed are given in Table 1.

TABLE 1

Summary of the Major Findings of the Studies Reviewed

Sl. No.	Author	Year	Characteristics of Gifted children
1.	Terman	1965	Healthy, well-rounded, committed, responsible and likable
2.	Carrol	1940	High ability to see relation, make association and adapt abstract principles to concrete situations; originality, earlier development of self criticism, initiative, independence in thinking and superior in traits like desire to know, desire to excel and power to learn.
3.	Bristow, *et al.*	1951	High degree of insight into problem, ability to generalize, ability to do mental tasks at a high degree of difficulty and the ability to do abstract thinking.
4.	Cutts & Moseley	1959	Ability to make generalization, abstract thinking, insight into problems, reasoning, problem solving, speed of learning and completing intellectual tasks, creative ability, persistence, wide range of interests, memory and curiosity.
5.	Terman & Oden	1959	More interested in 'abstract' subjects than practical subjects, likes active games, play with tools and machinery, likes the companionship of others and shows no abnormal fondness for study or for solitude and more masculine nature than non-gifted at certain age level.
6.	Martinson	1961	Mathematically gifted children show unusual interest in number relations.
7.	DeHaan	1965	Motivation and ability are important determinant of achievement.
8.	Wilson	1965	General mental ability, interest in science and unusual understanding in the area.

9.	Silver blank	1970	Mathematically talented students are less sociable than talented students in English
10.	Dodson	1972	Mathematically gifted are strong in Mathematics, verbal and general reasoning, spatial reasoning, ability to identify critical elements and disregard irrelevant elements; divergent thinking low debilitating anxiety, high facilitating anxiety and a positive attitude towards Matheamtics.
11.	Hitchfied	1973	High intelligence, and divergent thinking, Mathematics and arts being the favorite subjects.
12.	Dunlap	1975	High ability to generalize, to see relationships, to make logical associations, a strong desire to excel and inaccurate in arithmetic.
13.	Hoyle & Wilks	1975	Superior powers of reasoning, of dealing with relations and imagination, and problem solving.
14.	L'Abate & Curtis	1975	Have superior abilities and learn at a faster pace and solve problems at a more mature level.
15.	Krutetskii	1976	Develop characteristics of an abiliy to generalize mathematical material, a flexibility of mental process easiest and economical ways to solve problems, remember generalized relation and reasoning schemes, curtailment of reasoning process and formation of mathematical perception of the environment.
16.	Kopelman *et al.*	1977	Stimulated by problem solving approaches to learning, able to induce, deduce and to connect related ideas and motivated toward learning and achieving in science.
17.	Vasantha	1978	Science interest is high for gifted boys than girls. They prefer occupations with science bias and creativity based occupations.

18.	Freeman	1979	High level of intellectual ability with extra ordinary good memories, concentration, lively creative activities, excellent school progress and a wide range of interests.
19.	Cropley	1981	Characterised by conventional abilities like good memory, logical thinking etc. and creative abilities like generating ideas, recognizing alternative possibilities etc.
20.	Consuegra	1982	Mathematically gifted students show propeurity towards quantitative relationships, use of numbers advanced mental abilities, unusual ability to solve mathematical problems and are capale of abstract thinking.
21.	Pratscher *et al.*	1982	Recommended to teach mathematics beyond the boundaries of the regular school day.
22.	Winnie *et al.*	1982	Better insight problem solving ability, and capable to spontaneously combine and integrate relevant data to solve problem.
23.	Sternberg & Davidson	1983	High academic self-esteem but not so in social and physical domains.
24.	Nicholls & Miller	1984	High achievement motivation.
25.	Sampat	1984	Profusely interested in reading on various subjects and intrested in radio programmes and movies.
26.	Stanley	1984	High motivation or 'academic hunger'.
27.	Van Tassel	1985	High academic Self Concept, well developed and diversigied interests.
28.	Whitmore	1985	Highly creative behaviour in producing ideas, things and solutions, aspiration of high standard of achievement and desire to excel.
29.	Zi-xiu	1985	Strong cognitive interests and intellectual curiosity, concentrated attention and good memory, keen perception and power of observation, quick thinking, good comprehension and creativity and confidence, competitiveness and persistence.

30.	Davidson	1986	Better insight problem solving ability.
31.	Walter & Gardner	1986	'Crystalizing experiences' dominated in music and prodigious achievement in Mathematics.
32.	Zha	1986	Curiosity, persistence and self-confidence.
33.	Barrington & Hendricks	1988	High attitude towards science.
34.	Miller	1990	Keen awareness and intense curiosity about numeric information, quick in learning, understanding and applying Mathematical ideas, abstract thinking, flexible, creative thinking of solving mathematical problem, transferring of learning to unfamiliar situation.
35.	Monson & Fukui	1991	Ability to manipulate abstract symbol system, generate original ideas, high level of planning, problem solving and abstract thinking.
36.	Muir & Coyle	1991	High analogy solving ability with more spontaneous, frequent and successful strategy.
37.	Corne'll *et al.*	1992	Relatively few differences in Self Concept between gifted student receiving 5 types of services - within regular classrooms, through pull-out resource rooms, ability grouping in separate classes, special schools or no programme offering.
38.	Lubinski & Humphreys	1992	Medical and physical wellbeing.
39.	Boyd	1993	High mathematical reasoning makes gifted boys out perform gifted girls.
40.	Fredette & Hunter	1993	High in ability, personality traits and creativity.
41.	Hoge & Renzulli	1993	Higher academic Self Concept.
42.	Pyryt	1993	Educational attainment, IQ and amount of acceleration as significant contributors to the discrimination of least and most successful men in the "Genetic studies of Genius."

43.	Schack	1993	Multi-age, multi-ability setting helped to develop linguistic and logical-mathematical creativity.
44.	Wilkinson	1993	Gifted students excel in complex reasoning but not different in sequential reasoning and visual-spatial perception.
45.	Caropreso & White	1994	High level performance in geometric analogy task.
46.	Gallaghes & De-Lisi	1994	Highly able girls in mathematics used conventional Problem Solving strategies and this is associated with negative mathematical attitude.
47.	Hunsaker	1994	Teachers consider creativity as the common characteristic of varied types of giftedness.
48.	Kranzler *et al.*	1994	Highly effective in higher-order cognitive process and have high speed and efficiency in lower-order cognitive processes.
49.	Williams & Mehtgomery	1994	Internal comparisons across academic areas and external ability comparisons relative to peess determines Self Concepts of academically able students.
50.	Shore *et al.*	1994	Gifted students not always out perform others on cognitive tasks.
51.	Cornell *et al.*	1995	Minority gifted students have high ahievement scores but not in academic or social self concept. White gifted students scored significantly higher than non-gifted on achievement and academic and social Self Concepts.
52.	Frasier *et al.*	1995	High in communication skills, imagination, creativity, humour, enquiry, insight, interests, memory, motivation, problem solving and reasoning.
53.	Hannath & Shore	1995	Use meta cognitive skills and knowledge.

54.	Lea-wood	1995	Non-gifted girls have high total and social self esteem than gifted girls (Self-esteam was measured using school form of Cooper Smith self-esteem Inventory).
55.	Luvisi	1995	High in self-esteem, creative thinking, critical thinking and problem solving skills.
56.	Diezmann & Watters	1996	Ability to analyze, synthesize and evaluate newly acquired information and decontextualisation skills in constructing solution to new problems.
57.	Jausovec	1996	Higher alpha power during information processing.
58.	Jones & Day	1996	Social problem solving.
59.	Plucker *et al.*	1996	Express high aspiration and perceive the school climate as supportive and fostering achievement and aspirations.
60.	Khire	1997	An SOI model was developed to identify the type of giftedness and the highly gifted from the gifted students.
61.	Zental *et al*	1997	Free reading, mental mathematics, social skills, memory creativity and like specific subject areas.
62.	Zhang *et al.*	1997	Mathematics and verbal Self Concept are highly related for gifted students.
63.	Modi *et al.*	1998	The amount of independent reading, enrollment in academic programs, high educational aspirations and time spent on home work are associated with academic talent.
64.	Freeman	1999	Self Concepts of musically precocious children were improved by their crytallizing experiences.
65.	Renzulli	1999	Developed school wide enrichment model (SEM) to escalate the level and quality of learning experiences of talented children.

Conclusion

Further review of the studies in the area of giftedness thus enabled the investigator to conclude that:

1. Most of the works done in the area of giftedness are western. Only very few studies are reported in the Indian context.

The Survey of Educational Research in India reports that the first study on giftedness in India was appeared only in the second half of 1960's. The education of gifted children is a neglected one and this may be because of the special cultural and economical background of the Indian population and the policies by the Government like universalization of education. Recently the picture has changed and enriching of gifted is the "Mantra" of educationists. The NPE[70] (1986) thus has stressed that with the large investment in education and the demand for talent and excellence for securing a quality of life, this condition can not be allowed to continue.

2. The area of Mathematical giftedness and the allied factors is less tackled one.

3. Theoretical and practical works on giftedness point out several characteristics of gifted children mainly of cognitive and affective nature.

In this context, the present study of Mathematical Giftedness and the contributing variables is a worthwhile one hoping that the results of the study will contribute much both to theory and practice in education.

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SOME PSYCHOLOGICAL VARIABLES CONTRIBUTING TO MATHEMATICAL GIFTEDNESS OF SECONDARY SCHOOL PUPILS OF KERALA

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CHAPTER III

METHODOLOGY

VARIABLES – OBJECTIVES – HYPOTHESES – TOOLS USED – SAMPLE SELECTION – DATA COLLECTION, SCORING AND CONSOLIDATION OF DATA – STATISTICAL TECHNIQUES USED FOR ANALYSIS

'Methodology of a study is the totality of the procedures followed by the investigator to make it scientific and valid to the extent possible. As such it is very crucial that the success of any research depends on the method adopted and the tools and techniques employed for data collection and analyses.

The decision of the method to be employed depends on the nature of the problem and the kind of data needed for its solution. The major objective of the present study is to find out the psychological variables, the presence or absence of which contribute significantly to mathematical giftedness. This suggest that the design of study is to be 'Ex Post Facto'. Ex Post Facto Research is a systematic, empirical inquiry in which the researcher does not manipulate any variable; the variables occur in the setting and the researcher attempts to determine the relationship and effects occurring between the variables.

The method followed for the study is described under the major headings viz.,

1. Variables
2. Objectives
3. Hypotheses

4. Tools used
5. Sample selection
6. Data collection, scoring and consolidation
7. Statistical Techniques used for analyses.

3. 1 VARIABLES

As the study is an 'Ex Post Facto' research, two types of variables, criterion and predictor variables are involved in the study. The major objective of the study is to findout the psychological variables, the presence or absence of which contribute to Mathematical giftedness and hence the study is designed with Mathematical giftedness as the criterion variable and a select set of psychological variables as predictor variables.

3. 1. 1. Criterion Variable

The criterion variable for the study is 'Mathematical Giftedness'of secondary school pupils. For the study 'Mathematical Giftedness' is assumed as having the presence of higher mathematical abilities and a good level of mathematical creativity. A student is considered as Mathematically Gifted if he/she secures 70 percent or above marks in the Test of Mathematical Abilities and a very high score (greater than $\overline{X} + \sigma$) in the Test of Mathematical Creativity.

3.1. 2. Predictor Variables

Theoretical as well as empirical literature in the area of giftedness suggests that certain psychological and non-psychological characteristics differentiate the gifted children from non-gifted. Some of such psychological characteristics according to educational investigators are Motivation, Self Concept, Anxiety, and Attitude. The non-psychological characteristics are physiological and environmental factors, not considered for the study.

In the present study the investigator selected the predictor variables as some prominent psychological characteristics of Mathematics domain which may contribute to Mathematical Giftedness.

The history of Mathematicians divulged that majority of them are men implying that Mathematics is a masculine subject. But Mathematics itself is delighted as the 'Queen of Sciences'. Again in the realm of human beings, those who have extraordinary capabilities show a different behaviour pattern in which they are concerned primarily with things within the self, with their own thoughts and feelings rather than with the external environment. Hence the investigator selected two other psychological constructs 'Introversion' and 'Masculinity' as predictor variables which can throw light into the existing belief with respect to Mathematical giftedness.

Thus the predictor variables selected for the study were

1. Problem Solving Ability in Mathematics
2. Abstract Reasoning
3. Achievement Motivation in Mathematics
4. Mathematics Interest
5. Attitude towards Mathematics
6. Self Concept in Mathematics

7. Mathematics Anxiety
8. Introversion and
9. Masculinity

3. 2. OBJECTIVES

The major objective of the study was "to find out the psychological variables, the presence or absence of which contribute significantly to Mathematical Giftedness". The objectives set forth, the testing or procedures implied in which will lead to the answering of the major objective are the following.

i. To compare Mathematically Gifted and Non-gifted pupils for each of the select psychological variables and to decide the variables for which the two groups significantly differ and hence may contribute to Mathematical Giftedness.

ii. To test whether Mathematical Giftedness is dependent on the select psychological variables so that the dependent predictor variables can be considered as the contributing variables.

iii. To test whether Mathematically Gifted and Non-gifted pupils can be significantly discriminated by a linear combination of the select psychological variables and to decide the relative importance of such variables as contributors to Mathematical Giftedness.

iv. To derive the psychological factor structures of Mathematically Gifted and Non-gifted pupils and to decide the contributing variables by the presence or absence of the variables having highly significant factor loadings in the factor with the highest percent of variance or eigen value.

v. To compare the psychological factor structures of Mathematically Gifted and Non-gifted pupils in terms of

   a) number of factors
   b) presence or absence of the variables in the factor and
   c) percent of variance accounted for by each factor

and to decide whether the factor structures of the two groups are different or not.

3. 3. HYPOTHESES

To bringout the theory in a vivid manner, any research work should highlight a testable educated guesswork which provide structure to the study. The clique of the present study is the hypothesis that 'each select predictor variable will be a significant contributor of Mathematical Giftedness.' This major hypothesis was tested by testing the following ones.

1. Mathematically Gifted and Non-gifted groups are significantly different in the case of each psychological variable selected.
2. Mathematical Giftedness is significantly dependent on each of the select psychological variables.
3. Mathematically Gifted and Non-gifted groups can be significantly discriminated by means of a single linear function of the select psychological variables.

4. The psychological factor structure of Mathematically Gifted and Non-gifted pupils are significantly different in terms of
   a) number of factors
   b) presence or absence of variables in the factor and
   c) percent of variance accounted for by each factor.

3.4. TOOLS USED

A broad spectrum of phenomena is often covered by researches in education and hence a variety of variables are to be measured. What is measured and how is measured are very specific to the study. The investigator has to take decision about the tools or devices to be used for measuring variables which is an important step in the conduct of the study.

For the present study, the data needed were collected using the tools listed below

1. Test of Mathematical Abilities (Sumangala & Malini, 1995)
2. Test of Mathematical Creativity (Sumangala, 1993)
3. Test of Abstract Reasoning (Sumangala & Malini, 1993)
4. Scale of Attitude towards Mathematics (Sumangala & Sunny, 1987)
5. Scale of Self Concept in Mathematics (Sumangala & Malini, 1993)
6. Scale of Mathematics Anxiety (Sumangala & Malini, 1993)
7. The Kerala Introversion - Extraversion Scale (Nair, 1976)
8. The Kerala Masculinity- Femininity Scale (Nair, 1979)
9. Test of problem Solving Ability in Mathematics
10. Scale of Achievement Motivation in Mathematics
11. Mathematics Interest Inventory

Each tool is described below for details like the variable it measures, general nature, mode of responding, scoring procedure and the psychometric properties like reliability and validity.

3. 4. 1. Test of Mathematical Abilities (Sumangala & Malini, 1995)

This test for secondary school pupils of Kerala was developed by Sumangala and Malini in 1995 conceiving Mathematical ability as a combination of five basic abilities in the working of Mathematical problems with ease and accuracy. The five abilities considered are Reversibility, Generalization, Curtailment, Flexibility and Information gathering. Each ability is measured by the test and the test has five subtests (each for each ability) with 62 questions altogether. The time limit for the whole test to answer is 60 minutes.

Eventhough the test contains five subtests the investigator used only four of these viz., I, II, III, and V. Subtest IV which measure flexibility of thinking while solving mathematical problems was eliminated as it is a major component of Mathematical Creativity which was measured using a separate tool,viz., 'Test of Mathematical Creativity', the component abilities measured being fluency, flexibility, and originality.

The select subtests are described below:

3. 4. 1. 1. Subtest I. Reversibility

This subtest is intended to measure the ability of the pupils to restructure the direction of a mental process. That is to change from a direct to a reverse train of thought.

There are 19 objective type test items under this subtest and the student has to respond to the items by writing the answers in the separate answersheet provided.

Sample item: If you get 2 when +9 is added to -7, what will you get when 9 is subtracted from 2 ?

3. 4. 1. 1. 1. Scoring procedure: As all the test items are of objective type the scoring scheme is, 'one score for every correct answer and zero score for every incorrect answer'.

3. 4. 1. 2. Subtest II. Generalization

This subtest is to measure the ability of pupils to make generalization from given particular cases. Under each item, three particular cases are given. Student is to understand the similarities and differences in the three cases provided and then write the generalized form.

There are 14 items in this test and all are objective type

Sample item: If $1^{o} = 1$, $2^{o} = 1$, $3^{o} = 1$, then n^{o} = ----

3. 4. 1. 2. 1. Scoring Procedure: The scoring scheme is 'one score for every correct answer and zero score for every incorrect answer'.

3. 4. 1. 3. Subtest III. Curtailment

Curtailment means the ability of shortening the Mathematical process in reaching the solution which can be recalled and explained in details upon request. Curtailment is a major construct of mathematical abilities as it reduces the normal time required for ordinary solution. To measure this, problems are given demanding solution by writing statements or steps where each statement indicates the mental process undergone. Subjects have to reach the solution by means of minimum number of steps possible by them. The less the number of steps for reaching the correct answer, the better is considered in the ability for curtailment.

There are seven items in this subtest.

Sample item: 1/a = 16, 1/b = 7. Find the value of (b-a)/ab.

3. 4. 1. 3. 1. Scoring Procedure: Scoring of this subtest is based on the number of steps used for solving the problem correctly. The scoring scheme is, 'One score for every reduced or curtailed step, if the answer is correct'.

3. 4. 1. 4. Subtest V Information gathering

The ability to discover the mathematical structure of a given problem is measured by this subtest. Two types of problems are used for this - problems with essential information missing and problems with super fluous information.

There are 15 items in this subtest. Each item (problem) is followed by four or five questions. Student is to respond to these questions. For this he has to analyse the problem and to recall many of the previously learned matters.

Sample item: If the side of a square is 4 cm and the length of its diagonal is $4\sqrt{2}$ cm. What will be the area of the square ?

Qns: a. What is the formula for finding the area of the square?

b. What are given in this problem for finding the area ?

c. In the given details, is there any unnecessary information for finding the area?

d. What is the area of the square?

3. 4. 1. 4. 1. Scoring Procedure: One score for each correct response of each question of a test item, so that the total possible score of a test item is four or five according to the number of questions in that item.

The test is presented as Appendix I.

3. 4. 1. 5. Reliability

Test - retest reliability coefficients estimated of the total test and of the subtests I, II, III, and V are 0.680, 0.510, 0.370, 0.470, and 0.340 respectively (N = 30 with a period of three weeks between administrations). This imply that the test is reasonably reliable.

The standard error of measurement of the test was calculated by the formula SEr = 0.432k , k being the number of items. SEr was found to be 3.400. This small value of SEr suggests that the test is reliable for measuring Mathematical Abilities.

3. 4. 1. 6. *Validity*

The test can be said to possess construct validity as it is developed based on theories of Mathematical Abilities described in Krutetskii's 'The Psychology of Mathematical Abilities in School Children'.

Construct validity of the test was examined empirically by setting two hypotheses viz.,

1. The measures of the test will be positively related to the measures of a standardized Achievement test in Mathematics.
2. The measures of the test will be positively related to measures of a standardized Aptitude test in Mathematics.

The hypotheses were found to be confirmed as the correlation coefficients obtained were 0.670 and 0.690 respectively which are high and significant at 0.01 level.

3. 4. 2. Test of Mathematical Creativity (Sumangala, 1993)

This test measures the extent of creative ability of secondary school pupils in solving Mathematical problems. It measures the ability of pupils to think originally and flexibly while learning and doing Mathematics. The working definition evolved in the development 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 stimulus situations. The test has seven such situations and is to be responded in 32 minutes.

Example of a test item: Write as many numbers as possible so that the sums of the digits is '7'.

Students are expected to write as many numbers as possible within the time limit prescribed for the item.

The test is given as Appendix II.

3. 4. 2. 1. Scoring procedure: Each test item and hence the test is to be scored for the three component abilities of creativity viz., fluency, flexibility, and originality. Each item of the test, therefore receive three scores and the sum of the three scores for all the items of the test is taken as the total creativity score of a subject.

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

Flexibility refers to the number of relevant categories in which the responses to an item falls (The nature of categories may vary from item to item). 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 based on differing degrees of uncommonness of the responses as shown in the Table 2.

TABLE 2

Scoring Scheme of Originality

Sl. No.	Grouping in terms of uncommonness of responses	Score
1.	Responses given by less than one percent in the sample	5
2.	Responses given by one to two percent in the sample	4
3.	Responses given by two to four percent in the sample	3
4.	Responses given by four to seven percent in the sample	2
5.	Responses given by seven to 12 percent in the sample	1
6.	Resonses given by more than 12 percent in the sample	0

3. 4. 2. 2. *Reliability*

Test - retest reliability of the test is 0.770 (N = 35) and Cronbach Alpha - coefficient of reliability is 0.765 (N = 100) which implies that the test is highly reliable.

3. 4. 2. 3. *Validity*

Validity of the test was estimated empirically by estimating its correlation coefficient with school examination marks in Mathematics as the external criterion. This coefficient was found to be 0.620 for N = 40. Hence the test has criterion validity.

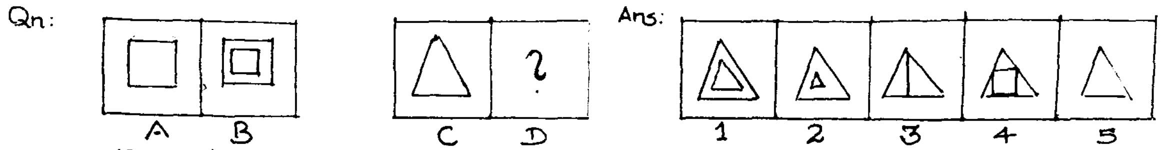
3. 4. 3. Test of Abstract Reasoning (Sumangala & Malini, 1993)

This test is a subtest of the 'Test of Mathematics Aptitude' developed and standardized by Sumangala and Malini (1993).

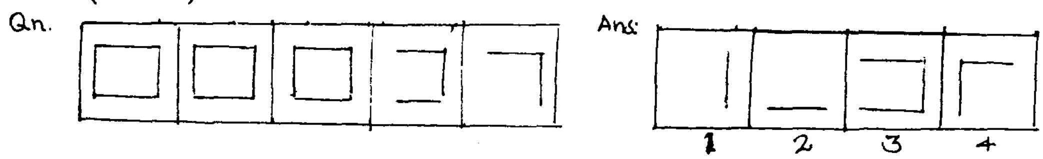
Test of Abstract Reasoning consists of three types of tests viz., Analogy, Series and Classification, which often forms part of intelligence testing. In these items, students are to find the answers by reasoning rather than by rote memory.

Example of items:

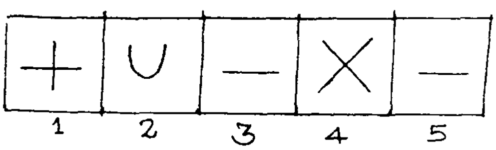
1. (Analogy)



2. (Series)



3. (Classification)



In the first type of items, that is in Analogy type, the subject has to select the correct pattern from the five choices given for the missing figure. In series type items the respondent has to select the next figure on the series, from the four choices given. In classification type, the subject has to identify the one that is different from other four.

The test includes 15 items, four on Analogy, five on Series and six on Classification. The time limit set for the test is eight minutes.

The test is presented as Appendix III.

3. 4. 3. 1. *Scoring procedure*

As all the items are of objective type the scoring scheme is to give one score for each correct answer and a zero score for an incorrect one.

3. 4. 3. 2. *Reliability*

Reliability of 'Test of Abstract Reasoning' was estimated by the investigator using test - retest method with an interval of three weeks between administrations. The reliability coefficient obtained is 0.733 (N = 40) suggesting that the test is a reliable one.

3. 4. 3. 3. *Validity*

The criterion related validity of the test 'Test of Abstract Reasoning' was established by the investigator by correlating the scores on the test with the scores on a standardized Achievement test in Mathematics. The validity coefficient obtained is 0.680 (N = 40) which shows that the test is valid.

3.4.4. Scale of Attitude towards Mathematics (Sumangala and Sunny, 1987)

This is a five-point Likert type attitude scale, having 30 items consisting of equal number of positive and negative statements. The items were prepared based on the following seven affective components of Mathematics.

i. Value of Mathematics in society
ii. Awareness of oneself in dealing with Mathematics
iii. Motivation in Mathematics
iv. Anxiety towards Mathematics
v. Perception of Mathematics teachers
vi. Enjoyment in Mathematics and
vii. Universalism of Mathematics

Example: Achievements due to the advancement of mathematics are beneficial to society.

The scale is presented as Appendix IV.

3. 4. 4. 1. Scoring procedure:

For a positive statement allot scores 5, 4, 3, 2 and 1 respectively to responses Strongly agree, Agree, Undecided, Disagree, and Strongly Disagree. For a negative statement, the scoring is in the reverse order. The total score on the scale is obtained by summing up the scores for all the statements.

3. 4. 4. 2. *Reliability*

Reliability coefficients of the scale, computed by test-retest method is 0.725. This suggests that the scale is highly reliable to measure the attitude of pupils towards Mathematics.

3. 4. 4. 3. *Validity*

In establishing the validity, the external criterion taken is the scores obtained in a standardized Achievement test with the assumption that Achievement and Attitude are correlated. The coefficient of correlation is 0.600, indicating that the scale is a valid one to measure the attitude towards Mathematics of secondary school pupils.

3.4.5. Scale of Self Concept in Mathematics (Sumangala and Malini, 1993).

The working definition set for the preparation of the scale is that Self Concept in Mathematics is one's estimation of himself/herself for his/her abilities and weakness as a student of Mathematics.

The scale is in the form of Likert's Attitude scale and consists of 24 statements - 18 positive and six negative.

Example: I always stand first in mathematics examinations.

The scale is given as Appendix V.

3. 4. 5. 1. *Scoring procedure:*

As each statement of the scale is to be responded in either of the five ways, viz., very much like this (A), like this (B), Uncertain (C), not like this (D), and not at all like this (E), the scoring scheme accepted for the scale is as follows. For positive statements assign scores 5, 4, 3, 2, and 1 and for negative statement assign scores 1, 2, 3, 4, and 5 to responses A, B, C, D, and E respectively. The sum of scores for all the statements is one's measure of Self Concept in Mathematics.

3. 4. 5. 2. *Reliability*

Reliability of the scale was established by both test - retest method and by Cronbach's alpha coefficient. The indices are respectively 0.823 (N = 35) and 0.812 (N = 100) which suggests that the scale is highly reliable.

3. 4. 5. 3. *Validity*

Construct validity of the scale was examined by setting hypotheses viz.,

i. The measures of the scale will discriminate significantly between groups like High - Achievers in Mathematics and Low - Achievers in Mathematics.

ii. The measures of the scale will be significantly and positively related to measures of the scale of Attitude towards Mathematics.

iii. The measures of the scale will be significantly and positively related to measures of Mathematics Aptitude.

On testing, using a sample of 30 students the values obtained are 37.362, 0.668 and 0.600 respectively which shows that the three hypotheses are confirmed.

The criterion related validity of the scale was established by correlating the scores of the scale with that of Kerala Self Concept Scale developed by Nair (1980). The validity coefficient obtained is 0.730 (N = 40).

3. 4. 6. Scale of Mathematics Anxiety (Sumangala and Malini, 1993)

This scale is in the form of a five point Likert type Attitude scale and 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 would possibly spur a student into working hard and hence improve his/her performance (Anxiety in this case is facilitating). If the apprehension is so intense that normal reasoning process is inhibited, then it is fear and hence debilitating anxiety.

This scale consists of 29 statements measuring both debilitating and facilitating anxiety. 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).

Example: I feel upset if I do not follow reading mathematics lessons.

The scale is presented as Appendix VI.

3. 4. 6. 1. Scoring Procedure:

For a debilitating anxiety item, the scores assigned are 5, 4, 3, 2 and 1 and for a facilitating anxiety item, scores assigned are 1, 2, 3, 4 and 5 for responses SA, A, U, D and SD respectively. The sum of the scores for all the statements gives the total score on the scale.

3. 4. 6. 2. Reliability

The test- retest reliability coefficient is 0.860 (N = 35). Reliability estimated by Cronbach's Alpha coefficient is 0.796 (N = 100).

3. 4. 6. 3. Validity

The statement of the scale were phrased in the least ambiguous way and hence wording of the statement will suggest that, the scale is a good measure of Mathematics Anxiety. So it can be said that the scale has face validity.

Construct validity of the scale was examined by testing the following hypotheses viz.,

i. The measure of the scale will discriminate significantly between high and low achievers in Mathematics.

ii. The measures of the scale will be negatively related to measures of the scale of Self Concept in Mathematics.

By testing, using a sample of 30 students the above two hypotheses were found confirmed. (t-value 38.207 and r = -0.632).

Validity of the scale was estimated empirically by comparing the scores on the scale with the scores of Kerala Examination Anxiety scale (Nair,1976), and by correlating with Achievement scores in Mathematics. The correlation coefficients obtained are 0.571 and -0.638 (N = 40) respectively.

3. 4. 7. The Kerala Introversion - Extraversion Scale (Nair, 1976)

The variable 'Introversion' was measured using the scale developed by Nair in 1976. The scale is based on the well known scales like 'Freyd - Heidbreders Introversion - Extraversion test, the Berneutes Personality Inventory, the Maudeley Personality Inventory, Mayers - Briggs Type Indicator etc.

The introverted behaviour is measured through behavioural patterns indicating thinking inwardly, reflectiveness, observant nature, meditativeness and philosophically inclined, being poised and serious minded, persistence and ability to control oneself. The extraversion dimension is measured through the presence of behaviour like interest in overt activity, mental disconcertedness, happy-go-lucky disposition and impulsive reactions.

The scale consists of 30 statements among which fifteen indicate introvert behaviour and the other fifteen items indicate extravert behaviour. Each statement can be responded in three ways Agree(A), Undecided (U), and Disagree (D).

Example of test items:

1) Very often you find yourself acting before thinking about what you are doing. (Extraversion)

2) You like to evaluate your past actions carefully (Introversion).

The scale is given as Appendix VII.

3. 4. 7. 1. Scoring procedure:

The scale can be scored either for introversion or for extraversion. For the present study, the scale is scored for 'introversion' by scoring the responses as given below:

Positive scoring (+1 for response of 'Agree') is given for an introversion item and negative scoring (-1 for an 'Agree' response) is given for an extraversion item.

3. 4. 7. 2. Reliability

The reliability of the scale was established by test-retest method. The test-retest reliability coefficient reported in the test manual is 0.810 for a sample of 105 students with an interval of one month.

Since the scale was developed few years back, the investigator estimated the reliability of the scale by test-retest method using a sample of 70 pupils, the interval between the two administrations being three weeks. Obtained value is 0.750 which implies that the scale is still reliable.

3. 4. 7. 3. Validity

The scale has construct validity as it was developed based on the models of the well-known personality scales of Introversion-Extraversion. The concurrent validity of the scale estimated against the 'extraversion scale' of the Bernreuter Personality Inventory is 0.730. Hence the scale is a valid one.

3. 4. 8. The Kerala Masculinity - Femininity Scale (Nair, 1979)

The psychological construct 'Masculinity - Femininity', a personality component, was measured using 'The Kerala Masculinity - Femininity Scale' prepared and standardized by Nair (1979). The scale is based on the items of some personality tests like Guilford - Zimmerman Temperament Survey, adapted for use in Indian culture.

The scale measures aspects like masculinity of emotions, interests, preferences, mode of reacting to familiar situations etc. The scale consists of thirty statements among which fifteen items indicate masculine behaviour and the remaining fifteen items indicate feminine behaviour. Each statement has three responses Agree(A), Undecided (U) and Disagree (D).

Example of items:

1) You don't mind sitting in a room full of disarranged things (Masculine).
2) The sight of blood always gives you a scare (Feminine).

The scale is given as Appendix VIII.

3. 4. 8. 1. Scoring procedure

The scale can be used to measure feminine as well as masculine traits depending upon the scoring scheme adopted. In the present study, the scale was scored for masculinity. Hence positive scoring (+1 for agree responses) is given for a masculine item and a negative scoring (-1 for agree response) is given for feminine items.

3. 4. 8. 2. Reliability

As reported in the test manual, the test - retest reliability coefficient of the scale is 0.830 (Using a sample of 115 secondary school pupils).

As the scale was prepared and standardised in seventies, the test-retest reliability of the scale was re-estimated by the present investigator on a sample of seventy secondary school pupils with an interval of three weeks. The reliability coefficient so obtained is 0.780 which indicates that the scale is satisfactorily reliable to the present population also.

3. 4. 8. 3. Validity

The scale has reasonable construct validity as it has been developed by adapting items of the established scale like Guilford-Zimmerman Temperament survey and considering the theoretical basis. Further, concurrent validity was ensured by correlating masculinity scores of the scale with that of the adapted version of the Masculinity scale of the Guilford - Zimmerman Temperament survey. The correlation coefficient obtained was 0.660for a group of eightyfive college students indicating that the tool is sufficiently valid to measure the trait Masculinity of secondary school pupils.

3. 4. 9. Test of Problem Solving Ability in Mathematics

This test was developed and standardized by the investigator together with the supervising teacher, to measure the 'Problem Solving ability in Mathematics' of secondary school pupils.

Problem solving ability in Mathematics is the ability to arrive at solutions which involve the use of Mathematics. To solve a problem, the student must draw upon previously learned piece of knowledge, skills and understandings in new situations.

Problem solving is a higher-order ability requiring abilities like Analysis, Synthesis, and Evaluation. It qualifies as the ultimate justification for teaching Mathematics, yet it is hardest to teach and often the most neglected part of the Mathematics curriculum. Knowledge, basic skills and understanding are important components of Mathematics learning, but ultimately a student learns Mathematics in order to solve a great variety of problems.

The standard definition of a 'Problem' given in the Webster's New Collegiate Dictionary[1] (1975) is 'a question raised for inquiry, consideration or solution .... a source of perplexity....' The working definition set for the preparation of the test is that a 'Problem' is a perplexing question which can often be attacked in several ways and can be solved using Mathematics.

'Perplexing' implies that the question is of some interest and that the student will accept it. If a reader is not interested in a problem, it is not perplexing. A problem is perplexing in relation to person and time.

The characteristics of a problem for a student are :

i. It is a question or a situation.
ii. It is accepted by the student.
iii. When a problem is presented, there is some challenge so that the solution is not immediate.
iv. Often there will be several different ways for students to attack the problem.

Problems in Mathematics include Insight problems, Work problems, Real life problems, Number theory problems, Age problems, Proofs, Motion problems and Abstract problems.

The draft test contains 35 items under three parts, Part I, Part II and Part III. Part I contains 25 multiple choice items, Part II five items as faulty proofs, and Part III contains five questions of descriptive type.

The draft test is given as Appendix IX.

3. 4. 9. 1. *Standardization of the tool*

Items for the final test were selected on the basis of items analysis. For this purpose, the draft test was administered to a sample of 100 secondary school pupils selected by stratified sampling method.

As the test is a power test, only discrimination power of the items was estimated and considered for the selection of items to Part I and Part II of the final test.

The discriminator power of each item under Part I and Part II was calculated using Ebel's formula, viz., Dp = (U-L)/N, where U is the number of correct responses in the upper group, L the number of correct responses in the Lower group and N the number of pupils in each group. The upper and Lower groups were identified using the 27 percent cut off to the scores of the Problem Solving Ability in Mathematics.

Eventhough 0.400 is the minimum index of satisfactory discrimination power, the investigator set the minimum as 0.285 to get desired number of test item in the final test.

Part III contains five descriptive type items and hence Pearson's 'r' was calculated for each test item with the total score of the test and hence this index was treated as the criteria for item selection to the final test. All items were selected for the final test, as the correlation coefficients obtained were highly significant (at 0.01 level).

The indices of discrimination power obtained for Part I and Part II and the correlation coefficients for Part III are presented as Appendix X.

The final test contains 26 items, 19 under Part I, two under Part II and five under Part III.

Example of test Items:

1. $2a + 2b + 5c = 9$ If $c=1$ what is $a+b+c$. (Part I)

   Ans.: A. 8 B. 4 C. 3 D. 2

2. i. $25-25=0$

   ii. $5-5 =0$

   iii. $25-25/5-5=0$

   iv. $5^2 - 5^2 / 5 - 5 = 0$

   v. $(5+5)(5-5) / 5 - 5 = 0$

   $5 + 5 = 0$

   i.e. $10 = 0$

   Find out the step at which error is committed first (Part II).

3. A man has one 5 litre and one 3 litre buckets. How can he take 7 litre of water correctly using the two buckets. (Part III)

The final test is furnished as Appendix XI.

3. 4. 9. 2. Scoring procedure

In part I the student has to select the correct answer from the four choices A, B, C, and D for each item. As all the items are of objective type the scoring scheme is, one score for each correct answer and zero score for every incorrect one, providing a maximum score of 19 under part I.

In part II, as the student has to detect the step at which mistake is taken place, the scoring scheme is, one score for each correct detection of error and zero score for every incorrect ones. The maximum score possible under this part is two.

As part III is of descriptive type, value points are predetermined to make the scoring objective and for each value point, one score is assigned giving a maximum score of 10 for part III.

The total score on the test of an individual is the sum of the scores obtained under part I, part II, and part III.

3. 4. 9. 3. *Reliability*

Reliability of the test was established by test-retest method on a sample of 40 students, the interval between administrations being three weeks. The reliability coefficient obtained is 0.760, indicating that the test is satisfactorily reliable.

3. 4. 9. 4. *Validity*

The test has construct validity as the component abilities and the test items are prepared on theoretical basis.

The criterion related validity of the test was estimated by correlating the scores of the test with the scores of the test of Mathematical Abilities. The correlation coefficient obtained is 0.580indicating that the test is valid.

3. 4. 10. Scale of Achievement Motivation in Mathematics

This scale is developed by the investigator together with supervising teacher, to measure the striving of secondary school pupils to attain expected goals by learning mathematics. The scale is a three point one prepared in the model of Scale of Achievement Motivation developed by Pillai and Salimkumar[2] (1995). The draft scale consists of 51 statements on seven constructs viz., Work ethic, Acquisitiveness, Dominance, Pursuit of excellence, Competitiveness, Status aspirations and Mastery.

Details of the constructs incorporated in the scale are as follows.

3. 4. 10. 1. Work ethic

Work ethic is considered as the desire to work hard and excel in Mathematics and is based on the reinforcement in the performance itself.

Example: I like to do Mathematical problems which others can not.

3. 4. 10. 2. Pursuit of excellence

Pursuit of excellence is the competition with a standard of excellence and is the reward obtained by making the best performance in Mathematics.

Example: I am satisfied by my excellence in Mathematics.

3. 4. 10. 3. *Status aspiration*

The desire to be a dominant member or leader among other students is incorporated under status aspiration. It is the reinforcement in climbing the social status hierarchy.

Example: Others should consider me as a model in Mathematics learning.

3. 4. 10. 4. *Competitiveness*

It is the satisfaction obtained while competing with others.

Example: I like to compete with students who are capable in Mathematics.

3. 4. 10. 5. *Acquisitiveness*

Motivation based on the reinforcing properties of position or possession attained by the individual is considered as acquisitiveness.

Example: I desire to be accepted in my mathematics class.

3. 4. 10. 6. *Mastery*

Mastery is the satisfaction obtained when succeeding in the study of difficult matters.

Example: I feel satisfaction when I am successful in completing difficult mathematical tasks.

3. 4. 10. 7. Dominance

It includes desire to lead or to take initiative or to become a dominant member of the group.

Example: I am the leader in all mathematical activities.

The draft scale is appended as Appendix XII.

3. 4. 10. 8. Scoring procedure

Students are to respond to the statements of the scale in any of the three ways viz., Always (A), Sometimes (B), and Never (C). For a positive statement the scores are three, two, and one and for a negative statement the scores to be assigned are one, two, and three respectively for responses Always (A), Sometimes (B), and Never (C).

3. 4. 10. 9. Standardization procedure

As part of Standardization, item analysis was done by calculating critical ratio (of two-tailed 't' test) for each statement, an index of the ability of the statement to discriminate between students of high achievement motivation in Mathematics and low achievement motivation in Mathematics.

For this, the scale was administered on a sample of 100 students, selected on the basis of stratified sampling technique. The score sheets were arranged in the ascending order of the total score and upper 27 percent of the sample was considered as the upper group and lower 27 percent as the lower group. Then critical ratio for mean difference was calculated for each statement.

The critical ratios obtained for statements are given as Appendix XIII.

Statements with critical ratios grater than 1.96 were selected for the final scale. The final scale comprises 42 statements among which 36 statements are positive and six are negative.

A copy of the final scale is given as Appendix XIV.

3. 4. 10. 10. Reliability

Reliability of the scale was established by test-retest method and the value obtained is 0.796 (N = 40 and the interval between administration is three weeks). As the scale is a three point one, Cronbach's Alpha coefficient was also estimated and the coefficient was found to be 0.833 (N = 52). These indices indicate that the scale is reasonably reliable.

3. 4. 10. 11. Validity

Since the statements of the scale are worded in the least ambiguous way, each of which highly resembles as a measure for achievement motivation in Mathematics, the scale can be said to have face validity.

The construct validity of the scale was examined by testing the hypothesis that the scores on the scale will be significantly related to the scores on the Test of Mathematics Achievement. When this hypothesis was tested, it was found that the hypothesis is confirmed (r = 0.721). Hence the scale has construct validity.

The scores of the scale was correlated with that of the scale of Achievement Motivation prepared and standardized by Pillai and Salimkumar and the correlation coefficients obtained is 0.657. Hence the scale has concurrent validity.

All these indices indicate that the scale is reasonably valid to measure Achievement Motivation in Mathematics.

3. 4. 11. Mathematics Interest Inventory

This inventory was developed by the investigator to measure secondary school pupil's interest in dealing with Mathematics as a subject of study. The inventory is patterned on the model of the well-known Kuder Preference Interest Inventory.

Each item of the inventory comprises of three activities, similar in nature, of which one is a mathematical activity (A,B and C). So that selection of a mathematical acivity, from the three, as their preference for working will reveal their interest in Mathematics.

The draft inventory contained 35 sets of activities and is given as Appendix XV.

3. 4. 11. 1. Scoring procedure

Each item in the inventory is presented in the form of a set of three activities, A, B, and C; of which one is a mathematical activity. The subject has to select the activity he/she likes the most to do. If the selected activity is related to Mathematics, give a score of 'one'; otherwise give a zero score.

3. 4. 11. 2. Standardization procedure

Item analysis was done as a part of the standardization procedure for which two tailed test of significance of mean difference ('t' value) was used.

The inventory was administered to 100 students selected using stratified sampling technique. Upper and lower groups were identified using the 27 percent cut off to the scores of the Mathematics interest. Then critical ratio was calculated for each item. Item with 't'-values grater than or equal to 2.576 were selected for the final inventory.

A list of the critical ratios obtained is given as Appendix XVI.

The final form of the inventory contain 32 sets of activities. A copy of the inventory is given as Appendix XVII.

3. 4. 11. 3. 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 0.761 which indicates that the inventory has considerable reliability.

3. 4. 11. 4. Validity

The inventory has face validity as the items are phrased in a way that the individual has to give his/her first preference among the three activities given. (Which are similar in nature, but one among them is related to Mathematics).

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

1. The measures of the inventory will be positively related to measures of the scale of attitude towards Mathematics.
2. The measures of the inventory will be positively related to measures of Mathematics Aptitude.
3. 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 obtained for the variable Mathematics Interest with Attitude towards Mathematics and Mathematics Aptitude are 0.581 and 0.456 respectively. These values show that the first two hypotheses are substantiated.

The critical ratio obtained for the mean score on Mathematics Interest for the members and non-members of Mathematics club is 4.450 which implies that the third hypothesis is also validated.'

Hence the inventory has construct validity and can be used to measure the interest in Mathematics of secondary school pupils.

3. 5. SAMPLE SELECTION

The results of any research study is supposed to have universal application for which the whole population has to be studied which is often impractical and impossible. The process of sampling makes it possible, with the help of inferential statistics, to draw valid inferences or generalisation on the basis of careful observation or measurement of variables with a relatively small proportion of the population.

For the present study, the population to be studied was secondary school pupils of Kerala, the size of which is very large to collect data from the whole population. Hence the investigator had to select a representative part of the population as sample for the conduct of study. As the representativeness of the sample determines the generalizability of the results, decision was to be made on the following aspects while selecting the sample.

3. 5. 1. Sampling Design

When the population is not homogeneous and consists of several strata, stratified sampling method is advised in which there is due representation to the different strata of the population. For the present study, the population consists of many subpopulations viz., girls, boys, rural students, urban students, private school students, Govt. school students etc. Hence the investigator selected the sample by stratified sampling method by considering only two strata of the population viz., sex of the students and locale of the schools.

3. 5. 2. Rationale for the selection of the two strata

3. 5. 2. 1. Sex of the subjects

Gender difference is often observed and reported in many of the psychological variables (Malini,[3] 1995; Jameela,[4] 1993; Tocci,[5] 1991, etc.). As the study is to identify the psychological factor structure of Mathematically Gifted and Non-gifted pupils, the investigator gave almost equal representation to boys and girls in the sample.

3. 5. 2. 2. Locale of the School

Often different performance in examination is noticed between rural and urban area schools. Since grater number of schools are in rural area compared to urban area, the investigator selected schools for the sample on the basis of locale in the ratio rural : urban = 3 : 1.

3. 5. 2. Size of the Sample

An important decision that has to be taken in adopting a sampling technique is about the size of the sample. The dependability of the parameters estimated is contingent upon the size of the sample on which the sampling error is also based. (As sample size increases, sampling error decreases).

For the present study the investigator decided to have a large sample of size 600 drawn from schools belonging to six districts of Kerala, with the hope that this sample will provide enough students who are gifted in Mathematics, for the study.

The break-up of the Basal sample is given in Table 3.

TABLE 3

Break-up of the Basal Sample

Locale	Sex of students		Total
	Boys	Girls	
Urban	100	50	150
Rural	200	250	450
Total	300	300	600

3. 6. DATA COLLECTION, SCORING AND CONSOLIDATION OF DATA

3. 6. 1. Data Collection Procedure

When the tools to be used and the sample for the study were decided; the investigator prepared a schedule for collecting data directly by herself. To make data collection easier and reliable the investigator sought co-operation of the concerned class teachers.

Prior to data collection enough copies of the different test-book lets and the respective response sheets were made. At the time of administration, all the subjects were informed of the nature of the tests and the purpose for which these were given. After looking into whether the subjects are seated comfortably, book-lets and reponse sheets were distributed one by one by the investigator.

As the tools are of different nature, the method of marking reponses are different and hence the investigator explained the procedure of marking responses for each tool, at the time of administration. The rules and procedure of responding was also strictly followed for each tool. All the test materials and response sheets were collected back after due time. A time gap of five to fifteen minutes was allowed between testing in order to avoid boredom of answering series of psychological tests.

3. 6. 2. Scoring and Consolidation of Data

The response sheets of all the tests were scored as per the scoring scheme of each tool. Incomplete answer sheets were primarily rejected and data that are complete in all respects only were considered for scoring and hence for final statistical analysis.

Rejection of incomplete cases resulted in the reduction of sample size to 564 and this comprised the final sample of the study.

The break-up of the final sample is given in Table 4.

TABLE 4

Break-up of the Final Sample

Locale	Sex of students		Total
	Boys	Girls	
Urban	97	35	132
Rural	148	284	432
Total	245	319	564

A detailed list of schools selected for the sample is given as Appendix XVIII.

After scoring the response sheets according to the scoring scheme of each tool, the scores of the 564 cases were consolidated so as to enable statistical analysis.

Mathematically Gifted students were identified from the total sample according to the criterion given below.

"A score of 70 percent or above (77 or above) in the test of Mathematical Abilities together with a high Mathematical Creativity score (greater than or equal to 121), the round score of $\overline{X}+\sigma$ of Mathematical Creativity. This resulted in a sample of 45 Mathematically gifted students and 519 non-gifted students.

3. 7. STATISTICAL TECHNIQUES USED FOR ANALYSIS

The statistical analysis of the data was done with the help of computer using SPSS/PC+ (Statistical Package for Social Sciences ver. 5.0.2). However, the techniques used for analysis are described below.

3. 7. 1. Two-tailed Test of Significance of Difference between Mean scores of Large Independent Samples (Garrett,[6] 1966)

To compare Mathematically Gifted with Non-gifted pupils for each of the select psychological variables, two tailed test of significance of difference between means was calculated using the formula

$$C.R = (M_1 - M_2)/(SE_{M1-M2})$$

Where $SE_{M1-M2} = \sqrt{(\sigma_1^2/N_1) + (\sigma_2^2/N_2)}$

M_1 and M_2 are group means; σ_1 and σ_2 standard deviations and N_1 and N_2 respective group size.

The mean difference is said to be significant depending upon whether the critical ratio exceeds $\pm$ 2.576 or $\pm$ 1.960 at 0.01 level and 0.05 level of significance respectively.

3. 7. 2. The Chi-square Test of Independence (Ferguson,[7] 1976)

Chi-square test of independence is a non-parametric technique to test whether two variables are dependent or not in cases when normality of the distributions of the variables are suspected and when the variables are nominal. The paired observation are arranged in contingency table with 'R' rows and 'C' columns.

Chi-square is calculated using the formula

$$\chi^2 = \sum (O-E)^2/E$$

where

O = Observed frequency

E = The expected frequency under the assumption of independence of the variables

The number of degrees of freedom associated with the value of χ^2 for an R X C contingency table is (R-1) (C-1).

The null hypothesis of "independence of variables" is accepted or rejected depending upon whether the calculated χ^2-value is less than or greater than the tabled value of χ^2 at a particular level of significance associated with (R-1) (C-1) degree of freedom.

3. 7. 2. 1. *The 'C' coefficient of contingency*

If two variables are found to be dependent on each other using the Chi-square test of independence the descriptive statistics 'C' coefficient of contingency is analogous to the correlation coefficient, to describe the degree of association. The formula for estimating 'C' is

$$C = \sqrt{(\chi^2/N+\chi^2)}$$

whereN-size of the sample,χ^2- the calculated value of chi-square

3. 7. 3. Discriminant Function Analysis (Tacq,[8] 1997)

To discriminate the population groups discriminant function analysis by direct method was used which involves mainly three steps.

Step-I: Prior classification of the sample into defined groups which are proposed to be discriminated.

Step-2: Analysis by means of the many discriminating characteristics which results in a function (in the case of two groups situation) which is a linear combination of the selected variables in the form of

$D = B_0 + B_1X_1 + B_2X_2 + \ldots\ldots. + B_rX_r$. where B's are the linear coefficients estimated from the data and $X_1, X_2, \ldots. X_r$ are the predictor variables used in the study.

Step-3: Testing the effectiveness of the discriminant function to discriminate groups and classification of new cases in to groups.

3. 7. 4. Principal Component Factor Analysis (Kim & Mueller,[9] 1978)

Given an array of correlation coefficients for a set of variables, factor analytic technique enable us to see whether some underlying pattern of relationships exists such that the data may be 'rearranged or 'reduced' to a smaller set of factors or components that may be taken as source variables accounting for the observed interrelations in the data.

In order to make a meaningful patterning of variables the factors obtained through Principal Component Analysis was undergone Varimax rotation.

The nature and content of the factors were identified using the following criteria:

i. Locate the group of variables on which the factor has the highest loadings
ii. Locate the group of variables on which the factor has the lowest loadings.
iii. Examine the possibility of different factors becoming independent.
iv. Treat factor loadings with absolute values graater than 0.4 as significant and other factor loadings as not significant.

v. Factor loadings above ± 0.900 - extremely high presence/absence of the variable.

vi. Factor loadings between ±0.800 and ±0.900 - very high presence/absence of the variable.

vii. Factor loadings between ±0.700 and ±0.800 - high presence/absence of the variable.

viii. Factor loadings between ±0.600 and ±0.700 - considerable presence/absence of the variable.

ix. Factor loadingsbetween ±0.500 and ±0.600 - the variable is present/absent to a low extent.

x. Factor loadings between ±0.400 and ±0.500 - slight or very low presence/absence of the variable.

xi. Factor loadings below ±0.400 - the variable is negligibly present/absent.

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SOME PSYCHOLOGICAL VARIABLES CONTRIBUTING TO MATHEMATICAL GIFTEDNESS OF SECONDARY SCHOOL PUPILS OF KERALA

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CHAPTER IV

ANALYSIS

PRELIMINARY ANALYSIS – IDENTIFICATION OF THE PSYCHOLOGICAL VARIABLES FOR WHICH GROUPS MG AND MNG SIGNIFICANTLY DIFFER – DEPENDENCY OF MATHEMATICAL GIFTEDNESS WITH THE SELECT PSYCHOLOGICAL VARIABLES – IDENTIFICATION OF THE COMBINATION OF PSYCHOLOGICAL VARIABLES FOR WHICH GROUPS MG AND MNG DIFFER – PSYCHOLOGICAL FACTOR STRUCTURE OF GROUPS MG AND MNG – SUMMARY OF FINDINGS – TENABILITY OF HYPOTHESES

The analysing techniques used are the mirror of the research problem, eventhough there is no one to one correspondence between the theoretical ideas and technical choices. The pragmatic decisions taken will bring the investigator from one technique to another. In the present study, the contributing psychological variables were identified by looking for,

i. the variables significantly discriminating between groups, Mathematically Gifted (MG) and Non-gifted (MNG).

ii. the variables having significant dependency with Mathematical Giftedness

iii. the linear discriminant function of variables which is capable of effective discrimination between groups MG and MNG and the variables that are major contributors to the function.

iv. the similarities and differences in the factor structures of groups MG and MNG and finding the variables having very high significant loadings in the dominant factors of group MG.

Details of the analyses and discussion of results are presented under the major headings viz.,

1. Preliminary analysis

2. Identification of the psychological variables for which Groups MG and MNG significantly differ.

3. Dependency of the select psychological variables with Mathematical Giftedness.

4. Identification of the linear combination of psychological variables for which groups MG and MNG differ.

5. Psychological factor structure of Groups MG and MNG and

6. Comparison of the factor structures of Groups MG and MNG.

4.1 PRELIMINARY ANALYSIS

4.1.1 The major purpose of the study was to find out the psychological variables that contribute to Mathematical Giftedness and the statistical analyses adopted for the study needed a classification of the total sample (N = 564) into two groups, MG and MNG. This was done based on the criteria of Mathematical Giftedness set for the study viz., the presence of high mathematical abilities (above 70 percent) and high mathematical creativity (above mean plus standard deviation).

To know how far is the representation of Gifted in the sample and of boys and girls in the groups of MG and MNG, the break-up of the subsamples MG and MNG is given as Table 5.

TABLE 5

Break-up of Groups MG and MNG based on Gender

Gender / Group	Boys	Girls	Total
MG	28 (62.222)	17 (37.778)	45 (7.979)
MNG	217 (41.811)	302 (58.189)	519 (92.021)
Total	245 (43.440)	319 (56.560)	564

Note: The number in the brackets indicate the respective percentages.

Table 5 shows that in the Group MG the number of boys exceeds that of girls suggesting that boys are more Mathematically Gifted than girls or proportion of Mathematically Gifted Girls is below that of boys. Similarly, among the group MNG, number of girls are more than that of boys which strengthens the belief that boys are superior in mathematical abilities and creativity than girls.

4.1.2. To know the nature of distributions of the select psychological variables, the investigator worked out the basic descriptive statistics like arithmetic mean, median, mode, standard deviation, skewness and kurtosis for total sample and for groups Mathematically Gifted (MG) and Non-gifted (MNG).

These statistics are presented in Table 6.

TABLE 6

Basic Descriptive Statistics of the Select Psychological Variables

Sl. No.	Predictor Variables	Total Sample (N = 564)						Group MG (N = 45)						Group MNG (N = 519)					
		Mean	Median	Mode	S.D.	Skew-ness	Kurto-sis	Mean	Median	Mode	S.D.	Skew-ness	Kurto-sis	Mean	Median	Mode	S.D.	Skew-ness	Kurto-sis
1.	Problem Solving Ability in Mathematics	9.415	9.000	9.000	4.936	0.892	0.836	17.333	18.000	18.000	4.317	0.547	1.076	8.728	8.000	9.000	4.357	0.865	1.028
2.	Abstract Reasoning	7.917	8.000	9.000	2.690	-0.093	-0.406	10.778	11.000	11.000	2.088	-0.193	-0.156	7.669	8.000	9.000	2.593	-0.116	-0.424
3.	Achievement Motivation in Mathematics	91.250	91.000	100.0	11.821	-0.725	3.742	99.156	98.000	98.000	4.522	1.844	3.682	90.565	91.000	91.000	12.010	-0.637	3.636
4.	Mathematics Interest	9.635	9.000	9.000	5.093	0.908	1.371	13.222	12.000	11.000	3.133	0.885	0.211	9.324	9.000	9.000	5.113	1.045	1.714
5.	Attitude towards Mathematics	112.151	113.000	116.000	15.240	-0.284	0.101	117.178	116.000	116.00	6.461	0.868	1.175	111.715	112.00	105.00	15.70	-0.220	-0.062
6.	Self Concept in Mathematics	76.933	77.000	72.000	13.537	-0.090	0.179	85.333	87.000	94.000	9.135	-0.378	-0.771	76.204	76.000	72.000	13.616	-0.017	0.242
7.	Mathematics Anxiety	83.729	85.000	86.000	14.910	-0.515	0.996	73.200	72.000	70.000	14.190	0.225	-0.090	84.642	86.000	89.000	14.631	-0.591	1.381
8.	Introversion	12.039	12.000	12.000	3.816	0.253	-0.203	12.684	12.000	12.000	4.481	0.202	-0.824	11.983	12.000	12.000	3.753	0.243	-0.138
9.	Masculinity	7.640	7.000	7.000	3.432	0.637	0.508	7.756	8.000	8.000	4.238	0.461	0.497	7.630	7.000	7.000	3.358	0.659	-0.456

4.1.2.1. Discussion of Results

The fundamental descriptive statistics presented in Table 6 reveals that for the total sample values of the three measures of central tendency (arithmetic mean, median and mode) are almost the same for the variables Problem Solving Ability in Mathematics, Abstract Reasoning, Mathematics Interest, Attitude towards Mathematics, Self Concept in Mathematics, Mathematics Anxiety, Introversion and Masculinity. For the variable Achievement Motivation in Mathematics the value of mode is slightly greater than of mean and median.

The indices of skewness are almost equal to zero for the variables Abstract Reasoning, Attitude towards Mathematics, Self Concept in Mathematics, Mathematics Anxiety and Introversion suggesting that the distributions of these variables are non-skewed for the total sample. The variables Problem Solving Ability in Mathematics, Achievement Motivation in Mathematics, Mathematics Interest and Masculinity have values of skewness slightly greater than zero indicating the distributions of these variables are slightly positively skewed.

Values of kurtosis for the variables Abstract Reasoning, Attitude towards Mathematics, Self Concept in Mathematics, Introversion and Masculinity are very nearer to zero which implies that the distributions of these variables are mesokurtic (the most acceptable measure of kurtosis $g_2 = (\mu_4/\mu_2^2) - 3$ gives zero value to a mesokurtic distribution).

The distribution of the variables Problem Solving Ability in Mathematics, Achievement Motivation in Mathematics, Mathematics

Interest and Mathematics Anxiety are slightly leptokurtic as the values of kurtosis are greater than zero.

Table 6 of the basic descriptive statistics again reveals that for the MG group, the values obtained of the three major measures of central tendency viz., arithmetic mean, median and mode are almost equal for all variables except for Self Concept in Mathematics (slight variation in the values occur for the variable Self Concept in Mathematics). This suggests the possibility of the distributions of the eight psychological variables to be normal for the group MG.

The values of skewness are almost equal to zero in the case of the variables viz., Problem Solving Ability in Mathematics, Abstract Reasoning, Self Concept in Mathematics, Mathematics Anxiety, Introversion and Masculinity, which suggest that the distribution of these variables are non-skewed. In the case of three variables, Achievement Motivation in Mathematics, Mathematics Interest and Attitude towards Mathematics, the values of skewness are slightly greater than zero indicating that the distributions of these three variables are slightly positively skewed.

Values of kurtosis, the measure of peakedness or flatness of the distribution, imply that distributions of Abstract Reasoning, Mathematics Interest, Self Concept in Mathematics, Mathematics Anxiety, Introversion and Masculinity are approximately mesokurtic as the indices of kurtosis of these variables are very nearer to zero. The distributions of Problem Solving Ability and Attitude towards Mathematics are slightly leptokurtic as the values of kurtosis of these variables are just greater than zero.

For the MNG group, the values of mean, median and mode are almost equal for all the psychological variables, suggesting the possibility of these variables to follow normality.

The values of skewness, an index of symmetry of the distribution about the mean, are very nearer to zero for the variables Problem Solving Ability in Mathematics, Abstract Reasoning, Achievement Motivation in Mathematics, Attitude towards Mathemtics, Self Concept in Mathematics, Mathematics Anxiety, Introversion and Masculinity. This suggests that the distributions of these variables are non-skewed. For the variable Mathematics Interest, the value of skewness obtained is 1.045 indicating that the distribution is slightly positively skewed.

The measures of kurtosis show that the distributions of the variables Abstract Reasoning, Attitude towards Mathematics, Self Concept in Mathematics, Introversion and Masculinity are mesokurtic as the magnitude of the obtained values of kurtosis appear to be almost equal to zero. The values of kurtosis for Problem Solving Ability in Mathematics, Achievement Motivation in Mathematics, Mathematics Interest and Mathematics Anxiety are slightly greater than zero and hence the distributions of these variables are slightly leptokurtic.

However, on the whole, it can be seen that the distributions of the select psychological variables do not depart markedly from normality for either total sample or for subgroups MG and MNG. For a large sample, a slight non normality of the population does not seriously affect the probabilities of acceptance or rejection of the hypothesis. The values of standard deviations of the variables for the two groups are almost equal which suggests the homogeneity of the variances in the population. This further suggested that parametric tests of significance can be applied for hypothesis testing.

4.2. IDENTIFICATION OF THE PSYCHOLOGICAL VARIABLES FOR WHICH GROUPS MG AND MNG SIGNIFICANTLY DIFFER

To compare Mathematically Gifted (MG) and Non-gifted (MNG) groups for each select psychological variable, and to find out the discriminating variables the technique used was two tailed test of significance of difference between mean scores for large independent samples' as this is the robust method for comparison of the performance of two independent groups.

The basic data for test of significance and the obtained critical ratios (t-ratios) are presented in Table 7.

TABLE 7

Test of Significance of Difference in Mean Scores of Psychological Variables between Mathematically Gifted and Non-gifted Pupils

Sl. No.	Psychological Variables (Predictors)	Groups: Mathematically Gifted (MG) (N = 45)		Groups: Mathematically Non-gifted (MNG) (N = 519)		Critical ratio (t-ratio)
		Mean	S.D.	Mean	S.D.	
1.	Problem Solving Ability in Mathematics	17.333	4.317	8.728	4.357	12.622**
2.	Abstract Reasoning	10.778	2.088	7.669	2.593	9.589**
3.	Achievement Motivation in Mathematics	99.156	4.522	90.565	12.010	9.024**
4.	Mathematics Interest	13.222	3.133	9.324	5.113	7.534**
5.	Attitude towards Mathematics	117.178	6.461	111.715	15.700	3.799**
6.	Self Concept in Mathematics	85.333	9.135	76.204	13.616	5.311**
7.	Mathematics Anxiety	73.200	14.190	84.642	14.631	-4.527**
8.	Introversion	12.684	4.481	11.983	3.753	0.695
9.	Masculinity	7.756	4.238	7.630	3.358	0.193

Note: ** $p \leq 0.01$.

4.2.1. Discussion of Results

From Table 7 it can be observed that the groups MG and MNG differ significantly (at 0.01 level) in the mean scores of the variables, i) Problem Solving Ability in Mathematics, ii) Abstract Reasoning, iii) Achievement Motivation in Mathematics, iv) Mathematics Interest, v) Attitude towards Mathematics, iv) Self Concept in Mathematics and vii) Mathematics Anxiety, as the critical ratios estimated for these variables are greater than 2.576, the minimum value required for significance at 0.01 level. This suggests that the mean scores of these variables obtained for groups MG and MNG are significantly different. This further suggests that the groups MG and MNG are significantly different for these variables and that these two groups cannot be considered as belonging to the same population in the case of these variables.

But at the same time, the critical ratios obtained for the two variables, Introversion and Masculinity are far below the cut off value required for significance even at 0.05 level (1.960). Hence in the case of these two variables, the mean scores of MG and MNG groups are not significantly different. This suggests that the groups MG and MNG can be considered as belonging to the same population for these two variables.

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

i. Problem Solving Ability in Mathematics (12.622).

ii. Achievement Motivation in Mathematics (9.589).

iii.	Abstract Reasoning	(9.024)
iv.	Mathematics Interest	(7.534)
v.	Self Concept in Mathematics	(5.311)
vi.	Mathematics Anxiety	(-4.527)
vii.	Attitude towards Mathematics	(3.799)

Even though sign of the critical ratios are immaterial in a non-directional test, the positive value of the critical ratio is indicative of the fact that Mathematically Gifted pupils have high mean scores in the compared variables and hence are higher in variables like, Problem Solving Ability in Mathematics, Abstract Reasoning, Achievement Motivation in Mathematics, Mathematics Interest, Attitude towards Mathematics and Self Concept in Mathematics.

The negative critical ratio in the case of Mathematics Anxiety indicates that Mathematically Gifted have less mean score and hence are lower in Mathematics Anxiety compared to Non-gifted.

4.2.2. Findings

(a) Groups MG and MNG differ significantly (at 0.01 level) in the mean scores of the following variables with preference to group MG in all the variables except of Mathematics Anxiety.

- (i) Problem Solving Ability in Mathematics
- (ii) Abstract Reasoning
- (iii) Achievement Motivation in Mathematics
- (iv) Mathematics Interest
- (v) Attitude towards Mathematics

(vi) Self Concept in Mathematics and

(vii) Mathematics Anxiety

Hence the two groups can be considered as belonging to different populations for these variables.

(b) Mathematics Anxiety of Mathematically Gifted pupils are significantly lower than that of Non-gifted.

(c) The two groups do not differ significantly in the case of the variables Introversion and Masculinity, which imply that the two groups are identical in these variables.

4.3. DEPENDENCY OF MATHEMATICAL GIFTEDNESS WITH THE SELECT PSYCHOLOGICAL VARIABLES

To test whether Mathematical Giftedness 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 Giftedness and each of the psychological variables under consideration are independent.

In order to calculate χ^2-values for the dependency of the nine psychological variables with Mathematical Giftedness, data was arranged in the form of nine 2x2 contingency tables (each in the case of each psychological variable). For this, each psychological variable was categorised into two groups High- and Low- using median as the cut off point. In all the nine cases, Mathematically Gifted (MG) and Non-gifted

(MNG) groups worked as the two categories of the variable Mathematical Giftedness.

The contingency tables prepared are given as Appendix XIX.

The χ^2 values estimated are presented in Table 8.

TABLE 8

Chi-square values and the 'c' coefficients calculated for the dependency of the Psychological Variables with Mathematical Giftedness

Sl. No.	Psychological Variables	χ^2 Value	'C' coefficient
1.	Problem Solving Ability in Mathematics	75.897**	0.344
2.	Abstract Reasoning	37.191**	0.249
3.	Achievement Motivation in Mathematics	49.600**	0.284
4.	Mathematics Interest	46.312**	0.275
5.	Attitude towards Mathematics	15.482**	0.163
6.	Self Concept in Mathematics	22.634**	0.196
7.	Mathematics Anxiety	21.128**	0.190
8.	Introversion	0.011	--
9.	Masculinity	1.382	--

Note: ** $p \leq 0.01$.

Whenever a χ^2 value indicated significant dependency of Mathematical Giftedness with the psychological variable against one degree of freedom, 'C' coefficient of contingency was estimated to know the extent of relation or dependency of the variables. The so estimated 'C' coefficients are also presented in Table 8.

4.3.1. Discussion of Results

4.3.1.1. The values of χ^2 obtained for the variable Problem Solving Ability in Mathematics with Mathematical Giftedness is 75.897 (Table 8) which far exceeds 6.640, the tabled value of χ^2 for one degree of freedom and at 0.01 level of significance. This results in the rejection of the null hypothesis "Problem Solving Ability in Mathematics and Mathematical Giftedness are independent" which in turn implies the significant association of the two variables. That is Problem Solving Ability in Mathematics and Mathematical Giftedness are significantly related or associated.

As the relationship 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 0.344 (Table 8). The maximum value of 'c' for a 2x2 contingency table being 0.707, the 'C' coefficient of 0.344 indicates that the relationship between Problem Solving Ablity in Mathematics and Mathematical Giftedness is not only significant but moderate also.

4.3.1.2 For the variable Abstract Reasoning, the χ^2-value obtained is 37.191 which is highly greater than 6.640, the tabled value of χ^2 at 0.01 level of significance and for one degree of freedom. This suggests significant association of the variable Abstract Reasoning with Mathematical Giftedness.

'C' coefficient, the index of the extent of association between the variables, was found as 0.249 indicating a low relationship between the variables Abstract Reasoning and Mathematical Giftedness.

4.3.1.3. The χ^2 value obtained for the variable Achievement Motivation in Mathematics is 49.600. This value is highly greater than the required value of χ^2 (6.640) for significance at 0.01 level and for one degree of freedom. This suggests that the relationship between the variables, Achievement Motivation in Mathematics and Mathematical Giftedness is significant at 0.01 level. That is Mathematical Giftedness is significantly dependent on Achievement Motivation in Mathematics.

'C' coefficient calculated to find the extent of dependency is 0.284 indicating a low relationship between the variables.

4.3.1.4. The χ^2-value calculated for the variable Mathematics Interest is 46.312 which is far greater than 6.640, the χ^2-value needed for significance at 0.01 level associated with one degree of freedom. This implies that the variable Mathematical Giftedness is significantly associated with Mathematics Interest.

The 'C' coefficient calculated to know the extent of association between the variables is 0.275 indicating the relation between the variables to be low.

4.3.1.5. Mathematical Giftedness have significant association with Attitude towards Mathematics as the χ^2-value (15.482) is greater than the needed vlaue of χ^2 (6.640) for one degree of freedom, the level of significance being '1' percent.

The 'C' coefficient obtained in this respect is 0.163 which indicates a very low but significant relationship between the variables.

4.3.1.6. When the null hypothesis "Self Concept in Mathematics and Mathematical Giftedness are independent" was tested for significance at 0.01 level, the χ^2-value obtained was found as 22.634 which is greater than 6.640, the χ^2-value needed for significance at 0.01 level for 'one' degree of freedom. This suggests the rejection of the null hypothesis that Mathematical Giftedness is independent of Self Concept in Mathematics.

The 'C' coefficient obtained is 0.196 indicating a very low relationship between the variables Self Concept in Mathematics and Mathematical Giftedness.

4.3.1.7. For the variable Mathematics Anxiety, the χ^2-value obtained is 21.128, which is greater than 6.640, the value needed for significance at 0.01 level associated with one degree of freedom. This suggests the significant association of Mathematics Anxiety with Mathematical Giftedness.

The 'C' coefficient obtained is 0.190 which is indicative of very low relationship. This suggests that eventhough the association between the two variables is very low, it is significant at 0.01 level.

4.3.1.8. The χ^2-value obtained for the variable introversion is 0.011 associated with one degree of freedom. This value is far behind the tabled value of χ^2 at 0.05 level (3.840). This suggests that there is no ground to reject the null hypothesis that the two variables, Introversion and Mathematical Giftedness are independent. That is Mathematical Giftedness is independent of Introversion.

4.3.1.9. The variable Masculinity is not significantly associated with Mathematical Giftedness as the χ^2-value obtained is 1.382, which is less than 3.840, the needed value of χ^2 for significance at 0.05 level associated with one degree of freedom.

4.3.2. Findings

Mathematical Giftedness is found to have significant association with the variables Problem Solving Ability in Mathematics, Abstract Reasoning, Achievement Motivation in Mathematics, Mathematics Interest, Attitude towards Mathematics, Self Concept in Mathematics and Mathematics Anxiety. The variables Introversion and Masculinity are not significantly associated with Mathematical Giftedness. The variables in the order of the extent of relationship are presented below:

i.	Problem Solving Ability in Mathematics	(0.344)
ii.	Achievement Motivation in Mathematics	(0.284)
iii.	Mathematics Interest	(0.275)
iv.	Abstract Reasoning	(0.249)
v.	Self Concept in Mathematics	(0.196)
vi.	Mathematics Anxiety	(0.190)
vii.	Attitude towards Mathematics	(0.163)

4.4. IDENTIFICATION OF THE COMBINATION OF PSYCHOLOGICAL VARIABLES FOR WHICH GROUPS MG AND MNG DIFFER

Discriminant function analysis (Direct method - computer analysis) was done in the study to identify the combination of variables for which the groups Mathematically Gifted and Non-gifted (Groups MG and MNG) differ and thereby to develop a function for predicting group membership of new cases whose group membership is undetermined.

4.4.1. Analysis of Group Difference

As a preliminary step to discriminant function analysis, difference between groups MG and MNG were examined by estimating Wilk's Lambda and the F-value for each variable. (Even though the same was done by means of two tailed 't'-test, in Section 4.2).

The preliminary data for this viz., means and standard deviations of the two groups MG and MNG and of the total sample and the estimated Wilk's Lambdas and the respective F-values are presented in Table 9.

TABLE 9

Univariate Statistics of Predictor Variables

Sl. No.	Predictor Variables	Group MG		Group MNG		Total Sample		Wilk's Lamda (λ)	F-Value
		Mean	S.D.	Mean	S.D.	Mean	S.D.		
1.	Problem Solving Ability in Mathematics	17.333	4.317	8.728	4.357	9.415	4.936	0.776	161.8**
2.	Abstract Reasoning	10.778	2.088	7.669	2.593	7.917	2.690	0.901	61.22**
3.	Achievement Motivation in Mathematics	99.156	4.522	90.565	12.010	91.250	11.821	0.961	22.720**
4.	Mathematics Interest	13.222	3.133	9.324	5.113	9.635	5.093	0.957	25.320**
5.	Attitude towards Mathematics	117.178	6.461	111.715	15.700	112.151	15.240	0.990	5.362*
6.	Self Concept in Mathematics	85.333	9.135	76.204	13.616	76.933	13.537	0.966	19.450**
7.	Mathematics Anxiety	73.200	14.190	84.642	14.631	83.729	14.910	0.956	25.440**
8.	Introversion	12.689	4.481	11.983	3.753	12.039	3.816	0.997	1.419
9.	Masculinity	7.755	4.238	7.630	3.358	7.640	3.432	0.999	0.055

Note: ** $p \leq 0.01$; * $p \leq 0.05$.

4.4.1.1. Discussion of results

A comparison of the group means of the predictor variables for Groups MG and MNG (Table 9) suggests that Group MG has higher mean scores than Group MNG for seven out of nine variables viz.,

i. Problem Solving Ability in Mathematics
ii. Abstract Reasoning
iii. Achievement Motivation in Mathematics
iv. Mathematics Interest
v. Attitude towards Mathemtics
vi. Self Concept in Mathematics and
vii. Introversion.

In the case of Mathematics Anxiety, the mean score of MG group is less than that of MNG Group suggesting that Group MG has comparatively less Mathematics Anxiety than Group MNG. The mean scores of Groups MG and MNG are almost equal for the variable Masculinity (7.755 and 7.630 respectively).

When tested for significance using the univariate statistic Wilk's Lambda, the value of Lambda obtained for the variable Problem Solving Ability is 0.776 suggesting a significant difference in the mean scores of the two groups. But the values of Wilk's Lambda for the remaining eight variables Abstract Reasoning, Achievement Motivation in Mathematics, Mathematics Interest, Attitude towards Mathematics, Self Concept in Mathematics, Mathematics Anxiety, Introversion and Masculinity are almost equal to '1' suggesting that the two groups do not differ in the mean scores of these variables.

But when the mean difference was tested for significance using F-test, the value obtained for (1,562) degrees of freedom indicate significant difference in the mean scores of Problem Solving Ability in Mathematics, Abstract Reasoning, Achievement Motivation in Mathematics, Mathematics Interest, Self Concept in Mathematics and Mathematics Anxiety at 0.01 level of significance and for the variable Attitude towards Mathematics, significant difference in mean scores exist at 0.05 level for (1,562) degrees of freedom. This suggests that Mathematically Gifted pupils differ significantly from the Non-gifted in the mean scores of all these seven variables.

It was also found from the F-values that the two groups MG and MNG do not differ significantly in the mean scores of the variables Introversion and Masculinity as the obtained F-values (1.419 and 0.055 respectively) are less than 3.850, the tabled value of F for (1,562) df and at 0.05 level of significance.

Even though Wilk's Lamda indicate a significant mean difference between groups MG and MNG in the case of Problem Solving Ability in Mathematics only, the F-values obtained suggest that the two groups MG and MNG are significantly different in the mean scores of the following seven predictor variables.

i. Problem Solving Ability in Mathematics.

ii. Abstract Reasoning

iii. Achievement Motivation in Mathematics

iv. Mathematics Interest

v. Attitude towards Mathematics

vi. Self Concept in Mathematics and

vii. Mathematics Anxiety

Hence the null hypothesis that all group means are equal is rejected by the F-test.

This findings by the F-test is in par with the findings obtained by 't' test described under Section 4.2.

4.4.2. Interdependencies among the Predictor Variables

Since interdependencies among the variables affect most multivariate analyses, it is worth examining the correlation matrix of the predictor variables. Hence a pooled correlation matrix, obtained by averaging the two separate correlation matrices for the two groups MG and MNG was estimated and is presented as Table 10.

TABLE 10

Pooled Within-groups correlation Matrix of the Psychological Variables

Sl. No.	Psychological variables	1	2	3	4	5	6	7	8	9
1.	Problem Solving Ability in Mathematics	1	0.411	0.149	0.098	0.188	0.097	-0.182	0.079	0.073
2.	Abstract Reasoning		1	0.205	0.149	0.366	0.181	-0.117	0.105	0.049
3.	Achievement Motivation in Mathematics			1	0.332	0.366	0.462	-0.282	0.235	-0.102
4.	Mathematics Interest				1	0.265	0.367	-0.218	0.087	-0.108
5.	Attitude towards Mathematics					1	0.431	-0.347	0.235	-0.057
6.	Self Concept in Mathematics						1	0.336	0.221	-0.042
7.	Mathematics Anxiety							1	-0.149	-0.073
8.	Introversuion								1	0.073
19.	Masculinity									

4.4.2.1. Discussion of results

Table 10 reveals that the value of correlation coefficients (r's) range from 0.042 to 0.462, with r's greater than 0.400 in three cases only. Since low relationships were observed for majority of the variables indicating not much interdependencies, the relative importance of the variables in discriminating the two groups MG and MNG were assessed by discriminant function analysis.

4.4.3. Discriminant Function

For the discriminant function derived by the discriminant analysis which serves as the basis for classification of the population into groups MG and MNG to be 'optimal' (minimizing the probability of misclassification) two assumptions about the data must be met. These are:

i. Each group must be a sample from a multivariate normal population.

ii. The population covariance matrices of the groups must all be equal.

The normality of each predictor variable is a necessary condition for multivariate normality of the population and this was verified in section 4.1.2. This analysis showed that the distribution of the predictor psychological variables do not deviate markedly from normality.

To test the equality of the group covariance matrices, Box's M test was done which is based on the determinants of the group covariance matrices. The values of Box's M test are presented in Table 11.

TABLE 11

Statistics for Testing Equality of Group Covariance Matrices

Group	Rank	Log determinant
MG	9	26.153
MNG	9	32.864
Pooled within group Covariance Matrix	9	32.696
Box's M 201.160	Approximate F 4.139**	Degrees of Freedom [45, 19221.8]

Note: ** $p \leq 0.01$.

Table 11 shows that the obtained value of F is 4.139 which is greater than 1.750 the F-value required for significance at 0.01 level for (45, 19221.8) degrees of freedom indicating slight dissimilarity of the group covariance matrices. The small value of F and the small difference between obtained and tabled F's suggests that the found difference in the covariance matrices of the groups may be due to the sensitivity of the test. Even though the two assumptions were found as not perfectly satisfied, the investigator proceeded with the discriminant analysis.

By discriminant function analysis (computer estimation) a linear combination of the predictor variables was formed which serves as the basis for assigning cases to groups MG and MNG. The so worked out unstandardized and standardized canonical discriminant function coefficients are presented in Table 12.

TABLE 12

Unstandardised and Standardised Canonical Discriminant Function Coefficients

Sl. No.	Predictor Variables	Unstandardised coefficient	Standardised coefficients
1.	Problem Solving Ability in Mathematics	0.179	0.786
2.	Abstract Reasoning	0.091	0.234
3.	Achievement Motivation in Mathematics	0.008	0.096
4.	Mathematics Interest	0.039	0.192
5.	Attitude towards Mathematics	-0.017	-0.264
6.	Self Concept in Mathematics	0.011	0.141
7.	Mathematics Anxiety	-0.012	-0.172
8.	Introversion	-0.008	-0.032
9.	Masculinity	-0.014	-0.047
	Constant	-1.225	--

4.4.3.1. Discussion of results

The linear discriminant equation formed on the basis of unstandardised discriminant function coefficients is

$$
\begin{aligned}
D = {} & 0.179\,X_1 + 0.091\,X_2 + 0.008\,X_3 + 0.039\,X_4 + \\
& -\,0.017\,X_5 + 0.011\,X_6 + -0.012\,X_7 + -0.008\,X_8 + \\
& -\,0.014\,X_9 + -1.225
\end{aligned}
$$

where X_1, X_2, X_3, ..., X_9 are the individual's scores obtained for the nine predictor variables.

Using the standardised discriminant function coefficients, the discriminant function is

$$D = 0.786\,Z_1 + 0.234\,Z_2 + 0.096\,Z_3 + 0.192\,Z_4 + -0.264\,Z_5 + 0.141\,Z_6 + -0.172\,Z_7 + -0.032Z_8 + -0.047\,Z_9$$

where Z_1, Z_2, Z_3, ... Z_9 are the standard scores of the predictor variables X_1, X_2, X_3, ... X_9 respectively.

The magnitude of the standardised coefficients given in Table 12 reveals that the variable Problem Solving Ability in Mathematics (0.786) is the most capable and Introversion (-0.032) is the least capable variable in discriminating the groups MG and MNG.

The variables in the order of their relative ability in discriminating between groups MG and MNG are listed below.

i.	Problem Solving Ability in Mathematics	(0.786)
ii.	Attitude towards Mathematics	(-0.264)
iii.	Abstract Reasoning	(0.234)
iv.	Mathematics Interest	(0.192)
v.	Mathematics Anxiety	(-0.172)
vi.	Self Concept in Mathematics	(0.141)
vii.	Achievement Motivation in Mathematics	(0.096)
viii.	Masculinity	(-0.047)
ix.	Introversion	(-0.032)

The sign of the coefficients indicate which variable values result in large or small discriminant function values. From Table 12 it can be observed that the sign of the standardised coefficients of the following variables are positive.

Problem Solving Ability in Mathematics

Abstract Reasoning

Achievement Motivation in Mathematics

Mathematics Interest and

Self Concept in Mathematics

The positive coefficients indicate that high values of these variables result in high function values. At the same time, the sign of the coefficients for the variables, Attitude towards Mathematics, Mathematics Anxiety, Introversion and Masculinity are negative implying that the high values of these variables may make function value small.

4.4.3.2. *Findings*

The standardised canonical discriminant coefficients suggested the relative importance of each variable in predicting group membership and the variables in the order of importance of prediction are,

i) Problem Solving Ability in Mathematics
ii) Attitude towards Mathematics
iii) Abstract Reasoning
iv) Mathematics Interest
v) Mathematics Anxiety

vi) Self Concept in Mathematics

vii) Achievement Motivation in Mathematics

viii) Masculinity and

ix) Introversion

4.4.4. Correlation between Discriminating Variables and Canonical Discriminant Function

The contribution of a variable to the discriminant function was examined by estimating correlation between the values of the function and the values of each variable. The so estimated pooled within-groups correlations between discriminating variables and canonical discriminant functions in the order of magnitude of correlations are presented in Table 13.

TABLE 13

Pooled Within-groups correlation between Predictor Variables and Canonical Discriminant Function

Sl. No.	Discriminating Variables	Correlation coefficients
1.	Problem Solving Ability in Mathematics	0.904
2.	Abstract Reasoning	0.556
3.	Mathematics Anxiety	-0.358
4.	Mathematics Interest	0.357
5.	Achievement Motivation	0.339
6.	Self Concept in Mathematics	0.313
7.	Attitude towards Mathematics	0.165
8.	Introversion	0.085
9.	Masculinity	0.017

4.4.4.1. Discussion of results

Table 13 shows that among the nine predictor variables used, seven are significant contributors on the function. That is, the seven variables load highly with the function. The seven variables are,

Problem Solving Ability in Mathematics

Abstract Reasoning

Achievement Motivation in Mathematics

Mathematics Interest

Attitude towards Mathematics

Self Concept in Mathematics

Mathematics Anxiety

This suggests that these seven variables are highly capable of discriminating between the groups MG and MNG.

The remaining two variables, viz., Introversion and Masculinity have comparatively low loading with the function and hence these variables may be poor in discriminating the Groups MG and MNG.

Table 13 reveals that the sign of coefficient of correlation is negative in the case of Mathematics Anxiety implying that absence of Mathematics Anxiety will result in larger values of the function and hence to Mathematical Giftedness.

4.4.4.2. Findings

The following variables were found to have high capacity to discriminate between Mathematically Gifted and Non-gifted groups and hence these are the major psychological predictor variables contributing to Mathematical Giftedness.

i. Problem Solving Ability in Mathematics
ii. Abstract Reasoning
iii. Achievement Motivation in Mathematics
iv. Mathematics Interest
v. Attitude towards Mathematics
vi. Self Concept in Mathematics and
vii. Mathematics Anxiety

The variables that are poor in discriminating the two groups are

i. Introversion and

ii. Masculinity

4.4.5. Significance of the Discriminant Function

The eigen value, an indicator of the effectiveness of the function, percent of variance,cumulative percent, canonical correlation which is a measure of the degree of association between the discriminant scores and the groups, Wilk's Lamda (λ) and Chi-square value, the related discriminant statistics which are the indicatives of the significance of the function are presented in Table 14.

TABLE 14

Statistical Indicators of Significance of the Discriminant Function

Function	Eigen value	Percent of Variance	Cumulative percent	Canonical correlation	Wilk's Lambda (λ)	Chi-square	Degrees of freedom
1	0.353	100	100	0.511	0.739	168.342**	9

Note: ** $p \leq 0.01$.

4.4.5.1. Discussion of Results

From Table 14 it can be observed that the eigen value of the function is 0.353 indicating the function derived is an effective one.

As the number of groups is two, the percent of variance and the cumulative percent are 100.

The value of canonical correlation (0.511) indicates that the discriminant scores and the group variable are substantially related.

Wilks' Lamda (λ) obtained is 0.739. The null hypothesis that the population means are equal was tested by transforming Wilks' Lamda to a Chi-square and the corresponding χ^2-value for 9 degrees of freedom is 168.342. This value is greater than 21.670, the tabled value of Chi-square at 0.01 level associated with nine degrees of freedom. This shows that the mean discriminant scores of the two groups MG and MNG are significantly different and that the discriminant function is significant enough to distinguish between the two groups.

4.4.5.2. Findings

The eigen value, Wilks' Lamda and the corresponding Chi-square value suggest that the mean discriminant scores of the two groups Mathematically Gifted and Non-gifted differ significantly. In other words the function derived is an efficient one to distinguish between the Mathematically Gifted and Non-gifted.

4.4.6. Classification of the Cases using the Discriminant Function

Using the discriminant function equation, the discriminant score for each case in the sample was calculated and the most likely group for a case based on the discriminant function was determined. The cases that were correctly classified and misclassified, using the discriminant function were also found out.

The number and percentage of pupils correctly classified and misclassified as belonging to Groups MG and MNG, using the discriminant function is given as Table 15 named 'Confusion Matrix'.

TABLE 15

Confusion Matrix

Actual Group	No. of Cases	Predicted Group Membership				Percent of grouped cases correctly classified
		Group MG		Group MNG		
		No. of cases	Percentage	No. of cases	Percentage	
Group MG	45	39	86.667	6	13.333	86.170
Group MNG	519	72	13.872	447	86.127	

4.4.6.1. Discussion of results

From Table 15 it can be seen that under Group MG with 45 cases, 39 cases (86.667 percent) were correctly classified as belonging to Group MG and 6 cases (13.333 percent) were misclassified. Under Group MNG, it can be seen that 447 cases (86.127 percent) were correctly classified as belonging to MNG while 72 (13.872 percent) were misclassified.

The percent of grouped cases correctly classified by the function which is an index of the effectiveness of the discriminant function is 86.170. This means that if the function is used to assign new cases to the two groups, MG and MNG, the function will classify the cases, the misclassification rate being 13.830 percent.

To see how much the two groups overlap and to examine the distribution of the discriminant scores, the scores for the groups are plotted graphically.

Figures 1 and 2 are the plots of the discriminant scores for Groups MG and MNG respectively. The row of '1's and '2's underneath the plot denote the group to which scores are assigned. The average score for a group (group centroid) is indicated on each plot.

The combined distribution of the scores for the two groups is shown as Figure 3 in which the amount of overlapping between the two groups is evident.

```
Symbols used in Plots
Symbol  Group
------  -----
  1       1
  2       2
--------------------------------------------------------------
            Canonical Discriminant Function 1

     16 +                                        +
        I                                        I
        I                                        I
        I                                        I
     12 +                                        +
        I                                        I
        I                     1                  I
        I                     1                  I
      8 +                   1 1                  +
        I                   1 1                  I
        I                   111                  I
        I                  11111                 I
      4 +                 111111                 +
        I                 111111                 I
        I                1111111  1              I
        I               11111111 111             I
         X----+----+----+----+----+----+----+----X
       Out -6.0 -4.0 -2.0   .0  2.0  4.0  6.0   Out
  Class   222222222222222222222211111111111111111
Centroids                     1
```

Figure 1. Graphical Representation of the Discriminant Scores for Group MG

```
            Canonical Discriminant Function 1

    160 +                                        +
        I                                        I
        I                                        I
        I                                        I
    120 +                                        +
        I                                        I
        I                                        I
        I                  2                     I
     80 +                  222                   +
        I                  222                   I
        I                 22222                  I
        I                 22222                  I
     40 +                 222222                 +
        I                22222222                I
        I                222222222               I
        I               22222222222 2            I
         X----+----+----+----+----+----+----+----X
         Out -6.0 -4.0 -2.0   .0  2.0  4.0  6.0   Out
        222222222222222222222211111111111111111
Class
Centroids                  2
```

Figure 2. Graphical Representation of the Discriminant Scores for Group MNG

```
            Canonical Discriminant Function 1

    160 +                                        +
        I                                        I
        I                                        I
        I                                        I
    120 +                                        +
        I                                        I
        I                                        I
        I                  2                     I
     80 +                  222                   +
        I                  222                   I
        I                 22222                  I
        I                 22222                  I
     40 +                 222222                 +
        I                222222222               I
        I                2222222222              I
        I               2222222211111            I
         X----+----+----+----+----+----+----+----X
       Out -6.0 -4.0 -2.0   .0  2.0  4.0  6.0   Out
  Class   222222222222222222222211111111111111111
Centroids                     2     1
```

Figure 3. Combined Distribution of the Discriminant Scores for the Two Groups MG and MNG

4.4.6.2. Findings

The discriminant function framed is efficient enough to discriminate significantly between groups Mathematically Gifted and Non-gifted with 86.170 percent of correct classification.

4.4.7. Classification Function Coefficients

In order to make the procedure of assigning new cases into the two groups MG and MNG, Fisher's linear discriminant function coefficients were calculated. The set of coefficients obtained for each group is given in Table 16.

TABLE 16

Fisher's Linear Discriminant Function Coefficients

Sl. No.	Predictor Variables	Group MG	Group MNG
1.	Problem Solving Ability in Mathematics	0.723	0.328
2.	Abstract Reasoning	-0.212	-0.412
3.	Achievement Motivation in Mathematics	0.655	0.637
4.	Mathematics Interest	-0.083	-0.167
5.	Attitude towards Mathematics	0.477	0.515
6.	Self Concept in Mathematics	0.282	0.259
7.	Mathematics Anxiety	0.801	0.827
8.	Introversion	0.076	0.094
9.	Masculinity	1.214	1.244
	Constant	-112.244	-107.553

4.4.7.1. Discussion of results

Table 16 gives two sets of coefficients for the groups MG and MNG. A case is assigned to the group for which it has the largest discriminant score calculated using the coefficients and the scores on the variables.

4.5. PSYCHOLOGICAL FACTOR STRUCTURES OF GROUPS MG AND MNG

The review of literature in the area of Giftedness suggests that selection or identification of Mathematically able or gifted students using a single criterion measure is not appreciable and that it will be better if a battery of psychological variables are used in the selection procedure. With such an intention, the investigator attempted to study the psychological factor structure of Mathematically Gifted and Non-gifted pupils.

This section of analysis deals with the identification of the psychological factor structures of both MG and MNG pupils. The factor structure of the two groups were derived using Principal Component method of Factor Analysis (Analysis by means of the SPSS package for Social Sciences in Computer). Factors derived were undergone Varimax rotation (Varimax rotation simplifies the factor structure and makes a meaningful pattern of factors which can be interpreted easily).

The rotated factor structures are interpreted for their nature and content. To facilitate interpretation the rotated factors were represented schematically also. Each factor was then given a psychological labelling based on the conventional procedure described below.

(a) i. Locating the group of variables on which the factor has high loadings.

ii. Locating the groups of variables on which the factor has low loadings.

iii. Ensuring the probability of different factors becoming independent.

(b) Treating factor loadings with absolute values greater than 0.400 as significant and factor loadings below this as not significant.

i. Treating factor loadings above $\pm$0.900 as extremely high presence/absence of the variable.

ii. Treating factor loadings between $\pm$0.800 and $\pm$0.900 as very high presence/absence of the variable.

iii. Treating factor loadings between $\pm$0.700 and $\pm$0.800 as high presence/absence of the variable.

iv. Treating factor loadings between $\pm$0.600 and $\pm$0.700 as considerable presence/absence of the variable.

v. Treating factor loadings between $\pm$0.500 and $\pm$0.600 as the variable is present/absent to a low extent.

vi. Treating factor loadings between $\pm$ 0.400 and $\pm$ 0.500 as slight or very low presence/absence of the variable.

vii. Factor loadings below $\pm$0.400 as the variable is negligibly present/absent.

4.5.1. Factor structure of Mathematically Gifted Pupils

The correlation matrix of the psychological variables, which is the basic input data for the Factor analysis of the Mathematically Gifted is presented as Table 17.

TABLE 17

Correlation Matrix of the Psychological Variables for the MG Group

Sl. No.	Psychological Variables	Psychological Variables 1	2	3	4	5	6	7	8	9
1.	Problem Solving Ability in Mathematics	--								
2.	Abstract Reasoning	0.541	--							
3.	Achievement Motivation in Mathematics	0.412	0.432	--						
4.	Mathematics Interest	0.215	0.383	0.427	--					
5.	Attitude towards Mathematics	0.417	0.527	0.762	0.330	--				
6.	Self Concept in Mathematics	0.160	0.104	0.414	0.196	0.334	--			
7.	Mathematics Anxiety	-0.083	-0.048	0.022	-0.290	0.096	-0.071	--		
8.	Introversion	0.337	0.041	0.019	-0.081	0.086	0.188	-0.066	--	
9.	Masculinity	0.323	0.063	0.122	0.160	-0.127	0.012	-0.420	0.214	

The unrotated and rotated factor matrices along with the respective communalities are presented in Table 18.

Schematic representation of the derived factors is attempted as Figure 4.

TABLE 18

Unrotated and Rotated Factor Matrices of the MG Group

Sl. No.	Psychological Variables	Unrotated					Rotated				
		Factor 1	Factor 2	Factor 3	Factor 4	h^2	Factor 1	Factor 2	Factor 3	Factor 4	h^2
1.	Problem Solving Ability in Mathematics	0.679	-0.152	-0.138	0.492	0.745	0.835	-0.006	0.180	0.120	0.745
2.	Abstract Reasoning	0.725	0.064	-0.248	0.321	0.694	0.815	0.130	0.036	-0.105	0.694
3.	Achievement Motivation in Mathematics	0.837	0.195	0.071	-0.130	0.762	0.575	0.653	-0.012	-0.072	0.762
4.	Mathematics Interest	0.601	-0.156	-0.333	-0.450	0.713	0.290	0.469	0.442	-0.463	0.713
5.	Attitude towards Mathematics	0.808	0.388	0.088	0.006	0.810	0.635	0.593	-0.232	-0.040	0.810
6.	SelfConcept in Mathematics	0.474	0.064	0.548	-0.462	0.743	-0.027	0.829	0.052	0.229	0.743
7.	Mathematics Anxiety	-0.152	0.776	0.128	0.334	0.753	0.083	-0.094	-0.855	0.081	0.753
8.	Introversion	0.117	-0.272	0.796	0.261	0.789	0.020	0.182	0.111	0.862	0.789
9.	Masculinity	0.226	-0.813	0.045	0.209	0.758	0.236	-0.150	0.760	0.320	0.758
	Eigen value						2.243	1.767	1.607	1.151	
	Percent of variance						33.141	26.108	23.744	17.007	
	Cumulative percent						33.141	59.249	82.993	100.00	

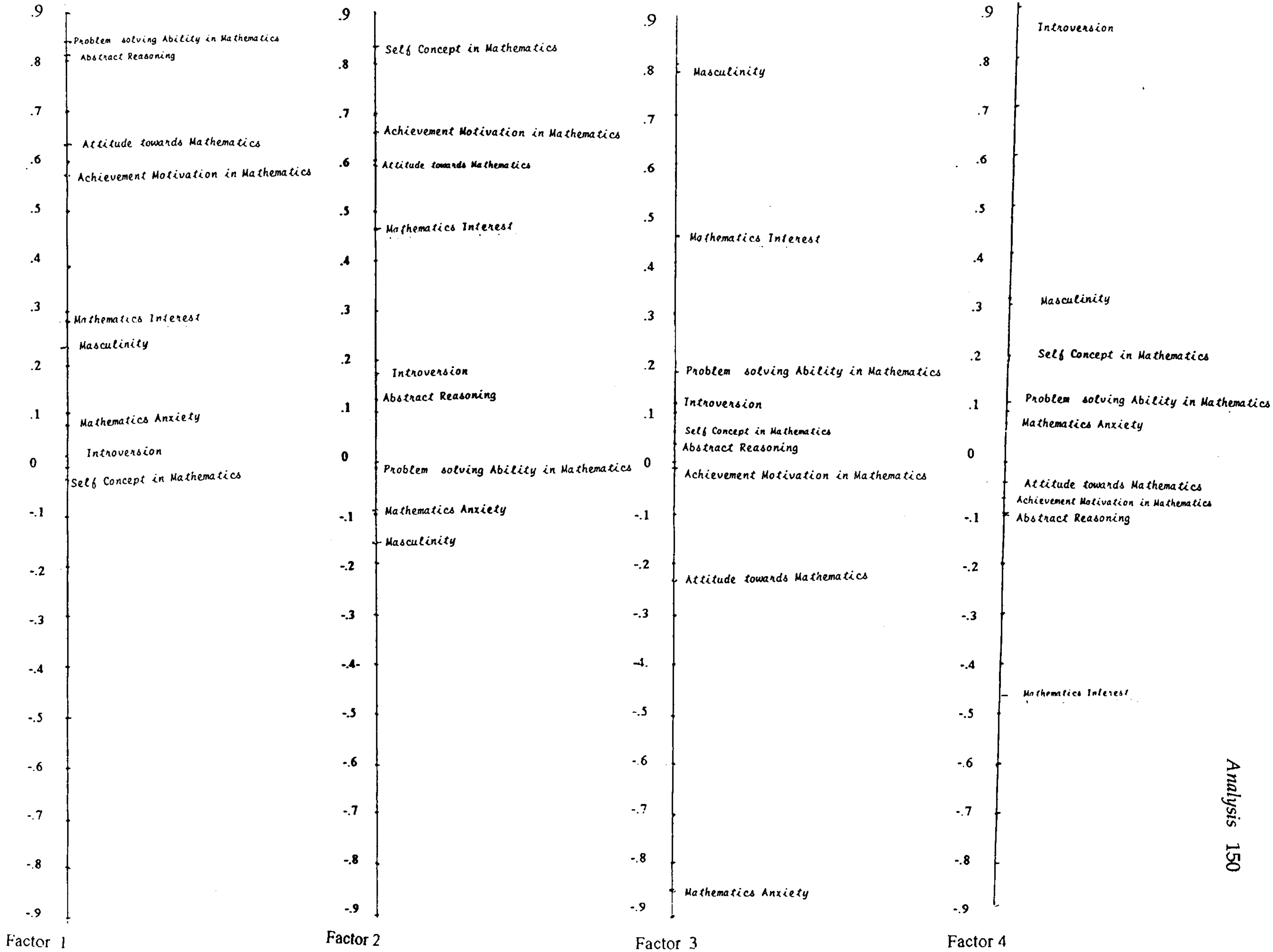

Figure 4 Schematic Representation of the Psychological Factors (rotated) Of MG Group

4.5.1.1. Discussion of the factor matrix

After computerised varimax rotation, four significant factors were evolved to the nine psychological variables subjected to study. Each factor is explained below in terms of the variables having significant loadings and the percent of variance accounted for by each.

4.5.1.1.1. Factor 1: This factor has significant loadings on four psychological variables and these variables in the order of the level of presence or absence is presented below.

Very high presence

Problem Solving Ability in Mathematics	(0.835)
Abstract Reasoning	(0.815)

Considerable presence

Attitude towards Mathematics	(0.635)

Low presence

Achievement Motivation in Mathematics	(0.575)

Factor loadings of this factor also suggests that remaining five variables viz., Mathematics Interest, Self Concept in Mathematics, Mathematics Anxiety, Introversion and Masculinity have no significant factor loadings on this factor.

Thus it can be seen that the first factor is characterised by the very high presence of the two cognitive variables Problem Solving Ability in Mathematics and Abstract Reasoning, by considerable presence of

Attitude towards Mathematics and by the low presence of Achievement Motivation in Mathematics which are affective in nature. This factor is therefore named as "Accelerated Problem Solving Ability in Mathematics".

The eigen value of this first factor is 2.243 (Table 18) indicating that the proportion of the variance attributable to Factor 1 is 2.243 or the percentage of variance accounted for by this factor is 33.141. As majority of the variance of the battery of psychological variables is explained by this factor, it can be considered as the dominant factor among the four factors derived for the group MG.

4.5.1.1.2. Factor 2: This factor has significant loadings on four variables viz., Achievement Motivation in Mathematics, Mathematics Interest, Attitude towards Mathematics and Self Concept in Mathematics.

The level of presence of the variables is as below.

Very high presence

Self Concept in Mathematics (0.829)

Considerable presence

Achievement Motivation in Mathematics (0.653)

Low presence

Attitude towards Mathematics (0.593)

Slight presence

Mathematics Interest (0.469)

The factor loadings of the variables Problem Solving Ability in Mathematics, Abstract Reasoning, Mathematics Anxiety, Introversion and Masculinity are less than 0.400 indicating the presence or absence of these variables as non-significant.

Thus factor 2 is characterised by very high presence of Self Concept in Mathematics, considerable presence of Achievement Motivation in Mathematics; low presence of Attitude towards Mathematics together with a slight or very low presence of Mathematics Interest. As Self Concept and Achievement Motivation are the major contributors, this factor is labelled as 'Commitment in Mathematics'.

The eigen value of this factor is 1.767 which suggests that the proportion of the variance attributable to factor 2 is 1.767. The percent of variance accounted for by this factor is 26.108.

4.5.1.1.3. Factor 3: This factor has significant loadings on three variables Mathematics Interest, Mathematics Anxiety and Masculinity. The level of presence or absence of the variables is as follows:

Absent to a very high level

Mathematics Anxiety (-0.855)

Highly present

Masculinity (0.760)

Slightly present

Mathematics Interest (0.442).

The factor loadings of all other variables are less than 0.400, the cut off point for significance.

Thus this factor is described by the high presence of Masculinity together with very high absence of Mathematics Anxiety and a slight presence of Mathematics Interest. As low anxiety is a characteristic of masculinity this factor is labelled as "Masculinism".

The eigenvalue of this factor (1.607) shows that the variance attributed by this factor is 1.607. The percent of variance is 23.744 indicating that 24 percent of variance is accounted for by this factor.

4.5.1.1.4. Factor 4: Only two variables viz., Mathematics Interest and Introversion have significant factor loadings with this factor. The variable Introversion has a factor loading of 0.862 and the variable Mathematics Interest has factor loading -0.463 in the factor. All other variables have non-significant factor loadings and hence the factor is characterised by the very high presence of the variable Introversion and the slight absence of the variable Mathematics Interest.

Thus very high presence of Introversion with a slight absence of Mathematics Interest defines this factor. Introverted behaviour is often of lack of interest, and hence this factor is labelled as 'Introversion'.

The eigen value of the factor is 1.151 (Table 18) which suggests that this factor accounts for only 17.007 percent of variance of the battery of psychological variables.

4.5.1.2. Overlapping/Dependence of the Factors

The cluster of variables present or absent in each factor with significant loadings are different from factor to factor and this suggests that the four factors of the MG group are independent.

4.5.1.3. Findings

The psychological factor structure of the MG group consists of four significant independent factors viz., Accelerated Problem Solving Ability in Mathematics, Commitment in Mathematics, Masculinism and Introversion with percent of variance accounted for by each as 33, 26, 24 and 17.

The first dominant factor is characterised by the presence of the variables,

i) Problem Solving Ability in Mathematics
ii) Abstract Reasoning
iii) Attitude towards Mathematics and
iv) Achievement Motivation in Mathematics

The second factor is characterised by

i) Self Concept in Mathematics
ii) Achievement Motivation in Mathematics
iii) Attitude towards Mathematics and
iv) Mathematics Interest

The third factor is characterised by the presence of

i) Masculinity and

ii) Mathematics Interest and the absence of Mathematics Anxiety.

The fourth factor is characterised by high presence of Introversion together with a very low absence of Mathematics Interest.

4.5.2. Psychological Factor Structure of the MNG Group

The intercorrelation matrix of the nine psychological variables which is the basic data for deriving factor matrix is given as Table 19.

The unrotated and rotated factor matrices along with the respective communalities (h^2); eigenvalue and the percent of variance accounted for by each rotated factor are given in Table 20.

The schematic representation of the rotated factors is given as Figure 5.

TABLE 19

Correlation Matrix of the Psychological Variables for the MNG Group

Sl. No.	Psychological Variables	Psychological Variables 1	2	3	4	5	6	7	8	9
1.	Problem Solving Ability in Mathematics	--								
2.	Abstract Reasoning	0.402	--							
3.	Achievement Motivation in Mathematics	0.143	0.200	--						
4.	Mathematics Interest	0.092	0.139	0.330	--					
5.	Attitude towards Mathematics	0.183	0.333	0.361	0.264	--				
6.	Self Concept in Mathematics	0.094	0.185	0.465	0.373	0.435	--			
7.	Mathematics Anxiety	-0.190	-0.122	-0.295	-0.216	-0.366	-0.352	--		
8.	Introversion	0.084	0.110	0.250	0.098	0.247	0.226	-0.158	--	
9.	Masculinity	0.056	0.048	-0.115	-0.128	-0.056	-0.046	-0.038	-0.502	

TABLE 20

Unrotated and Rotated Factor Matrices of the MNG Group

Sl. No.	Psychological Variables	Unrotated				Rotated			
		Factor 1	Factor 2	Factor 3	h^2	Factor 1	Factor 2	Factor 3	h^2
1.	Problem Solving Ability in Mathematics	0.392	0.659	-0.320	0.690	0.067	0.826	0.049	0.690
2.	Abstract Reasoning	0.490	0.583	-0.326	0.686	0.181	0.808	0.003	0.686
3.	Achievement Motivation in Mathematics	0.694	-0.232	0.001	0.536	0.715	0.093	-0.126	0.536
4.	Mathematics Interest	0.552	-0.327	-0.224	0.462	0.570	0.064	-0.366	0.462
5.	Attitude towards Mathematics	0.722	0.025	0.024	0.522	0.658	0.298	0.023	0.522
6.	Self Concept in Mathematics	0.725	-0.257	0.117	0.605	0.776	0.033	-0.038	0.605
7.	Mathematics Anxiety	-0.591	0.005	-0.228	0.401	-0.592	-0.130	-0.186	0.401
8.	Introversion	0.423	0.021	0.524	0.454	0.492	-0.052	0.458	0.454
9.	Masculinity	-0.075	0.524	0.663	0.720	-0.107	0.085	0.837	0.720
	Eigen value					2.512	1.465	1.099	
	Percent of variance					49.488	28.861	21.651	
	Cumulative percent					49.488	78.349	100	

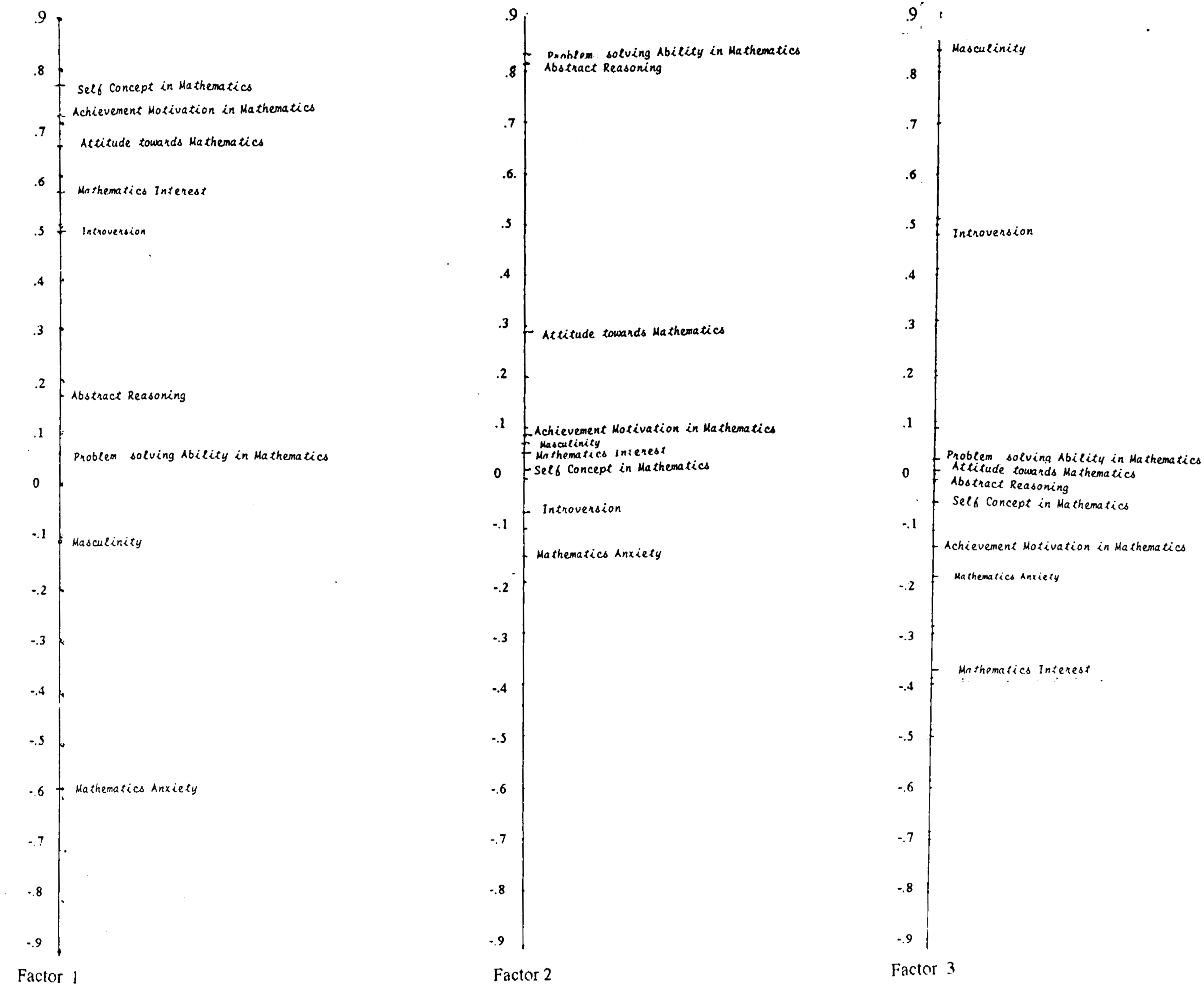

Figure 5 Schematic Representation of the Psychological Factors (rotated) Of MNG Group

4.5.2.1. Discussion of the Factor Matrix

After analysis, three factors emerged to the nine select psychological variables of the study and these three factors were rotated for meaningful interpretation.

Each factor is explained below for its nature and the percent of variance accounted for by each.

4.5.2.1.1. Factor 1: Factor 1 has significant loadings on five variables, as listed below.

High presence

Self Concept in Mathematics (0.776)

Achievement Motivation in Mathematics (0.715)

Considerable presence

Attitude towards Mathematics (0.658)

Low Presence

Mathematics Interest (0.570)

Very low presence

Introversion (0.492)

Absence to a low extent

Mathematics Anxiety (-0.592)

That is, Factor 1 is characterised by the high presence of Self Concept in Mathematics and Achievement Motivation in Mathematics; considerable presence of the variable Attitude towards Mathematics, presence of Mathematics Interest at a low extent, very low presence of Introversion and the absence of Mathematics Anxiety to a low extent.

No other variable has significant loading in the first factor. Factor 1 can thus be considered as composed of the affective variables like Self Concept in Mathematics, Achievement Motivation in Mathematics, Attitude towards Mathematics, Mathematics Interest and Introversion together with absence of the affective variable Mathematics Anxiety. Hence this factor can be labelled as 'Introverted Self-esteem'.

The eigenvalue is 2.512, indicating that the variance attributable to the factor is 2.512. This factor accounts for 49.488 percent of the variance of the battery of the psychological variables and hence is a dominant factor.

4.5.2.1.2. Factor 2. This factor has significant loadings for two variables, Problem Solving Ability in Mathematics (0.826) and Abstract Reasoning in Mathematics (0.808). These two variables have high presence in the factor and no other variable has significant loading. This implies that factor 2 is constituted by two variables Problem Solving Ability in Mathematics and Abstract Reasoning. Hence this factor can be labelled as 'Reasoned Problem Solving Ability in Mathematics'.

The eigen value of this factor being 1.465, contribute a variance of 1.465 to the set of variables. Factor 2 thus accounts for 28.861 percent of the variance of the battery of psychological variables.

4.5.2.1.3. Factor 3. Factor 3 has significant loadings on two variables viz., Introversion (0.458) and Masculinity (0.837). The values of factor loadings indicate a very high presence of Masculinity and a very low presence of the variable Introversion. The factor loadings of the remaining seven variables are not significant.

Factor 3 is thus characterised by the two affective variables, Introversion and Masculinity. The factor therefore can be labelled as 'Introverted Masculinism'. Only 1.099 variance is attributable by this factor to the set of psychological variables and the percent of variation contributed by this factor to the battery of psychological variables is 21.651.

4.5.2.2. *Overlapping/Dependence of the factors*

The cluster of variables significantly loaded in the three factors suggests that the three factors are independent.

4.5.2.3. *Findings*

The psychological factor structure of the MNG group consists of three significant independent factors viz., Introverted self-esteem, Reasoned Problem Solving Ability in Mathematics and Introverted Masculinism with percent of variance accounted by each as 49, 29 and 22 respectively.

The first dominant factor is characterised by the presence of the variables.

i) Self Concept in Mathematics

ii) Achievement Motivation in Mathematics

iii) Attitude towards Mathematics

iv) Mathematics Interest

v) Introversion and the absence of the variable Mathematics Anxiety.

The second factor is characterised by two cognitive variables.

i. Problem Solving Ability in Mathematics and

ii. Abstract Reasoning

The third factor is characterised by the presence of two variables Masculinity and Introversion.

4.6. COMPARISON OF THE PSYCHOLOGICAL FACTOR STRUCTURES OF MG AND MNG GROUPS

The psychological factor structures derived of the two groups MG and MNG are compared for their similarities and differences in terms of (i) no. of factors (ii) variables present/absent (iii) percent of variance to know how far are the factor structures different between the two groups.

To enable comparison the two factor matrices are represented in a single table, Table 21 with details like number and name of factors, variables highly representing the factor, factor loadings of each variable and the percent of variance accounted for by each factor.

TABLE 21

Comparison of Psychological Factor Structure of Groups MG and MNG

Sl. No.	Group MG				Group MNG			
	Factor Name	Variables present or absent	Factor loadings	Percent of Variance	Factor Name	Variables present or absent	Factor loadings	Percent of variance
1.	Accelerated Problem-solving Ability in Mathematics	Problem Solving Ability in Mathematics Abstract Reasoning Attitude towards Mathematics Achievement Motivation in Mathematics	0.835 0.815 0.635 0.575	33.141	Introverted self-esteem	Achievement Motivation in Mathematics Mathematics Interest Attitude towards Mathematics Self Concept in Mathematics Mathematics Anxiety Introversion	0.715 0.570 0.658 0.776 -0.592 0.492	49.488
2.	Commitment in Mathematics	Achievement Motivation in Mathematics Mathematics Interest Attitude towards Mathematics Self Concept in Mathematics	0.653 0.469 0.593 0.829	26.108	Reasoned Problem Solving Ability in Mathematics	Problem Solving Ability in Mathematics Abstract Reasoning	0.826 0.808	28.861
3.	Masculinism	Mathematics Interest Masculinity Mathematics Anxiety	0.442 0.760 –0.855	23.744	Introverted Masculinism	Introversion Masculinity	0.458 0.837	21.651
4.	Introversion	Introversion Mathematics Interest	0.862 –0.463	17.007	--	--	--	--

4.6.1. Discussion of Results

Comparison of the factor structures suggest that neither of the factor of MG group is perfectly comparable with the factors of the MNG group. However, the similarities and differences noticed are the following:

1. The number of factors of the MG group is four and that of MNG group is three. That is the factor structures differ in the number of factors.

2. The first factor of the MG group and the second factor of the MNG group are comparable for the following reasons.

The dominant variables of the two factors are Problem Solving Ability in Mathematics and Abstract Reasoning whose factor loadings are almost the same in the two factors.

The first factor of MG group is characterised by a combination of affective and cognitive variables (by the considerable presence of the Attitude towards Mathematics and the low presence of Achievement Motivation in Mathematics), but the corresponding factor of Group MNG is purely characterised by the two cognitive variables.

The percent variance accounted for by the two factors differ markedly as the first factor of MG group accounts for about 33 percent of variance where as the second factor of MNG group accounts only 29 percent of variance in the battery of psychological variables. Besides, the first factor of group MG is the dominant factor of that group but is not so for the MNG group.

3. The second factor of MG group and the first factor of MNG group are comparable as both are in terms of affective variables like Achievement Motivation in Mathematics, Mathematics Interest, Attitude towards Mathematics and Self Concept in Mathematics. The major variables that constitute the factor are the same (Self Concept in Mathematics and Achievement Motivation in Mathematics) in both. But the first factor of Group MNG has a very low presence of the variable Introversion which is not included in the second factor of Group MG.

The two factors differ in percent of variance attributed by them. The second factor of MG group attributes only 26 percent of variance where as 49 percent of variance is attributable to the first factor of Group MNG.

4. Another notable feature of the two factor structures is that the third and fourth factors of Group MG and the third factor of the Group MNG are characterised by affective variables only. The third factor of Group MG has a high presence of Masculinity which is very highly present in the third factor of Group MNG. The fourth factor of MG group has a very high presence of Introversion together with an absence of Mathematics Interest but the third factor of MNG group has a very low presence of Introversion.

Thus it can be found that even though the factors of Group MG and Group MNG are comparable to a certain extent; the factors underlying the two groups are highly different. This suggests that the psychological factor structures of Groups MG and MNG are different.

4.6.2. Findings

The psychological factor structures of Mathematically Gifted and Non-gifted pupils are different to a good amount as differences are observed in:

(i) The number of factors

(ii) Variables present/absent in each factor

(iii) The variance accounted for by the factors in the battery of psychological variables.

4.7. SUMMARY OF FINDINGS

The major objective of the study was to identify the psychological variables (from the select list) which contribute significantly to Mathematical Giftedness. To tackle this, the investigator applied four major statistical treatments to the collected data. The findings evolved by the four treatments are summarised below with reference to each treatment.

4.7.1. Two tailed 't' test of significance of difference between mean scores of the psychological variables revealed that the two groups, Mathematically Gifted and Non-gifted differ significantly in the case of the variables

(in the order of the values of the critical ratios)

i. Problem Solving Ability in Mathematics (CR = 12.622).

ii. Abstract Reasoning (CR = 9.589)

iii. Achievement Motivation in Mathematics (CR = 9.024)

iv. Mathematics Interest (CR = 7.534)

v. Self Concept in Mathematics (CR = 5.311)

vi. Mathematics Anxiety (CR = -4.527)

vii. Attitude towards Mathematics (CR = 3.799).

The two groups are not significantly different in the case of the variables

i. Introversion (CR = 0.695)

ii. Masculinity (CR = 0.193)

4.7.2. When tested for dependency of Mathematical Giftedness with the select psychological variables the following variables were found to have significant association with Mathematical Giftedness

(in the order of χ^2 values).

i. Problem Solving Ability in Mathematics (χ^2 = 75.897, C = 0.344).

ii. Achievement Motivation in Mathematics (χ^2 = 49.600, C = 0.284).

iii. Mathematics Interest (χ^2 = 46.312, C = 0.275).

iv. Abstract Reasoning (χ^2 = 37.191, C = 0.249).

v. Self Concept in Mathematics (χ^2 = 22.634, C = 0.196).

vi. Mathematics Anxiety (χ^2 = 21.128, C = 0.190).

vii. Attitude towards Mathematics (χ^2 = 15.482, C = 0.163).

The following variables are not significantly associated with Mathematical Giftedness.

i. Introversion (χ^2 = 0.011)

ii. Masculinity (χ^2 = 1.382)

4.7.3. Discriminant Analysis yielded a linear function

$$D = 0.786\,Z_1 + 0.234\,Z_2 + 0.096\,Z_3 + 0.192\,Z_4 + -0.264\,Z_5 + 0.141\,Z_6 + -0.172\,Z_7 + -0.032\,Z_8 + -0.047\,Z_9$$

in which Z_1, Z_2 .... Z_9 are the standard scores of the nine predictor variables, viz.,

i. Problem Solving Ability in Mathematics
ii. Abstract Reasoning
iii. Achievement Motivation in Mathematics
iv. Mathematics Interest
v. Attitude towards Mathematics
vi. Self Concept in Mathematics
vii. Mathematics Anxiety
viii. Introversion and
ix. Masculinity.

This function is efficient to discriminate between the two groups, Mathematically Gifted and Non-gifted as

i. The percent of correct classification is 86.17.
ii. The Chi-square value (168.342) with nine degrees of freedom is greater than the needed value for significance at 0.01 level.
iii. The eigen value is 0.353.
iv. The value of canonical correlation is 0.511.

The following variables are found to have high loadings with the discriminant function and hence are capbale of discriminating between Mathematically Gifted and Non-gifted pupils.

i. Problem Solving Ability in Mathematics (0.904)

ii. Abstract Reasoning (0.556)

iii. Mathematics Anxiety (-0.358)

iv. Mathematics Interest (0.357)

v. Achievement Motivation in Mathematics (0.339)

vi. Self Concept in Mathematics (0.313) and

vii. Attitude towards Mathematics (0.165)

The variables that are less capable for discriminating the two groups are:

i. Introversion (0.085) and

ii. Masculinity (0.017).

4.7.4. The psychological factor structure of Mathematically Gifted and Non-gifted pupils were derived using Principal Component Method of Factor Analysis followed by Varimax rotation. The factor structure of each group is described below.

4.7.4.1. The psychological factor structure of Mathematically Gifted pupils comprises of four factors to nine variables.

The first factor 'Accelerated Problem Solving Ability in Mathematics' which accounts for 33 percent variance is characterised by the presence of

i. Problem Solving Ability in Mathematics

ii. Abstract Reasoning

iii. Attitude towards Mathematics and

iv. Achievement Motivation in Mathematics

The second factor 'Commitment in Mathematics' explains almost 26 percent of variance in the battery of psychological variables and is characterised by the presence of the variables

i. Self Concept in Mathematics

ii. Achievement Motivation in Mathematics

iii. Attitude towards Mathematics and

iv. Mathematics Interest

The third factor 'masculinism' which accounts for almost 24 percent of variance, is characterised by the variables

i. Masculinity

ii. Mathematics Interest and

iii. Mathematics Anxiety

The fourth factor 'Introversion' is characterised by high presence of Introversion and a very low absence of Mathematics interest which accounts for only 17 percent of variance to the battery of psychological variables.

4.7.4.2. The psychological factor structure of Mathematically Non-gifted group consists of three factors to nine psychological variables.

The first factor defines almost 49 percent of variance and is characterised by the presence of

i. Self Concept in Mathematics

ii. Achievement Motivation in Mathematics

iii. Attitude towards Mathematics

iv. Mathematics Interest

v. Introversion and

the absence of the variable Mathematics Anxiety.

The second factor (Reasoned Problem Solving Ability in Mathematics) explains 29 percent of variance and is characterised by two cognitive variables Problem Solving Ability in Mathematics and Abstract Reasoning.

The third factor 'Introverted Masculinism' contributes nearly 22 percent of variance to the battery of psychological variables and is characterised by the two variables Masculinity and Introversion.

4.7.5. When the psychological factor structures of Mathematically Gifted and Non-gifted pupils were compared, it was found that the two groups differ in their psychological factor structures in the following aspects.

i. Number of factors evolved

ii. The variables present/absent in the factors and

iii. Percent of variance accounted for by the factors.

4.7.6. To tackle the major objective of the study, four major statistical treatments were applied and in all these the variables viz.,

i. Problem Solving Ability in Mathematics

ii. Abstract Reasoning

iii. Achievement Motivation in Mathematics

iv. Mathematics Interest

v. Attitude towards Mathematics

vi. Self Concept in Mathematics and

vii. Mathematics Anxiety

were found to be significantly discriminating between Mathematically Gifted and Non-gifted; significantly associated with Mathematical Giftedness; represented highly the dominant factors of the Mathematically Gifted group and loaded highly in the linear discriminant function.

4.8. TENABILITY OF HYPOTHESES

The tenability of the hypotheses set for the study are discussed below based on the results of statistical analyses done.

The first hypothesis states that "Mathematically Gifted and Non-gifted groups are significantly different in the case of each plsychological variable selected". This hypothesis is almost substantiated as seven variables out of the nine, differ significantly between Mathematically Gifted and Non-gifted pupils.

The second hypothesis "Mathematical Giftedness is significantly dependent on each of the select psychological variables" is also almost substantiated. The Chi-square values estimated by the χ^2 test of independence indicated that Mathematical Giftedness is significantly dependent on seven variables and not significantly dependent on two variables Introversion and Masculinity.

The third hypothesis is "Mathematically Gifted and Non-gifted groups can be significantly and effectively discriminated by means of a single linear function of the select psychological variables". This hypothesis is fully substantiated as a linear discriminant function formed based on the nine variables selected for the study was found to be efficient (in terms of percent of correct classification, χ^2 value, eigen value and canonical correlation) to discriminate between Mathematically Gifted and Non-gifted pupils.

The fourth hypothesis states that "the psychological factor structures of Mathematically Gifted and Non-gifted pupils are different in terms of

i. number of factors
ii. presence or absence of the variables in the factors.
iii. percent of variance accounted for by each factor.

This hypothesis also is substantiated as differences are observed in the three aspects of the factor structures viz.,

i. number of factors
ii. variables present or absent in the factors and the level of presence of absence of the variables.
iii. percent of variance account for by the factors to the battery of psychological variables.

The four hypotheses set forth for the study are found to be substantiated and among the nine variables, seven are found to be significant contributors of Mathematical Giftedness. This implies that the major hypothesis "each select predictor variable will be a significant contributor of Mathematical Giftedness" is almost substantiated.

SOME PSYCHOLOGICAL VARIABLES CONTRIBUTING TO MATHEMATICAL GIFTEDNESS OF SECONDARY SCHOOL PUPILS OF KERALA

VIJAYAKUMARI K.

Thesis submitted for the Degree of
DOCTOR OF PHILOSOPHY
IN EDUCATION

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CHAPTER V

SUMMARY, CONCLUSIONS AND SUGGESTIONS

METHODOLOGY IN RETROSPECT – MAJOR FINDINGS OF THE STUDY – CONCLUSIONS – EDUCATIONAL IMPLICATIONS OF THE STUDY – SUGGESTIONS FOR FURTHER RESEARCH

This chapter presents an overall summary of the study, a discussion of the findings and general conclusions of the study. Some suggestions for educational implication and for further research in the area are also included. These are presented under the major headings viz.,

Methodology in retrospect

Major findings of the study

Conclusions drawn

Educational implications and

Suggestions for further research in the area.

5.1. METHODOLOGY IN RETROSPECT

5. 1. 1. Title of the study.

The study is entitled as "SOME PSYCHOLOGICAL VARIABLES CONTRIBUTING TO MATHEMATICAL GIFTEDNESS OF SECONDARY SCHOOL PUPILS OF KERALA".

5. 1. 2. Variables

The design of the study warranted two types of variables, criterion and predictor variables. Mathematical Giftedness defined as the presence of high Mathematical Abilities and Mathematical Creativity, was considered as the criterion variable.

The predictor psychological variables selected for the study were the following

i. Problem Solving Ability in Mathematics
ii. Abstract Reasoning
iii. Achievement Motivation in Mathematics
iv. Mathematics Interest
v. Attitude towards Mathematics
vi. Self Concept in Mathematics
vii. Mathematics Anxiety
viii. Introversion
ix. Masculinity

5. 1. 3. *Objectives*

The major objective of the study, as explained by the statement itself, was "to find out the psychological variables, the presence or absence of which contribute significantly to Mathematical Giftedness". This was realized through the following objectives.

i. To compare Mathematically Gifted and Non-gifted pupils for each of the select psychological variables and to decide the variables for which the two groups significantly differ and hence may contribute to Mathematical Giftedness.

ii. To test whether Mathematical Giftedness is dependent on the select psychological variables so that the dependent predictor variables can be considered as the contributing variables.

iii. To test whether Mathematically Gifted and Non-gifted pupils can be significantly discriminated by a linear combination of the select psychological variables and to decide the relative importance of such variables as contributors to Mathematical Giftedness.

iv. To derive the psychological factor structures of Mathematically Gifted and Non-gifted pupils and to decide the contributing variables by the presence or absence of the variables having highly significant factor loadings in the factor with the highest percent of variance or eigen value.

v. To compare the psychological factor structures of Mathematically Gifted and Non-gifted pupils in terms of

   a). Number of factors

   b). Presence or absence of the variables in the factor and

   c). Percent of variance accounted for by each factor and to decide whether the factor structures of the two groups are different or not.

5. 1. 4. Hypotheses

The major hypothesis around which the study was conducted is that each select predictor variable will be a significant contributor of

Mathematical Giftedness. The following hypotheses were stated and tested which in turn confirm the major hypothesis.

i. Mathematically Gifted and Non-gifted groups are significantly different in the case of each psychological variable selected.

ii. Mathematical Giftedness is significantly dependent on each of the select psychological variables.

iii. Mathematically Gifted and Non-gifted groups can be significantly discriminated by means of a single linear function of the select psychological variables.

iv. The psychological factor structure of Mathematically gifted and Non-gifted pupils are significantly different in terms of:

   a). number of factors
   b). presence or absence of the variables in the factor
   c). percent of variance accounted for by each factor.

5. 1. 5. Sample

Sample for the study comprised of 564 secondary school pupils of Kerala selected by stratified sampling technique, from 12 schools belonging to six revenue districts. Among these 564 pupils, 45 were identified as Mathematically Gifted (Using the criterion that 70 percent or above mark in the Test of Mathematical Abilities and a very high score in the Test of Mathematical Creativity).

5. 1. 6. Tools Used

The data necessary for the study was collected using the tools listed below.

i. Test of Mathematical Abilities (Sumangala & Malini, 1995)
ii. Test of Mathematical Creativity (Sumangala, 1993)
iii. Test of Problem Solving Ability in Mathematics
iv. Test of Abstract Reasoning (Sumangala & Malini, 1993)
v. Scale of Achievement Motivation in Mathematics
vi. Mathematics Interest Inventory
vii. Scale of Attitude towards Mathematics (Sumangala & Sunni, 1987)
viii. Scale of Self Concept in Mathematics (Sumangala & Malini, 1993)
ix. Scale of Mathematics Anxiety (Sumangala & Malini, 1993)
x. The Kerala Introversion - Extraversion Scale (Nair, 1976)
xi. The Kerala Masculinity- Femininity Scale (Nair, 1978)

5. 1. 7. Statistical Techniques Used

The hypotheses set forth for the study was tested using the following statistical techniques.

i. Two tailed 't' test
ii. Chi-square test of independence
iii. Discriminant function analysis (Direct method)
iv. Factor analysis (Principal component method followed by varimax rotation).

5. 2. MAJOR FINDINGS OF THE STUDY

In order to tackle the major objective of the study, that is to identify the psychological variables which contribute significantly to Mathematical Giftedness, the investigator employed four statistical treatments to the collected data. Each statistical treatment together with the major results obtained are summarised below.

5. 2. 1. Two tailed `t' test to test the significance of mean difference in the psychological variables between the two groups Mathematically Gifted and Non-gifted suggested that among the nine variables, the two groups differ significantly in the mean scores of seven variables. The variables in the order of magnitude of the critical ratios are:

i. Problem Solving Ability in Mathematics (CR = 12.622).

ii. Abstract Reasoning (CR = 9.589).

iii. Achievement Motivation in Mathematics (CR = 9.024)

iv. Mathematics Interest (CR = 7.534).

v. Self Concept in Mathematics (CR = 5.341)

vi. Mathematics Anxiety (CR = -4.527) and

vii. Attitude towards Mathematics (CR = 3.799).

The variables for which the two groups do not differ significantly are:

Introversion (CR = 0.695) and

Masculinity (CR = 0.193).

5. 2. 2. Chi-square test of independence was used to test the dependency of Mathematical Giftedness with the select predictor variables. The variables that are significantly associated with Mathematical Giftedness in the order of extent of relationship are:

i. Problem Solving Ability in Mathematics ($\chi^2 = 75.897$, C = 0.344)
ii. Achievement Motivation in Mathematics ($\chi^2 = 49.600$, C = 0.284)
iii. Mathematics Interest ($\chi^2 = 46.312$, C = 0.275)
iv. Abstract Reasoning ($\chi^2 = 37.191$, C = 0.249)
v. Self Concept in Mathematics ($\chi^2 = 22.634$, C = 0.196)
vi. Mathematics Anxiety ($\chi^2 = 21.128$, C = 0.190)
vii. Attitude towards Mathematics ($\chi^2 = 15.482$, C = 0.163).

The following variables are not significantly associated with Mathematical Giftedness

i. Introversion ($\chi^2 = 0.011$)
ii. Masculinity ($\chi^2 = 1.382$).

5. 2. 3. Discriminant analysis (Direct Method) was used to derive a linear function that can efficiently discriminate between Mathematically Gifted and Non-gifted pupils and to identify the variables that are important in the function.

The linear function obtained, which can classify individuals to the two groups, Mathematically Gifted and non-gifted with 86.17 percent of correct classification, is

$D = 0.786Z_1 + 0.234Z_2 + 0.096Z_3 + 0.192Z_4 + - 0.264Z_5 + 0.141Z_6 + -0.172Z_7 + -0.032Z_8 + -0.047Z_9$ where

$Z_1, Z_2 \ldots Z_9$ are the standard scores of the nine predictor variables viz.,

i. Problem Solving Ability in Mathematics
ii. Abstract Reasoning
iii. Achievement Motivation in Mathematics.
iv. Mathematics Interest
v. Attitude towards Mathematics
vi. Self Concept in Mathematics
vii. Mathematics Anxiety
viii. Introversion and
ix. Masculinity

This function is found to be efficient to discriminate between Mathematically Gifted and Non-gifted as

i. The chi-square value (168.342) with nine degrees of freedom is greater than the needed value for significance at 0.01 level
ii. The eigen value is 0.353
iii. The value of canonical correlation is 0.511.

The following variables are found to have high loadings and significant relation with the discriminant function and hence are capable of discriminating between Mathematically Gifted and Non-gifted pupils

(in the order of importance)

i. Problem Solving ability in Mathematics (0.904)

ii. Abstract Reasoning (0.556)

iii. Mathematical Anxiety (-0.358)

iv. Mathematics Interest (0.357)

v. Achievement Motivation in Mathematics (0.339)

vi. Self Concept in Mathematics (0.313) and

vii. Attitude towards Mathematics (0.165)

The variables that have low loadings and negligible relationship with the discriminant function and hence are less capable for discriminating the two groups are:

i. Introversion (0.085) and

i. Masculinity (0.017).

5. 2. 4. The psychological factor structures of Mathematically Gifted and Non-gifted pupils were derived using Principal component Method of Factor Analysis followed by Varimax rotation.

5. 2. 4. 1. Four factors were derived using the nine psychological variables and this four factors comprised the psychological factor structure of Mathematically Gifted pupils.

The first factor (Accelerated Problem Solving Ability in Mathematics) which accounts for 33 percent of variance is characterized by the presence of:

i. Problem Solving Ability in Mathematics

ii. Abstract Reasoning

iii. Attitude towards Mathematics and

iv. Achievement Motivation in Mathematics

The second factor (commitment in Mathematics) which explains almost 26 percent of variance is characterized by the presence of the variables:

i. Self Concept in Mathematics
ii. Achievement Motivation in Mathematics
iii. Attitude Towards Mathematics and
iv. Mathematics Interest

The third factor (Masculinism) accounts for almost 24 percent of variance and is characterized by the presence of variables:

i. Masculinity
ii. Mathematics Interest and
iii. absence of Mathematics Anxiety

The fourth factor (introversion) is characterized by high presence of introversion and a very low absence of Mathematics Interest which accounts for only 17 percent of variance to the Battery of psychological variables.

5. 2. 4. 2. The psychological factor structure of Mathematically Non-gifted pupils consists of three factors derived from the nine psychological variables.

The first factor (Introverted self-esteem) the dominant factor of the Non-gifted pupils accounts for almost 49 percent of variance and is characterized by the presence of:

i. Self Concept in Mathematics

ii. Achievement Motivation in Mathematics'

iii. Attitude towards Mathematics

iv. Mathematics Interest

v. Introversion and the absence of the variable Mathematics Anxiety.

The second factor (Reasoned Problem Solving Ability in Mathematics) explains 29 percent of variance and is characterized by the two cognitive variables

i. Problem Solving Ability in Mathematics and

ii. Abstract Reasoning

The third factor (Introverted Masculinism) contributes around 22 percent of variance to the battery of psychological variables and is characterized by the high presence of Masculinity and a very low presence of Introversion.

5. 2. 5. When the psychological factor structures of Mathematically Gifted and Non-gifted pupils were compared, significant difference was observed mainly in the following aspects

i. Number of factors evolved

ii. The variables present/absent in the factors

iii. Percent of variance accounted for by the factors to the battery of psychological variables.

5. 3. CONCLUSION

As stated earlier, the major objective of the study was to identify the psychological variables (from the select list) which will contribute to

Mathematical Giftedness. To identify this, the investigator applied four statistical techniques and the findings evolved by each are given below.

5. 3. 1. The two tailed test of significance of mean difference for large independent samples resulted that the two groups Mathematically Gifted and Non-gifted are significantly different in the case of seven variables viz.,

(in the order of magnitude of values of `t')

i. Problem Solving Ability in Mathematics.
ii. Abstract Reasoning.
iii. Achievement Motivation in Mathematics.
iv. Mathematics Interest.
v. Self Concept in Mathematics.
vi. Mathematics Anxiety. and
vii. Attitude towards Mathematics.

5. 3. 2. By the Chi-square test of independence, it was found that seven variables have significant association with Mathematical Giftedness. The variables are:

(in the order of χ^2 values)

i. Problem Solving Ability in Mathematics.
ii. Achievement Motivation in Mathematics.
iii. Mathematics Interest.
iv. Abstract Reasoning.
v. Self Concept in Mathematics.
vi. Mathematics Anxiety and
vii. Attitude towards Mathematics.

Relationship of the following variables with Mathematical Giftedness are found to be high/moderate

(in the order of 'C'-coefficients)

i. Problem Solving Ability in Mathematics.
ii. Achievement Motivation in Mathematics.
iii. Mathematics Interest.
iv. Abstract Reasoning.

5. 2. 3. The linear discriminant function derived which was found to be significantly efficient to discriminate between Mathematically Gifted and Non-gifted, implied that the following variables have high loadings or contribute much to the function

i. Problem Solving Ability in Mathematics
ii. Abstract Reasoning
ii. Mathematics Anxiety
iv. Mathematics Interest
v. Achievement Motivation in Mathematics
vi. Self Concept in Mathematics.
vii. Attitude towards Mathematics

5. 3. 4. By factor analysis (Principal Component Method) factor structures of Mathematically Gifted and Non-gifted groups were derived and it was found that the two factor structures are different in terms of

i. Number of factors
ii. Variables present/absent in the factor and
iii. Percent of variance accounted for by the factors.

The dominant factor which contributes about 33 percent of variance to the battery of psychological variables, among the four factors derived for Mathematically Gifted is "Accelerated Problem Solving Ability in Mathemtics" which is loaded by the variables (i) Problem Solving Ability in Mathematics, (ii) Abstract Reasoning, (iii) Achievement Motivation in Mathematics and Attitude towards Mathematics.

The next important factor is "commitment in Mathematics" which is loaded by

i. Self Concept in Mathematics
ii. Achievement Motivation in Mathematics
iii. Attitude towards Mathematics and
iv. Mathematics Interest,

and this factor contributes about 26 percent of variance to the battery of psychological variables.

The third factor 'Masculinism' explains nearly 24 percent of the total variance and is characterised by the presence of Masculinity and Mathematics interest with very high absence of Mathematics Anxiety.

The above findings by means of four different statistical approaches made the investigator to arrive at the conclusion that the variables,

(in the order of importance)

i. Problem Solving Ability in Mathematics
ii. Abstract Reasoning
iii. Achievement Motivation in Mathematics

iv. Mathematics Interest

v. Self Concept in Mathematics

vi. Mathematics Anxiety and

vii. Attitude towards Mathematics

are the major contributing variables to mathematical Giftedness, as for these seven variables,

i. Mathematically Gifted and Non-gifted pupils are significantly different

ii. Significant association exists with Mathematical Giftedness

iii. Discriminant weights found in the linear function are high.

iv. The dominant factors of the Mathematically Gifted group are loaded with these variables and

Among the contributing variables to Mathematical Giftedness in all the four analyses, Mathematics Anxiety was found to be a negative contributor. That is low levels of the variable results in high levels of Mathematical Giftedness and vice versa.

5. 4. EDUCATIONAL IMPLICATIONS OF THE STUDY

The statistical analyses done to tackle the objectives and to test the hypotheses revealed that the seven variables viz.,

i. Problem Solving Ability in Mathematics

ii. Abstract Reasoning

iii. Achievement Motivation in Mathematics

iv. Mathematics Interest

v. Attitude towards Mathematics

vi. Self Concept in Mathematics and

vii. Mathematics Anxiety contribute to Mathematical Giftedness.

It was also found that the linear function derived through Discriminant Analysis is an effective one to identify Mathematically Gifted. When the psychological factor structures of Mathematically Gifted and Non-gifted pupils were compared, it was found that the factor structures differ in many aspects.

This made the investigator to perceive the following implications in the field of education.

1. In the normal mathematics classroom a good and active teacher can note the difference among students in the expression of psychological characteristics like interest, self-confidence, anxiety, ability to solve problems, see relations in the abstract ideas etc. A knowledge of the presence of these psychological characteristics (which are identified as significant contributors of Mathematical Giftedness) will then surely enable the teachers to recognize the mathematically talented. The teachers if motivated and interested, can then provide ample situations for the enrichment of such pupils. The teacher can as well identify the psychological characteristics lacking in other pupils and resort for methods by which such characteristics are boosted or developed.

   All the non-gifted can not be changed to gifted by mere programmes, but a small group of non-gifted pupils who are at the edge of Mathematical Giftedness can be made to have the gifted characteristics. This is possible if the characteristics like problem solving ability, abstract reasoning, motivation, self concept etc., are bettered at the same time decreasing the level of anxiety. Teachers can do a lot in this direction. The following are some suggestions, a mathematics teacher can adopt in classroom situations for the benefit of both gifted and non-gifted.

i. As Mathematically gifted are found to be better problem solvers and high in abstract reasoning, they have to be provided with more complex and abstract problem in addition to the normal ones so as to cope with their ability.

   Their abilities to solve problems and to reason out can be improved by enriching curriculum by including situations or exercises necessitating higher level thinking. They should be motivated by the teachers to read more about the subject and to widen their knowledge. Mathematics class can be made interesting by including mathematical 'gems', historical notes and other odd topics which captivate and excite students. To aid the teacher, a number of references should be given which are the store house of these gems, historical notes and odd topics.

ii. Problem solving ability which is a process as well as a product, being found as the major contributor of mathematical giftedness, strengthening of this should be the goal of the mathematics teachers. Instead of practising the routine way of solving problems, some creative and novel attempts should be made for problem solving. Generally mathematically gifted pupils will have a number of novel approaches to the problems and this may be spelled out to the normal students for triggering their ability to solve problems. Non-gifted pupils may not be successful in all the processes. Here the help of gifted students can be seeked to detect the erring phases and help for becoming better problem solvers.

iii. In leisure times pupils be given chances to answer mathematical puzzles and problematic and creative situations, so that mathematically gifted can improve their capabilities and the non-gifted can be motivated and made interested and confident in the subject.

iv. While giving assignment and projects to pupils (individual or group work) varied types (different in the complexity) of works be assigned considering the ability level of students. This will help the gifted to improve their talents and non-gifted to become more confident in their abilities and hence interested and motivated in the subject.

v. Workshops in the subjects can be conducted under the leadership of mathematically gifted pupils so that they will get chance to improve their motivation, confidence, etc.

vi. Peer teaching by gifted pupils can be used, through which the talent of mathematically gifted can be utilized for the benefit of others. The group works under the leadership of mathematically gifted will help them to increase the self-confidence and at the same time will motivate others to achieve more. This will be an assistance to the teachers concerned also.

2. In situations where talents cannot be identified through observed behaviours, psychological testing be used. For this authorities should take steps to have a pool of standardized psychological tests that are usable for secondary school pupils of Kerala.

3. The discriminant linear function evolved in the study can be used (the index of effectiveness being 86.17 percent) to identify the mathematically gifted children by administering the psychological tests used in the study. This will enable to locate the group of mathematically talented in each school as there are ample computer facilities to do the computation works.

4. The Mathematically talented, identified in each school can be put together as a group by educational district/revenue district/state wise. Summer programs may be arranged for them. This will help for their interaction and to achieve excellence. Through the interaction with other mathematically talented students, each will get chance for creative criticism and immediate feedback which will give the persistence and development of giftedness. Situations where they can sparkle their creativity, develop and experience their ability should be created.

5. Mathematically gifted pupils may be exposed to higher levels of the Mathematical thinking and for such, problem solving and reasoning under the supervision of experts in the field should be arranged.

6. In the era of information technology, the computer interaction programs given at secondary level will not be sufficient for the mathematically gifted and they should be exposed to programmes which instigate them in the field like software development, networking etc.

7. Students identified as mathematically precocious may be prepared and guided to participate in competitive programs conducted by various organisations nationally and internationally like Talent Search exams, International Mathematics Olympiad (IMO) etc. Those who have high potential should be accelerated so that they can make their contribution in the field at a very younger age itself.

8. Some special enthusiasm and creative thinking is necessary for the teachers to enrich the gifted and to transform the non-gifted to gifted. Therefore, teachers be given special inservice programmes orienting the needs of enriching the talented; identifying and nurturing the talents.

9. Mathematically gifted students themselves may vary in their level of giftedness by the variations in the level of contributing variables. This variations should be realized and enough experiences should be provided for rectification.

10. Students who are highly talented in Mathematics should be separated from the routine education system and special educational set up should be evolved for them. To teach these mathematically gifted children, the present system of teacher education is inadequate. More intelligent, creative, enthusiastic individuals

having preferences for teaching gifted should be trained in this respect.

11. Studies have established that the family environment of the students are very significant in the development of academic abilities and for right attitudes to education and for confidence. In this regard, the attitude of parents play a crucial role. So parents of mathematically gifted should be made aware that their child is gifted and therefore they have to give the optimum environment consisting of proper health, care to psychological essentials for the development of required abilities to their children. In this respect, as in western countries, such parents should be given orientation and necessary training.

5. 5. SUGGESTIONS FOR FURTHER RESEARCH

The following are some of the suggestions by the investigator for further research which will help to widen the theoretical and empirical understanding of Giftedness.

1. Replicate the study by widening the identification criteria by one more variable viz., 'Task commitment' and with a large set of cognitive and affective variables as predictors or contributors.

2. Replicate the study for other academic areas like science, language, arts, etc.

3. Conduct an indepth study of this nature on a very large sample which is highly representative of the secondary school pupils of Kerala by drawing samples from all the major educational districts.

4. A causal model of Giftedness in terms of a select set of psychological variables may be developed and tested for its efficiency through the sophisticated path analysis.

5. Teaching modules may be developed separately for Mathematically Gifted and Non-gifted so that both groups enjoy the advantages and there by to find the effectiveness of such modules.

6. A study on socio-familial correlates of giftedness.

7. A study on the gender difference in Giftedness and on the causing variables.

8. A study on the characteristics of highly gifted, moderately gifted and non-gifted pupils.

SOME PSYCHOLOGICAL VARIABLES CONTRIBUTING TO MATHEMATICAL GIFTEDNESS OF SECONDARY SCHOOL PUPILS OF KERALA

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SOME PSYCHOLOGICAL VARIABLES CONTRIBUTING TO MATHEMATICAL GIFTEDNESS OF SECONDARY SCHOOL PUPILS OF KERALA

VIJAYAKUMARI K.

Thesis submitted for the Degree of
DOCTOR OF PHILOSOPHY
IN EDUCATION

DEPARTMENT OF EDUCATION
UNIVERSITY OF CALICUT
KERALA

2000

APPENDICES

APPENDIX I

TEST OF MATHEMATICAL ABILITIES

(For Secondary School Pupils of Kerala - 1995)

DEPARTMENT OF EDUCTION
UNIVERSITY OF CALICUT

Instructions: This is a test to measure the abilities of students in Mathematics which contains 62 items. Write your responses in the separate response sheet given. Answer as many question as possible within the stipulated time.

TEST - 1

Time: 10 mts.

1. The area of a square is 25 sq. cm; Then ________ is its side.

2. The product of two numbers is 50. If one number is 5, then ________ is the other number.

3. x:y = 2:3, then x/y = ________.

4. If 6% of a number is 60 what is the number?

5. In rightangled triangle, height is 4 cm, hypotenuse is 5 cm, then base = ________ cm

6. When a number is divided by 3, the quotient is 4 and the remainder is 2 which is the number.

7. If you get 2 when +9 is added to –7, what will you get when 9 is substracted from 2?

8. Which number if multiplied with 4/5, will result in '1'.

9. If $\sqrt{144} = 12$, then 12^2 = ________.

10. m^3 x ________ $= m^5$

11. If the base angles of a triangle are equal, the triangle is a ________ triangle.

12. If $2^3 = 8$, then $3\sqrt{8}$ = ________.

13. With which number (1/10 + 1/20 + 1/30) should be multiplied to get (1/5 + 1/10 + 1/15).

14. If the volume of a cube is $64cm^3$, then the side of the cube is ________

15. If $x^2 = y$ then $y^{1/2}$ = ________

16. (2a-3) (_____ + 6a+9) = $8a^3$ - 27

17. The 5 times of which number is 60.

18. If one side of a triangle is the sum of squares of the other two sides, that triangles is a ________ triangle.

19. Which number is to be added with -3x + 2y to get zero.

TEST - 2

Time: 10 mts.

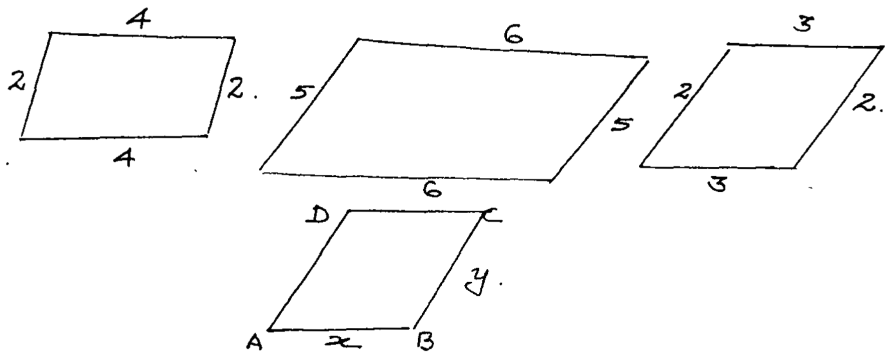
20. If 1^0=1, 2^0 = 1, 3^0 = 1 then n^0 = ________

21. 1 x 3 = $\sqrt{1x9}$, 2 x 3 = $\sqrt{4x9}$, 4 x 5 = $\sqrt{16 \times 25}$, like this write X x Y.

22. x + x = 2x , x + x +x = 3 x, x + x + x + x = 4x then, n + x x . . . x n times = ________.

23. The tenth term of the number series 2 x 2^0, 2 x 2^1 , 2 x 2^2 .... is ______.

24. Consider the following parallelograms.



AB = x cm, BC = y cm. what will be AD and CD?

25. $\log^2{}_2$ = 1, $\log^4{}_4$ = 1, $\log^{10}{}_{10}$ = 1, $\log^a{}_a$ = ________

26. The number of faces of a triangular prism is 5, that of a 'rectangular prism is 6 and a pentagonal prism is 7. If the base of a prism has 'n' sides, then it will have ________ faces.

27. $(\sqrt[2]{4})^2 = 4$ $(\sqrt[3]{7})^3 = 7$, $(\sqrt[5]{10})^5 = 10$, then $(\sqrt[n]{a})^n$ = ________.

28. 1! = 1, 2! = 1 x 2, 3! = 1x2x3 then 10! = _______

29. Some points on Y-axis are (0,2), (0,4), (0,-9) write another point on Y - axis.

30. $4C_3 = \frac{4!}{3! + !}$, $5C_2 = \frac{5!}{2!\,3!}$, $10C_6 = \frac{10!}{6!\,4!}$ then nC_r = ______

31. The first term of a number series is a, second terms is a + d, third terms is a + 2d, fourth term is a + 3d, then how can the 15th term be expressed?

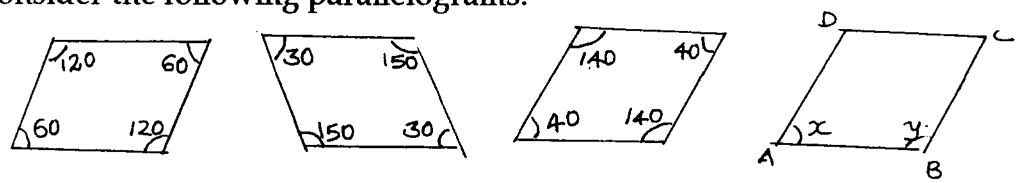
32. The sum of interior angles of a triangle = 1 x 2 (right angles)

The sum of interior angles of a rectangle = 2 x 2 right angles

The sum of interior angles of a pentagone = 3 x 2 right angles

then the sum of interior angles of a polygon with 'n' sides = ___ x 2 right angles.

33. Consider the following parallelograms.



Then ∠D = _______, ∠C = ______

TEST - 3

Time: 15 mts

Write angle the unavoidable steps while solving the following problem.

34. $p(x) = 3x^2 - 5x - 7$, then $P(0)$ = _____

35. $a(a+b) = 18$, $b(b+a) = 7$ then $(a+b)^2$ = _____

36. 102×98 = ____

37. $1/a = 16$, $1/b = 7$ then $b-a/ab$ = _____

38. Simplify $\frac{113^2 - 13^2}{113 + 13}$

39. $\frac{240}{\sqrt{a}} = 24$ then a = ____

40. $10^k \times 7 = 70$ then k = ____

41. $1/x = 7,\ 1/y = 9$ then $\sqrt{\dfrac{x+y}{xy}} =$ ____

42. $\dfrac{x}{\sqrt{25}} = 1/5$ then $X =$ ____

43. $x = 1, y = 2$ then $x^2 + 2xy + y^2 =$ ____

44. $2:x = x:8$ then $x =$ ____

45. $m = 2, a = 1, b = 3, c = 4$ then $ma^2 + mb^2 + mc^2 =$ _____

TEST - 4

Time: 10 mts

Write as many responses as possible for the following questions (from 46 to 52) within the stipulated there.

46. Write examples for null set.

47. Write similar form of the fraction 1/2 (Example 4/8).

48. Write different pairs of complementary angles. (Example $\angle 50, \angle 40$).

49. Write points in the first quadrant.

50. Using 3, 4, 5 and 6 write number so that their sum is 8.

51. Express 64 as the power of different numbers.

TEST - 5

Time: 15 mts.

53. If the ratio of the areas of two circles is 25:9, then find the ratio of their radii.

    a) What is to be find out?
    b) What is the ratio of the ares of the circles.
    c) What is the formula for area of a circle?
    d) How the ratio of radii can be written?

54. Find the side of a cube, volume and surface area of which are equal.

    a) What is to be find out?

b) What is the formula of volume of a cube?
c) What is the formula of surface area of a cube?
d) Here what is the relation between volume and surface area?
e) How the side of the cube can be find out? What is the side?

55. 1/4th of the total boys and 3/8th of the total girls participated in the annual arts festival. Then find the proportion of total students who didn't participate in the festival?

a) What is to be find out?
b) What are given?
c) Is the given data sufficient to find out the requried? why?

56. If 60% of 50 students passed, then how many students failed?

a) If 60% passed, how many students will be passed out of 100 students?
b) If 60% of 50 students passed, then how many students passed?
c) Then what is the number of failed students?

57. What is the highest angle of triangle ABC if AB =10 cm & BC = 12cm?

a) What is to be find out?
b) What are given?
c) To know an angle of a triangle, what are the minimum required information?

58. In the parallelogram ABCD, AB=4 cm, AD=2cm the altitude to the side AB = 3 cm. Calculate the area of the parallelogram.

a) What is the formula of area of a parallelogram.
b) What are given?
c) What information is not necessary for calculating the area?
d) What is the area?

59. The sum of two numbers is 45, and their difference is 20; then calculate the difference of their squares.

a) If the numbers are a & b, what is to be find out?
b) What is a + b? What is a-b?
c) How can the difference of squares of a & b can be calculated using the given data?
d) What is the difference of the squares?

60. The side of a square is 4 cm, and its diagonal is $4\sqrt{2}$ cm. Then find the area of the square.

a) What is the formula of area of a square?
b) what are the given information?
c) Is there any unnecessary information in the given problem?
d) What is the area?

61. The age of Babu's father is three time that of Babu. The sum of their ages is 56 years. Then find their ages?

a) What is to be calculated?
b) If x is the age of Babu and Y is the age of his father, how x and y can be related?
c) What is $x + y$?
d) Using the given information say Babu's age and his father's age.

62. The base angle of an isoscales triangle in 50°. What is its vertex angle?

a) What is the measure of base angle?
b) What is the particularity of the base angles of an isosceles triangle.
c) What is the sum of the angles of a triangle?
d) What is the measure of vertex angle?

APPENDIX II

TEST OF MATHEMATICAL CREATIVITY

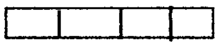
Dr. V. Sumangala
Reader in Education
Dept. of Education
University of Calicut.

This is a test to measure your creativity in Mathematics. There are seven different questions in this test. To each question, write as many possible answers as you can within the time limit specified. Your scores for creativity will increase as the number of right answers. Let your answers be unusual and novel as far as possible. Answer each question within the time limit given against each. Begin answering when the teacher says 'start' and 'stop' when the teacher says so.

1. Write as many numbers as possible so that the sum of the digits is '7'

   Time: 5 mts

2. Draw the figures of four squares arranged in different ways as possible.

   Ex. 

   Time: 5 mts

3. Represent the whole numbers 0, 1, 2 .... using four 4's and any mathematical operation between them.

   Time: 7 mts

   Ex: 44 - 44 = 0
   4/4 + 4/4 = 2 etc.

4. Write as many paths as possible from A to H through the edges of the cube ABCDEFGH

   Time: 5 mts

5. Using the fundamental mathematical operations +, -, x, ÷ connect the numbers 3, 4, 5 and 6 in possible ways to get the answer as 8.

   Time: 6 mts

6. Write as many equations as possible using the equation B-C = D, and Z = A+D.

   Time: 5 mts

   Ex: $B = C+D$, $Z^2 = (A+D)^2$

7. Using fundamental mathematical operations, +, -, x, ÷ between the digits 1, 9, 9 and 2 of the number 1992, write as many counting numbers as possible.

   Time: 5 mts

   Ex: 1 + 9 + 9 + 2 = 21
   -1 -9 +9 +2 = 1 etc.

TEST OF 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.

1. 

2. 

3. 

4. 

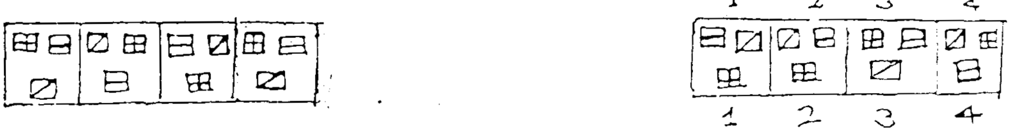
II. The following pictures are in a particular order. Select the answer figure which follows the same order.

1. 

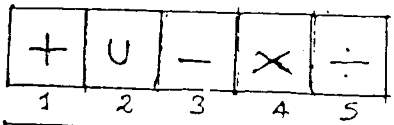
2. 

3. 

4. 

5. 

III. In the following five figure series, four belongs to one category and one stands out. Find the different one.

1


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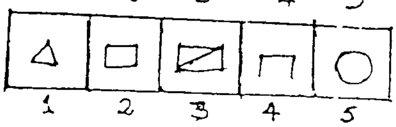

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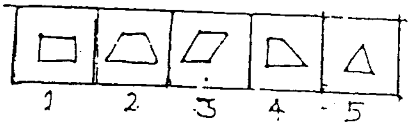

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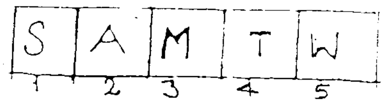
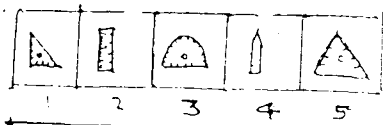


5.


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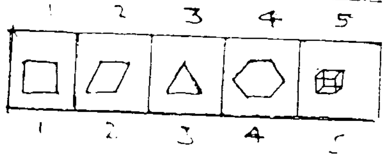

APPENDIX IV

SCALE OF ATTITUDE TOWARDS MATHEMATICS

DEPARTMENT OF EDUCATION
UNIVERSITY OF CALICUT 1987

A few statements to know your responses about mathematics and problems in mathematics. After reading each statement, you have to mark your response in any one of the ways viz., strongly agree (SA), agree (A), undecided (U), disagree (D), strongly disagree (SD) against each statement number in the separate answer sheet. If your response to a statement is 'strongly agree', 'agree', 'undecided', 'disagree' or 'strongly disagree', put an 'X' mark on circles SA, A, U, D or SD respectively.

Now read each statement and mark your responses.

1. Achievements due to the advancement of mathematics are beneficial to society.
2. Money spent for research in mathematics is a big national waste.
3. Time spent for participating in the activities of mathematics club is a real waste.
4. It is distressing for me to think of mathematics classes.
5. I won't reveal my doubts in mathematics classes thinking that others may consider that I am very poor in mathematics.
6. While dealing with any mathematical problem I will try my best to solve it.
7. Being a hard and bored subject, I won't attend classes of mathematics.
8. If the answer while doing mathematical problems, is found correct, then it is an inspiration for me to do more and more problems.
9. To the portions taught in mathematics class, learn thoroughly I do textual exercises everyday.
10. I study mathematics as a way to score high marks in examinations as it is easy to get very good marks in mathematics.
11. I think of answering to questions only when the turn is mine.
12. Eventhough some questions are unknown to me, I am able to do the test.

13. However interesting are mathematics classes, I find it difficult to attend the classes.

14. I do not attempt solving mathematical problems because of fear of committing mistakes.

15. However difficult a problem, I find pleasure in solving it myself.

16. Students don't like those teachers who compel students to do problems for themselves.

17. Teacher should take lead to present articles by students containing life history of mathematicians and their contributions to mathematics.

18. The teacher is to do all the problems in mathematics on the blackboard.

19. I do not care for doing extracurricular mathematics problems.

20. Constructing magic square is one of my recreational pastimes.

21. While reading periodicals my first attempt is to find solutions for crossword puzzles, picture puzzles, mathematical games and the like.

22. To draw geometrical figures and to colour them is one of my recreational pastimes.

23. It is boring to read the life history of mathematicians.

24. Many of the theories and principles of Mathematics are applicable in our day to day life.

25. Possibilities for getting cheated are there if one goes for shopping without a knowledge of mathematics.

26. Those who have a flair for Mathematics are likely to have precision in life also.

27. The number of female mathematicians are very few as their mathematical abilities are poor.

28. If mathematics had not been utilised our life would have progressed only slowly.

29. Researches in mathematics are only national.

30. Many scientific discoveries would not have been possible if mathematics had not progressed.

APPENDIX V

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION 1993

SCALE OF SELF-CONCEPT IN MATHEMATICS

A few statements which will help you in assessing yourself in relation to Mathematics are given herewith. After reading each statement, you have to mark your response in any one of the ways, viz., 'very much like this' (A), 'like this' (B), 'uncertain' (C), 'not like this' (D), or 'not at all like this' (E). For this, separate answer sheet with markings A, B, C, D, E in 5 circles is given against each statement number. If your response to a statement is 'very much like this'; 'like this', 'uncertain', 'not like this' or 'not at all like this', put an 'X' mark on circles A, B, C, D or E respectively. If you find that you have made a wrong entry, put a square around that entry, and then put the 'X' mark in the correct circle. Okey, start.

1. I always stand first in mathematics examinations.
2. I solve mathematical problems faster than my classmates.
3. My classmates often seek my help to do their homeworks.
4. I am thorough with the basics of mathematics.
5. I solve mathematical problems with the help of others.
6. To achieve high in mathematics is my aim.
7. I solve even tough mathematical problems.
8. Participating in mathematics quiz programmes is a thrill to me.
9. It is me the teacher engages to do problems on the blackboard.
10. Mathematical knowledge helps me to learn science subjects easily.
11. Mathematics is a problem for me.
12. My ability in mathematics has helped me to outsmart my foes.
13. It is my ambition to do higher studies in mathematics.
14. I am often unable to answer the questions of mathematics teacher.
15. My classmates view me as the best student in the class.
16. I find it easy to memorise mathematical formulae, principles and rules.
17. My friends are the best students of my class.
18. Students like me because of my ability in mathematics.
19. Teachers entrust me the job of helping students who are poor in mathematics.
20. I have not felt that mathematics is a difficult subject.
21. I like to do mathematical problems in recess time.
22. I study mathematics only to get through the examination.
23. Each mathematics class is a problem for me.
24. I am unhappy in my study of mathematics.

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

SCALE OF MATHEMATICS ANXIETY

The problems 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	X	O

In this example, the X mark is on D. This means that the student who answered disagrees to the statement.

Read each statement and mark your response as instructed above.

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 the exam well.

12. Even if I have severe doubts I do not try to solve it for I fear that I may be viewed as 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 neighbour 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 a loof 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 do 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 VII

THE KERALA INTROVERSION - EXTRAVERSION SCALE (ENGLISH VERSION)

INSTRUCTIONS

The statements given below have been used to assess your reaction to some of your personal experiences. Kindly read each statement carefully and enter your responses in the response sheet by putting a circle around 'A', 'U' or 'D'. Note that 'A' stands for 'agreed'; 'U' stands for 'Undecided'; and 'D' stands for 'disagreed'. Please do not leave any items unanswered.

1. Very often you find yourself acting before thinking about what you are doing.
2. You like to evaluate your past actions carefully.
3. You have always led a carefree life.
4. You often wish for excitement.
5. You often watch others to see what effect your words or actions have upon them.
6. You like to make the most of the present, leaving the past and future to your thoughts.
7. You like to have time to be alone with your thoughts.
8. You are inclined to look into yourself.
9. You often act on the first thought that comes to your mind.
10. You prefer to undertake work that requires careful attention to details.
11. In your discussions with friends you prefer to touch upon more serious questions of life.
12. You sometimes make quick decisions that you later wish you hadn't made.
13. You have nothing but contempt for the people who try to find answers to philosophic questions.
14. You enjoy analyzing your own feelings and thoughts.
15. You have a habit of starting things and then lossing interest in them.
16. You are inclined to stop to think things over before you act.

17. You don't approve of the activities of people who take life very seriously.

18. You often wonder why people behave as they do.

19. You find pleasure in spending all your leisure time in attending social function and witnessing festivals.

20. You take pleasure in reading books which throw light on some important philosophic questions of our time.

21. You often undertake to do things which will lead you to difficulties afterwards.

22. You often try to analyze the motives of others.

23. You selfom get time to think about yourself.

24. You succeed in controlling your temper even in the most provocative situations.

25. Your friends consider you as a person with cheap ideas and tastes.

26. You make it a point to complete tasks even when they are the most difficult ones which consume all your leisure time.

27. You don't have the patience to sit still and listen to complex arguments.

28. You frequently try to analyze your own thought and find how it moves.

29. You are considered by others as being incapable of attending to small details.

30. You try to sense what people are thinking about as they talk to you.

APPENDIX VIII

THE KERALA MASCULINITY - FEMININITY SCALE
(ENGLISH VERSION)

INSTRUCTIONS

The statements given below have been used to assess your reaction to some of your personal experiences. Kindly read each statement carefully and enter your responses in the response sheet by putting a circle around 'A', 'U' or 'D'. Note that 'A' stands for 'agreed'; 'U' stands for 'Undecided'; and 'D' stands for 'disagreed'. Please do not leave any items unanswered.

1. You don't mind sitting in a room full of disarranged things.
2. When you become emotional, you come to the point of tears.
3. You don't mind feeling the sharpness of a knife by rubbing your hand against the sharp edge.
4. You feel very badly if some one makes some unfavourable remark about your dress.
5. You can look at a moving snake close to you for sometime without getting excited.
6. The sight of blood always gives you a scare.
7. The sight of persons with unshaven faces always disgusts you.
8. You hate all forms of out door work.
9. The sight of some small creatures like the spider or the cockroach makes you nervous.
10. You are not perturbed at the sight of rough and villainous looking people.
11. You are disturbed at the sight of an animal caught in a death trap.
12. You have no difficulty in handling deadly weapons like a loaded gun or a sharp sword.
13. You cannot stand the sight of a dog which has just been run over by a car.
14. You are not affected by some tragic scenes in a drama or a film which makes others cry.

15. The idea of small creatures like a frog or cockroach crawling on you makes you shudder.

16. You enjoy looking at animals engaged in a mortal fight.

17. Any news of murder or suicide makes you brood over it for hours or days.

18. You would prefer to work in the army rather than taking up a job which keeps you indoors.

19. You are inclined to day-dream about things that can never come true.

20. You are not very much affected if you have to walk through roads full of dirt and rubbish.

21. Your mood is very easily influenced by people around you.

22. You are not very much perturbed if it comes to killing your pet dog.

23. When your parent or teacher or boss scolde you, you feel like weeping.

24. You don't mind going out when there is thunder and lightning on a large scale.

25. You cry very easily.

26. You enjoy making statements which are likely to be resoned by people around you.

27. You arrange things around you even when they have been arranged before.

28. You prefer dull coloured dress to bright coloured ones.

29. You avoid situations which will lead to loud discussions or quarrels.

30. You prefer doing things which require a good deal of strength and physical exertion.

APPENDIX IX

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION 1996

TEST OF PROBLEM SOLVING ABILITY IN MATHEMATICS

Dr. V. Sumangala
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University of Calicut

Miss. Vijayakumari, K.
Research Scholar
Department of Education.

Direction: This is a test to measure your ability in solving problems related to Mathematics. Answer each question after careful reading and mark your response in the separate answer sheet given. There are three parts for this test viz., Part I, II and III and separate directions are given for doing these parts. Each part should be completed within the allotted time.

PART I

In this part each question has four options (A, B, C, D). You have to find the correct answer and mark 'X' on the circle corresponding to the letter carrying the correct answer in your answer sheet. If you want to change the answer after marking it, you should draw a square (□) around it and then mark the correct answer.

Time: 40 mts.

1. A lily on a pond doubles its size every day. If in 15 days it covers half the pond, how long will it take to cover the whole pond?

   A. 30 B. 16 C. 15 D. 7.5

2. If a cat can kill a rat in 1 minute, how long will 60 cats take to kill 60 rats?

   A. 60 mts B. 6 mts. D. 1 mts. D. 1 hr

3. A family has seven children each boy in this family has as many sisters as his brothers, but each girl has twice as many brothers as her sisters. How many brothers and sisters are in the family?

   A. 5 sisters and 2 brothers
   B. 4 sisters and 3 brothers
   C. 1 sister and 6 brothers
   D. 3 sisters and 4 brothers

4. A father is 35 years old and his son is 2. After how many years will the father be 4 times as old as his son?

A. 5 B. 9 C. 27 D. 33

5. A train passes through a tunnel 450 m long in 45 seconds and goes past a post in 15 seconds. The length of the train is

A. 450 m B. 225 m C. 150 m D. 10 m

6. A bottle and a cork together cost Rs.1.10. The bottle costs Rs.1/- more than the cork. How much does the cork cost?

A. Rs.1.5 B. 55 paise C. 10 paise D. 5 paise

7. A money pouch contains Rs.700/-. There are equal number of 25 paise coins, 50 paise coins and one rupee coins. How many of each are there?

A. 700 B. 400 C. 100 D. 10

8. In an effort to motivate a student to do her home work a mathematics teacher offered to pay the student Rs.8/- for each correct answer on her assignment and to fine her Rs.5/- for each incorrect answer. After the student had worked 26 problems, (assume that no problem is omitted) it was discovered that neither person owed money to the other. How many problems did the student solve correctly.

A. 16 B. 13 C. 10 D. 8

9. What is the diameter of an automobile wheel if the distance covered by the wheel in ten rotations is 1570 cm?

A. 500 cm B. 157 cm C. 50 cm D. 25 cm

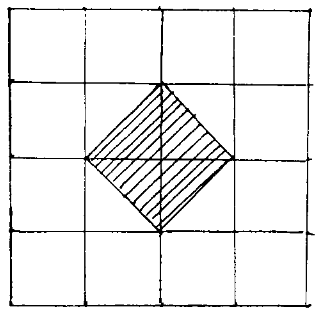
10. John can complete a job in a 4 hrs, and Ram can complete it in 5 hrs. How long will the boys take to complete it together?

A. 9/20 hrs. B. 9/20 hrs. C. 20/9 hrs. D. 9 hrs.

11. What is the greatest possible number of 1 inch cubes that can be placed into an empty box, 4 inches wide by 4 inches deep by 4 inches long.

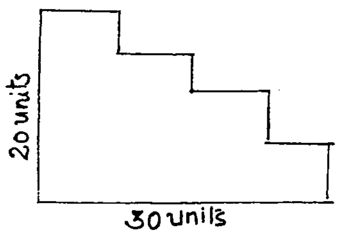
A. 4 B. 8 C. 16 D. 64

12. Each of the 16 small squares in Fig. is of side 1 unit. What is the area of the shaded square?



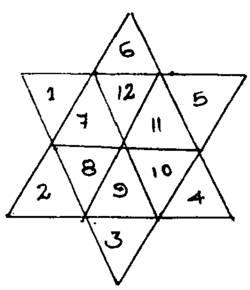
A. 1 Sq. units B. 2 Sq. units C. 4 Sq. units D. 16 Sq. units

13. What is the total length of the carpet that we would need to go from top to bottom of the stair case shown in fig.



A. 20 units B. 30 units C. 50 units D. 60 units

14. How many triangles are there in the figure.



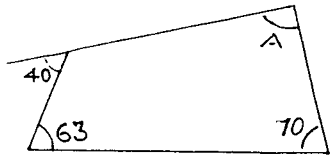
A. 12 B. 14 C. 19 D. 20

15. One circle has four times the radius of another circle. How many times greater is its area.

A. 16 B. 8 C. 4 D. 2

16. What is the measure of the angle A in the figure (without measuring directly)?

A. 30 B. 63
C. 87 D. 140



17. Ram bought a pen. If he paid for it 2 rupee notes he would have to pay out 3 more notes than if he paid in notes of Rs.5/-. How much did the pen cost?

A. Rs.20 B. Rs.15 C. Rs.10 D. Rs.6

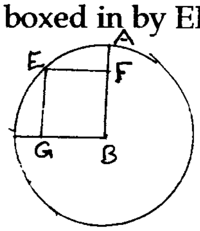
18. Age of Jim is half as that of George. John is 4 years older than Jim. If George is 4 years elder than John, what is the age of John?

A. 16 B. 12 C. 8 D. 4

19. If Raju walks at the speed of 5 km/hr. He will reach the school at correct time. If he reduces his speed to 4 km/hr he will late by 15 mts. What is the distance of the school from Raju's home?

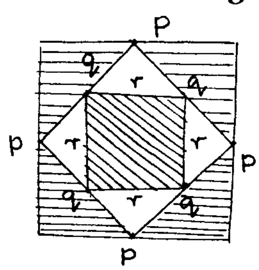
A. 60 km B. 5 km C. 4 km D. 1 km

20. Point B is the centre of this circle. Line AB, the radius of the circle is 2 cm, long. A rectangle is boxed in by EFG and B. Then GF = ?



A. 1 B. $\sqrt{2}$ C. 2 D. $2\sqrt{2}$

21. What is the area of the shaded figures?

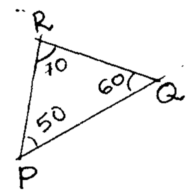


A. $p^2-(q^2+r^2)$ B. $p^2+q^2-r^2$ C. $p^2-q^2+r^2$ D. None of these.

22. If $2a+2b+5c = 9$. If $C = 1$ what is $a+b+c$?

A. 4 B. 3 C. 3 D. 2

23. Which is not true for the triangle given



A. $PR > QR$ B. $PQ > PR$
C. $PQ > RQ$ D. All sides are equal

24. $3x = 2y$; $2y = z$; which letter has highest value?

A. x B. y C. z D. Equal value for all letters.

25. A single line segment can be drawn using two points. Three line segments can be drawn using three points. Then what is the maximum number of line segments that can be drawn using 7 points?

A. 21 B. 12 C. 9 D. 7

PART II

Directions: Find out the first step at which error is committed in the following proofs and write the step number in the separate answer sheet given.

Time: 10 mts.

1.
i) $1/4 < ½$
ii) $(1/2)^2 < ½$
iii) $\log (1/2)^2 < \log ½$
iv) $2 \log ½ < \log ½$
v) Cancelling $\log ½$
$2 < 1$

2. Let $r = s$
i) $r^2 = rs$
ii) $r^2 - s^2 = rs - s^2$
iii) $(r - s)(r + s) = s(r - s)$
iv) cancelling $r - s$ on both sides
$r + s = s$
v) $r + r = s$
$2r = r$
$2 = 1$

3. i) $25 - 25 = 0$

ii) $5 - 5 = 0$

iii) $\dfrac{25 - 25}{5 - 5} = 0$

iv) $\dfrac{5^2 - 5^2}{5 - 5} = 0$

v) $\dfrac{(5+5)(5-5)}{5 - 5} = 0$

$5 + 5 = 10$

i.e. $10 = 0$

4. If $\sqrt{x} = 2$ $\sqrt{y} = 3$

i) $\sqrt{x+y} = 2+3 = 5$

ii) $x+y = 5^2 = 25$

$x+y = 25$

5. We know $-12 = -12$

i) $9 - 21 = 16 - 28$

ii) $3^2 - 7 \times 3 = 4^2 - 7 \times 4$

iii) $3^2 - 2 \times 7/2 \times 3 = 4^2 - 2 \times 7/2 \times 4$

iv) $3^2 - 2 \times 7/2 \times 3 + (7/2)^2 = 4^2 - 2 \times 7/2 \times 4 + (7/2)^2$

v) $(3 - 7/2)^2 = (4 - 7/2)^2$

vi) $3 - 7/2 = 4 - 7/2$

vii) $3 = 4 - (7/2) + (7/2)$

$3 = 4.$

PART III

Direction: After reading each question carefully, write the answer in the separate answer sheet provided. You should be careful in writing question numbers in the answer sheet.

Time: 10 mts

1. A man has one 5 litre and 3 litre buckets. How can he take 7 litres of water correctly using the two buckets.

2. If x and y are positive integers, $x/y = 1$ and $x+y = z$ which is the integer that cannot be value of z. Justify your answer.

   A. 36 B. 9 C. 8 D. 4

3. In a water tank there are two pipes. One fills the tank in 12 hrs and the other empties it in 9 hrs. If these two pipes are opened together, how long will it take to fill the tank? Justify your answer.

4. A box contains 8 lead balls. Seven of them weigh exactly the same, but one is just a bit heavier. Using a balance scale, how can you identify the heaviest ball in just two weighings.

5. There are 3 oranges in a bag. You have to give them to three children equally and you should not cut the orange. At the same time, one orange should be in the bag. How can you do this.

APPENDIX X

TEST OF PROBLEM SOLVING ABILITY IN MATHEMATICS

Indices of Discriminating Power of Items under Part I & Part II and the Item Total Correlation Coefficients for Part III.

Item No.	Dp
1	0.285
2	0.761
3	0.333
4	0.523
5	0.285
6	0.047
7	0.666
8	0.476
9	0.330
10	0.666
11	0.619
12	0.333
13	0.190
14	0.714
15	0
16	0.523
17	0.333
18	0.333
19	0.128
20	0.095
21	0.040
22	0.571
23	0.428
24	0.619
25	0.388

PART II

Item No.	Dp
1	0.095
2	0.047
3	0.285
4	0.476
5	0.142

PART III

Item No.	Coefficient of correlation
1	0.73
2	0.71
3	0.50
4	0.62
5	0.39

APPENDIX XI(a)

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION 2000

TEST OF PROBLEM SOLVING ABILITY IN MATHEMATICS

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നിർദ്ദേശങ്ങൾ

ഈ പരീക്ഷ നിങ്ങളുടെ ഗണിതശാസ്ത്രത്തിലെ പ്രശ്ന പരിഹാരയോഗ്യത അളക്കുന്നതിനുള്ളതാണ് ചോദ്യങ്ങൾ ശ്രദ്ധാപൂർവ്വം വായിച്ച് മനസ്സിലാക്കി ഉത്തരം പ്രത്യേകം തന്നിരിക്കുന്ന ഉത്തരക്കടലാസ്സിൽ അടയാളപ്പെടുത്തുക. ഭാഗം 1, ഭാഗം 2, ഭാഗം 3 എന്നീ മൂന്നുഭാഗങ്ങളിലായാണ് ചോദ്യങ്ങൾ തന്നിരിക്കുന്നത്. ഓരോ ഭാഗത്തിലും അവ ചെയ്യുന്നതിനുള്ള നിർദ്ദേശങ്ങൾ കൊടുത്തിട്ടുണ്ട്. നിശ്ചിത സമയത്തിനുള്ളിൽ ഓരോ പാർട്ടും ചെയ്തു തീർക്കേണ്ടതാണ്.

ഭാഗം 1

ഈ പാർട്ടിൽ തന്നിരിക്കുന്ന ചോദ്യങ്ങൾക്ക് നാല് ഉത്തരങ്ങൾ (ABCD) വീതം കൊടുത്തിരിക്കുന്നു. ഓരോന്നിന്റെയും ശരിയുത്തരം കണ്ടുപിടിച്ച് പ്രത്യേകം തന്നിട്ടുള്ള ഉത്തരക്കടലാസിൽ ആ ഉത്തരത്തെ സൂചിപ്പിക്കുന്ന അക്ഷരത്തിനു താഴെയുള്ള വൃത്തത്തിൽ 'X' രേഖപ്പെടുത്തുക. ഒരിക്കൽ അടയാളപ്പെടുത്തിയ ഉത്തരം തെറ്റാണെന്നു തോന്നിയാൽ അത് ഒരു ചതുരത്തിനുള്ളിലാക്കി പുതിയ ഉത്തരം സൂചിപ്പിക്കുന്ന അക്ഷരം രേഖപ്പെടുത്താവുന്നതാണ്.

സമയം: 30 മിനിട്ട്

1 ഒരു കുളത്തിലെ ആമ്പൽ ഓരോദിവസവും ഇരട്ടിയാകുന്നു. 15 ദിവസം കൊണ്ട് കുളത്തിന്റെ പകുതി നിറയുകയാണെങ്കിൽ കുളം നിറയാൻ എത്ര ദിവസം എടുക്കും?
A. 30 B. 16 C. 15 D. 7 1/2

2 ഒരു പൂച്ചയ്ക്ക് ഒരു എലിയെ കൊല്ലാൻ ഒരു മിനിട്ട് വേണമെങ്കിൽ 60 പൂച്ചകൾക്ക് 60 എലികളെ കൊല്ലാൻ എത്ര സമയം വേണം?

A. 60 മിനിട്ട് B. 6 മിനിട്ട് C. 1 മിനിട്ട് D. 1 മണിക്കൂർ

3 ഒരു വീട്ടിൽ 7 കുട്ടികളുണ്ട് ഓരോ ആൺകുട്ടിക്കും എത്ര സഹോദരൻമാരുണ്ടോ അത്രയും സഹോദരിമാരുണ്ട്. ഓരോ പെൺകുട്ടിക്കും എത്ര സഹോദരിമാരുണ്ടോ അതിന്റെ ഇരട്ടി സഹോദരൻമാരുണ്ട്. എങ്കിൽ ആ വീട്ടിൽ എത്ര സഹോദരിമാരും സഹോദരൻമാരും ഉണ്ട്?
A. 5 സഹോദരിമാർ, 2 സഹോദരൻമാർ B. 4 സഹോദരിമാർ,3 സഹോദരൻമാർ C. 3 സഹോദരിമാർ,4 സഹോദരൻമാർ D. 2 സഹോദരിമാർ,5 സഹോദരൻമാർ.

4 ഒരച്ഛന് 35 വയസ്സുണ്ട് അദ്ദേഹത്തിന്റെ മകന് 2 വയസ്സുണ്ട്. എത്ര വർഷം കഴിഞ്ഞാൽ അച്ഛന്റെ വയസ്സ് മകന്റെ വയസ്സിന്റെ നാലിരട്ടിയാകും ?
A. 5 B.9 C.27 D.33

5 ഒരു ട്രെയിൻ 450 m നീളമുള്ള ഒരു തുരങ്കം കടന്നുപോകാൻ 45 സെക്കന്റും ഒരു ഇലക്ട്രിക് പോസ്റ്റ് കടന്നുപോകാൻ 15 സെക്കന്റും എടുക്കുന്നു. എങ്കിൽ ട്രെയ്നിന്റെ നീളം എത്ര?
A. 450 m B.225 m C.150 m D.10 m.

6 ഒരു പണക്കിഴിയിൽ 700 രൂപയുണ്ട് അതിൽ തുല്യ എണ്ണം 25 പൈസ, 50 പൈസ, ഒരു രൂപാ നാണയങ്ങൾ ആണുള്ളതെങ്കിൽ ഓരോന്നും എത്രയെണ്ണം ഉണ്ട്?

A.700cm B.400cm C.100cm D.10cm.

7 ഹോം വർക്കുചെയ്യാൻ പ്രോത്സാഹനമായി ഒരു കണക്കു ടീച്ചർ വിദ്യാർത്ഥിക്ക് ഓരോ ശരിയുത്തരത്തിനും 8 രൂപാ വാഗ്ദാനം ചെയ്യുന്നു. എന്നാൽ ഒരു ഉത്തരം തെറ്റിയാൽ വിദ്യാർത്ഥി 5 രൂപാ ടീച്ചർക്കു നൽകണം. 26 കണക്കുകൾ ചെയ്തു കഴിഞ്ഞപ്പോൾ ടീച്ചറും വിദ്യാർത്ഥിയും പരസ്പരം കടപ്പെട്ടില്ല എങ്കിൽ എത്ര കണക്കുകൾക്ക് വിദ്യാർത്ഥി ശരിയുത്തരം നൽകി ?.

A.16 B.13 C.10 D.8

8 ഒരു വണ്ടി ചക്രം 10 പ്രാവശ്യം ഉരുളുമ്പോൾ 1570 cm നീങ്ങുന്നു എങ്കിൽ ചക്രത്തിന്റെ വ്യാസം ?

A.500 cm B.157 cm C.50 cm D.25 cm

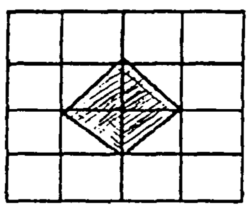
9 ജോണിന് ഒരു ജോലി തീർക്കാൻ 4 മണിക്കൂർ വേണം രാമന് അതേ ജോലി തീർക്കാൻ 5മണിക്കൂർ വേണം. രണ്ടാൾക്കും കൂടി ആ ജോലി തീർക്കാൻ എത്ര മണിക്കൂർ വേണം?.

A.9/20 B.9/2 C.20/9 D.9

10. 4 ഇഞ്ച് വീതിയും 4 ഇഞ്ച് ആഴവും 4 ഇഞ്ച് നീളവുമുള്ള ഒരു ചതുരപ്പെട്ടിയിൽ നിറയ്ക്കാൻ എത്ര ഇഞ്ച് സമചതുരക്കട്ടകൾ വേണ്ടി വരും

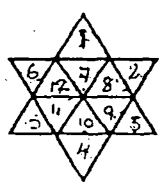
A.4 B.8 C.16 D.64

11 ചിത്രത്തിൽ കാണിച്ചിരിക്കുന്ന ഓരോ സമചതുരത്തിന്റെയും വശത്തിന്റെ നീളം 1 യൂണിറ്റ് ആയാൽ ഷെയ്ഡ് ചെയ്തിരിക്കുന്ന സമചതുരത്തിന്റെ വിസ്തീർണ്ണം ?



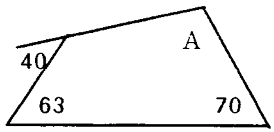
A. 1 ച. യൂണിറ്റ് B. 2 ച.യൂണിറ്റ് C. 4 ച.യൂണിറ്റ് D. 16 ച.യൂണിറ്റ്

12 ചിത്രത്തിൽ എത്ര ത്രികോണങ്ങൾ ഉണ്ട് ?



A.12 B. 14 C.19 D.20

13. ചിത്രത്തിൽ കാണിച്ചിരിക്കുന്ന കോൺ A യുടെ അളവ്?
(അളന്നു നോക്കാതെ വേണം ഉത്തരം എഴുതാൻ)



A . 30 **B. 63** **C. 87** **D.140**

14. രാമൻ ഒരു പേന വാങ്ങി. അയാൾ രണ്ടു രൂപാ നോട്ടുകളാണ് കൊടുക്കുന്നതെങ്കിൽ 5 രൂപാ നോട്ടുകൾ കൊടുക്കുന്നതിനേക്കാൾ 3 നോട്ടുകൾ കൂടുതൽ കൊടുക്കണം. എങ്കിൽ പേനയുടെ വില?

A. 20 രൂപ **B. 15രൂപ** **C. 10രൂപ** **D. 6രൂപ**

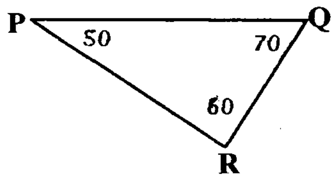
15. ജിമ്മിന്റെ വയസ്സ് ജോർജ്ജിന്റെ വയസ്സിന്റെ പകുതിയാണ്. ജോണിന് ജിമ്മിനേക്കാൾ 4 വയസ്സ് കൂടുതലാണ്. ജോർജിന് ജോണിനേക്കാൾ 4 വയസ്സുകൂടുതലാണെങ്കിൽ ജോണിന്റെ വയസ്സ്?

A. 16 **B. 12** **C. 8** **D.4**

16. $2a + 2b+5c = 9, c = 1$ ആയാൽ $a+b+c$ യുടെ വില?

A.8 **B.4** **C. 3** **D.2**

17. തന്നിരുക്കുന്ന ത്രികോണത്തെ സംബന്ധിച്ച് ശരിയല്ലാത്തത് ഏത്?



A. PR>QR **B. PQ>PR** **C. PQ>RQ** **D. PR=PQ**

18. $3x = 2y, 2y = z$ കൂടുതൽ വിലയുള്ള അക്ഷരം?

A. x **B.y** **C.z** **D.** എല്ലാ അക്ഷരത്തിനും തുല്യ വില

19. രണ്ട് ബിന്ദുക്കൾ ഉപയോഗിച്ച് ഒരു രേഖാഖണ്ഡം വരയ്ക്കാം. മൂന്ന് ബിന്ദുക്കൾ ഉപയോഗിച്ച് പരമാവധി മൂന്ന് രേഖാഖണ്ഡങ്ങൾ വരയ്ക്കാം. എന്നാൽ ഏഴ് ബിന്ദുക്കൾ ഉപയോഗിച്ച് പരമാവധി എത്ര രേഖാഖണ്ഡങ്ങൾ വരയ്ക്കാം?

A. 21 **B. 12** **C.9** **D.7**

ഭാഗം II

താഴെ കൊടുത്തിരിക്കുന്ന തെളിവുകൾ പരിശോധിച്ച് തെറ്റുള്ള ഭാഗം കണ്ടെത്തി ഏതു സ്റ്റെപ്പിലാണോ ആദ്യമായി തെറ്റു വന്നിരിക്കുന്നത് ആ സ്റ്റെപ്പിന്റെ നമ്പർ ഉത്തരക്കടലാസിൽ എഴുതുക. (സമയം 5 മിനിട്ട്)

i $25-25 = 0$

$5-5 = 0$

ii $\frac{25-25}{5-5} = 0$

iii $\frac{5^2-5^2}{5-5} = 0$

iv $\frac{(5+5)(5-5)}{5-5} = 0$

v $5 + 5 = 0$

$10 = 0$

2 $-12 = -12$

i $9 - 21 = 16 - 28$

ii $3^2 - 7 \times 3 = 4^2 - 7 \times 4$

iii $3^2 - 2 \times (7/2) \times 3 = 4^2 - 2 \times (7/2) \times 4$

iv $3^2 - 2 \times (7/2) \times 3 + (7/2)^2 = 4^2 - 2 \times (7/2) \times 4 + (7/2)^2$

v $\{3 - (7/2)\}^2 = \{4 - (7/2)\}^2$

vi $3 - (7/2) = 4 - (7/2)$

vii $3 = 4 - (7/2) + (7/2)$

$3 = 4$

ഭാഗം III

താഴെ തന്നിരിക്കുന്ന ചോദ്യങ്ങൾക്ക് വിശദമായി ഉത്തരം എഴുതേണ്ടതാണ്. ഓരോ ചോദ്യവും ശ്രദ്ധാപൂർവ്വം വായിച്ച് പ്രത്യേകം തന്നിരിക്കുന്ന ഉത്തരക്കടലാസിൽ, ചോദ്യനമ്പർ ഇട്ടതിനുശേഷം വ്യക്തമായി ഉത്തരമെഴുതുക.

സമയം: 10 മിനിട്ട്

1 ഒരു 5 ലിറ്റർ പാത്രവും ഒരു 3 ലിറ്റർ പാത്രവും തന്നിരുന്നാൽ എങ്ങനെ 7 ലിറ്റർ കൃത്യമായി അളന്നെടുക്കും ?.

2 x-ഉം y ഉം രണ്ടു പോസിറ്റീവ് പൂർണ്ണസംഖകളാണ്. $x/y=1$ ഉം $x+y=z$ ഉം ആയാൽ താഴെ തന്നിരിക്കുന്നവയിൽ z ന്റെ വിലയാകാൻ സാധ്യതയില്ലാത്തതേത് ?. കാരണം വിശദീകരിക്കുക ?.

A.36 B.8 C.4 D.9

3 ഒരു വാട്ടർ ടാങ്കിൽ രണ്ടു പൈപ്പുകളുണ്ട്. ഒന്ന് 12 മണിക്കൂർ കൊണ്ട് ടാങ്ക് നിറക്കുന്നു. മറ്റേത് 8 മണിക്കൂർ കൊണ്ട് കാലിയാക്കുന്നു. രണ്ടു പൈപ്പുകളും ഒരേ സമയം തുറന്നിട്ടിരുന്നാൽ എത്ര സമയം കൊണ്ട് ടാങ്ക് നിറയും, വിശദീകരിക്കുക ?.

4 ഒരു പെട്ടിയിൽ 8 ഈയക്കട്ടകൾ ഉണ്ട്. അവയിൽ 7 എണ്ണം തുല്യ ഭാരമുള്ളവയാണ്, ഒന്ന് അല്പം ഭാരക്കൂടുതലുള്ളതുമാണ്. ഒരു ത്രാസുപയോഗിച്ച് കൃത്യം രണ്ടു പ്രാവശ്യം അളന്നുനോക്കുന്നതിലൂടെ ഭാരക്കൂടുതലുള്ള ഈയക്കട്ട എങ്ങനെ കണ്ടെത്താം ?

(സൂചന: 3 വീതം രണ്ടു തട്ടിലും വച്ചാൽ രണ്ട് എണ്ണം ബാക്കിയാകും.)

5 ഒരു കുട്ടയിൽ 3 ഓറഞ്ചുണ്ട്. 3 കുട്ടികൾക്ക് ആ ഓറഞ്ചുകൾ തുല്യമായി പങ്കിട്ടു കൊടുക്കണം. അതേ സമയം കുട്ടയിൽ ഒരു ഓറഞ്ച് ഉണ്ടായിരിക്കണം. ഓറഞ്ച് മുറിക്കാൻ പാടില്ല. എങ്കിൽ ഇതെങ്ങനെ സാധിക്കും ?.

APPENDIX XI(b)

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION 2000

TEST OF PROBLEM SOLVING ABILITY IN MATHEMATICS

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Reader in Education
University of Calicut

Vijayakumari, K.
Research Scholar
Department of Education.

Direction: This is a test to measure your ability in solving problems related to Mathematics. Answer each question after careful reading and mark your response in the separate answer sheet given. There are three parts for this test viz., Part I, II and III and separate directions are given for doing these parts. Each part should be completed within the allotted time.

PART I

In this part each question has four options (A, B, C, D). You have to find the correct answer and mark 'X' on the circle corresponding to the letter carrying the correct answer in your answer sheet. If you want to change the answer after marking it, you should draw a square (□) around it and then mark the correct answer.

Time: 30 mts.

1. A lily on a pond doubles its size every day. If in 15 days it covers half the pond, how long will it take to cover the whole pond?

   A. 30 B. 16 C. 15 D. 7.5

2. If a cat can kill a rat in 1 minute, how long will 60 cats take to kill 60 rats?

   A. 60 mts B. 6 mts. D. 1 mts. D. 1 hr

3. A family has seven children each boy in this family has as many sisters as his brothers, but each girl has twice as many brothers as her sisters. How many brothers and sisters are in the family?

   A. 5 sisters and 2 brothers
   B. 4 sisters and 3 brothers
   C. 1 sister and 6 brothers
   D. 3 sisters and 4 brothers

4. A father is 35 years old and his son is 2. After how many years will the father be 4 times as old as his son?

A. 5 B. 9 C. 27 D. 33

5. A train passes through a tunnel 450 m long in 45 seconds and goes past a post in 15 seconds. The length of the train is

A. 450 m B. 225 m C. 150 m D. 10 m

6. A money pouch contains Rs.700/-. There are equal number of 25 paise coins, 50 paise coins and one rupee coins. How many of each are there?

A. 700 B. 400 C. 100 D. 10

7. In an effort to motivate a student to do her home work a mathematics teacher offered to pay the student Rs.8/- for each correct answer on her assignment and to fine her Rs.5/- for each incorrect answer. After the student had worked 26 problems, (assume that no problem is omitted) it was discovered that neither person owed money to the other. How many problems did the student solve correctly.

A. 16 B. 13 C. 10 D. 8

8. What is the diameter of an automobile wheel if the distance covered by the wheel in ten rotations is 1570 cm?

A. 500 cm B. 157 cm C. 50 cm D. 25 cm

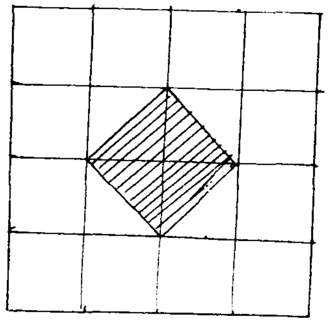
9. John can complete a job in a 4 hrs, and Ram can complete it in 5 hrs. How long will the boys take to complete it together?

A. 9/20 hrs. B. 9/2 hrs. C. 20/9 hrs. D. 9 hrs.

10. What is the greatest possible number of 1 inch cubes that can be placed into an empty box, 4 inches wide by 4 inches deep by 4 inches long.

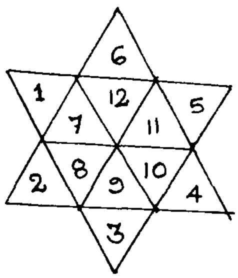
A. 4 B. 8 C. 16 D. 64

11. Each of the 16 small squares in Fig. is of side 1 unit. What is the area of the shaded square?



A. 1 Sq. units B. 2 Sq. units C. 4 Sq. units D. 16 Sq. units

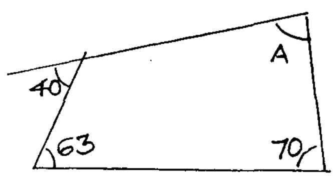
12. How many triangles are there in the figure.



A. 12 B. 14 C. 19 D. 20

13. What is the measure of the angle A in the figure (without measuring directly)?

A. 30 B. 63
C. 87 D. 140



14. Ram bought a pen. If he paid for it 2 rupee notes he would have to pay out 3 more notes than if he paid in notes of Rs.5/-. How much did the pen cost?

A. Rs.20 B. Rs.15 C. Rs.10 D. Rs.6

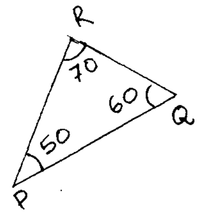
15. Age of Jim is half as that of George. John is 4 years older than Jim. If George is 4 years elder than John, what is the age of John?

A. 16 B. 12 C. 8 D. 4

16. If $2a+2b+5c = 9$. If $C = 1$ what is $a+b+c$?

A. 4 B. 3 C. 3 D. 2

17. Which is not true for the triangle given



A. PR > QR B. PQ > PR
C. PQ > RQ D. All sides are equal

18. $3x = 2y$; $2y = z$; which letter has highest value?

A. x B. y C. z D. Equal value for all letters.

19. A single line segment can be drawn using two points. Three line segments can be drawn using three points. Then what is the maximum number of line segments that can be drawn using 7 points?

A. 21 B. 12 C. 9 D. 7

PART II

Directions: Find out the first step at which error is committed in the following proofs and write the step number in the separate answer sheet given.

Time:4 mts.

1. i) $25 - 25 = 0$

ii) $5 - 5 = 0$

iii) $$\frac{25 - 25}{5 - 5} = 0$$

iv) $$\frac{5^2 - 5^2}{5 - 5} = 0$$

v) $$\frac{(5+5)(5-5)}{5 - 5} = 0$$

$5 + 5 = 10$

i.e. $10 = 0$

2. If $\sqrt{x} = 2$ $\sqrt{y} = 3$

i) $\sqrt{x}+y = 2+3 = 5$

ii) $x+y = 5^2 = 25$

$x+y = 25$

PART III

Direction: After reading each question carefully, write the answer in the separate answer sheet provided. You should be careful in writing question numbers in the answer sheet.

Time: 10 mts

1. A man has one 5 litre and 3 litre buckets. How can he take 7 litres of water correctly using the two buckets.

2. If x and y are positive integers, x/y = 1 and x+y = z which is the integer that cannot be value of z. Justify your answer.

   A. 36 B. 9 C. 8 D. 4

3. In a water tank there are two pipes. One fills the tank in 12 hrs and the other empties it in 9 hrs. If these two pipes are opened together, how long will it take to fill the tank? Justify your answer.

4. A box contains 8 lead balls. Seven of them weigh exactly the same, but one is just a bit heavier. Using a balance scale, how can you identify the heaviest ball in just two weighings.

5. There are 3 oranges in a bag. You have to give them to three children equally and you should not cut the orange. At the same time, one orange should be in the bag. How can you do this.

APPENDIX XII

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION 1996

SCALE OF ACHIEVEMENT MOTIVATION IN MATHEMATICS

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Instruction:

This is to measure secondary school pupils striving to attain expected goals by lerning Mathematics. This has 51 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 avoid difficult mathematics problems.
9. I am adament in completing the work assigned by my mathematics teacher within specified time.
10. It is obligatory that I shall get good marks in Mathematics examinations.
11. All my friends are good at Mathematics.
12. When I fail to understand what I learn in Mathematics I think that, I need not learn any Mathematics at all.

13. I am satisfied by my excellence in Mathematics.

14. I feel satisfaction when I am successful in completing difficult mathematical tasks.

15. I proudly show my mathematical ability in front of my peers.

16. I get depressed when others comment on my poor standard in Mathematics.

17. I have only inadequate opportunity for better mathematics learning.

18. I desire to be accepted in my mathematics class.

19. When I am successful in working out one problem, I tend to do the next immediately.

20. I respect those who perform well in Mathematics.

21. I want, I should be the No.1 in Mathematics learning.

22. Others should consider me as a model in Mathematics learning.

23. I am afraid to face the questions of my mathematics teacher.

24. Eventhough I am the top scorer in the class, I study Mathematics very carefully.

25. Leadership in all mathematical activities will be on me.

26. I am sure that I will succeed in life through mathematics learning.

27. I like to sit in backbench in the mathematics class without being noticed by anyone.

28. I wish to have higher studies in Mathematics as much as possible.

29. I work hard to defeat bright students in Mathematics competitions.

30. I feel jealous of others when they do mathematical activities more efficiently than me.

31. I like to compete with students who are good at Mathematics.

32. I don't take part in competitions related to Mathematics because of the fear of under performance when compared to others.

33. I don't like to compare my standard in Mathematics with others.

34. I take part and win prizes in mathematical competitions.

35. I volunteer myself first when Mathematics teacher asks to do the problem in the blackboard.

36. I do not permit any body to copy from my mathematics notebook.

37. I like to know more about Mathematics related matters which are not in the syllabus.

38. I get motivated in learning Mathematics by the small bits of appreciation.

39. I utilize the opportunities maximum to enrich my mathematical knowledge.

40. Getting a pass in the exams is my goal rather than attaining high knowledge in Mathematics.

41. I work hard to maintain my first place in Mathematics in the class.

42. Eventhough I study a small portion in Mathematics, I insist to make it thoroughly.

43. My achievement in Mathematics is the result of my hardwork.

44. I doubt whether my learning style is enough to achieve high grades in Mathematics.

45. I prefer easy problems to hard and lengthy ones.

46. I like to learn new lessons than revising the learnt one.

47. I wish my friends clarify their doubts in Mathematics by asking me.

48. I want to be the only person who can answer all the questions of my Mathematics teacher.

49. I desire the teacher to ask me to help those who are poor in Mathematics

50. I want to be the leader in all the mathematical activities.

51. I like to escape from activities related to Mathematics.

APPENDIX XIII

SCALE OF ACHIEVEMENT MOTIVATION IN MATHEMATICS

't' Values of the Statements in the Draft Scale

Statement No.	t-values
1	2.52
2	8.76
3	4.71
4	2.54
5	4.82
6	3.99
7	5.03
8	1.51
9	4.92
10	2.72
11	2.72
12	2.38
13	3.30
14	2.85
15	5.92
16	5.23
17	3.55
18	5.13
19	5.94
20	2.56
21	6.30
22	2.47
23	1.71
24	7.63
25	3.84
26	4.16
27	5.65
28	5.08
29	8.26
30	0.38
31	8.44
32	2.04
33	0.62
34	3.02
35	5.51
36	0.19
37	2.10
38	5.08
39	3.94
40	1.65
41	8.00
42	5.43
43	4.87
44	3.16
45	0.61
46	1.59
47	3.30
48	3.58
49	4.73
50	2.96
51	1.80

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION 2000

SCALE OF ACHIEVEMENT MOTIVATION IN MATHEMATICS

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നിർദ്ദേശങ്ങൾ:-

ഗണിതശാസ്ത്രത്തിൽ നേട്ടം കൈവരിക്കാനുള്ള നിങ്ങളുടെ അഭിപ്രേരണ അറിയുവാനുള്ള ഒരു പരീക്ഷയാണിത്. 42 പ്രസ്താവനകാളാണ് ഇതിൽ ഉള്ളത് ഓരോ പ്രസ്താവനയ്ക്കും മൂന്നുതരത്തിൽ പ്രതികരണം ആകാം. എല്ലായ്പോഴും (Always), ചിലപ്പോൾ (Sometimes), ഒരിക്കലുമില്ല (Never)എന്നിങ്ങനെ ഇവ യഥാക്രമം A,B,C എന്ന അക്ഷരങ്ങൾ കൊണ്ട് സൂചിപ്പിച്ചിരിക്കുന്നു. ഓരോ പ്രസ്താവനയ്ക്കും നിങ്ങളുടെ പ്രതികരണം (A,B or C)പ്രത്യേകം തന്നിരിക്കുന്ന ഉത്തരക്കടലാസിൽ പ്രസ്താവനകളുടെ നമ്പറിനെതിരെ, ആ പ്രതികരണത്തിനെ സൂചിപ്പിക്കുന്ന അക്ഷരത്തിനു ചുവടെയുള്ള വൃത്തത്തിൽ 'X' എന്ന ചിഹ്നം കൊണ്ട് രേഖപ്പെടുത്തുക. എല്ലാ പ്രസ്താവനകൾക്കും പ്രതികരണം രേഖപ്പെടുത്തേണ്ടതാണ്.

1. ക്ലാസ്സിലെ മറ്റു കുട്ടികൾക്ക് ചെയ്യാൻ കഴിയാത്തതരം ഗണിതപ്രശ്നങ്ങൾ ചെയ്യാനാണ് എനിക്കിഷ്ടം.
2. ഗണിത ശാസ്ത്രത്തിലെ വിഷമമേറിയ പാഠഭാഗങ്ങൾ സമയമെടുത്തായാലും ഞാൻ പഠിക്കും.
3. ഓരോ ദിവസവും ക്ലാസ്സിൽ പഠിപ്പിക്കുന്ന കണക്കുകൾ അന്നുതന്നെ ചെയ്തു പഠിക്കണമെന്ന് എനിക്ക് നിർബന്ധമാണ്.
4. ക്ലാസ്സിലെ മറ്റു കുട്ടികളുടെ നോട്ടുബുക്കിൽ നിന്നും ഹോം വർക്കുകൾ ഞാൻ പകർത്താറുണ്ട്.
5. ദിവസത്തിൽ കൂടുതൽ സമയവും ഗണിതശാസ്ത്ര പഠനത്തിനായി ഞാൻ ഉപയോഗിക്കുന്നു.
6. ഓരോ ദിവസവും അടുത്തദിവസം മുതൽ കണക്കു പഠിക്കാം എന്നു കരുതി ഞാൻ മാറ്റി വെക്കാറുണ്ട്.
7. ക്ലാസ്സിൽ ചെയ്യിക്കാത്ത, പാഠപുസ്തകത്തിലുള്ള ഗണിത പ്രശ്നങ്ങൾ ഞാൻ ചെയ്യാറുണ്ട്.
8. ഗണിതശാസ്ത്ര അധ്യാപകൻ/അധ്യാപിക എന്നെ ഏൽപിക്കുന്ന ജോലികൾ നിശ്ചിത സമയത്തിനുള്ളിൽ തന്നെ ചെയ്തു തീർക്കണമെന്ന് എനിക്ക് നിർബന്ധമാണ്.
9. ഗണിതശാസ്ത്ര പരീക്ഷയിൽ നല്ല മാർക്ക് വാങ്ങണമെന്ന് എനിക്ക് നിർബന്ധമാണ്.
10. ഗണിതശാസ്ത്രത്തിൽ മിടുക്കരായവരാണ് എന്റെ കൂട്ടുകാരെല്ലാം.
11. പഠിക്കുന്ന ഭാഗം മനസ്സിലാകാതെ വരുമ്പോൾ ഇനി ഗണിതശാസ്ത്രം പഠിക്കുകയേ വേണ്ട എന്നു തോന്നാറുണ്ട്.

12. ഗണിതശാസ്ത്രത്തിലുള്ള എന്റെ മികവിൽ ഞാൻ സംതൃപ്തനാണ്
13. ബുദ്ധിമുട്ടുള്ള ഗണിതശാസ്ത്ര ഭാഗങ്ങൾ പഠിച്ചു കഴിയുമ്പോൾ എനിക്ക് സംതൃപ്തി തോന്നാറുണ്ട്.
14. ഗണിതശാസ്ത്രത്തിലുള്ള കഴിവുകൾ കൂട്ടുകാരുടെ മുന്നിൽ ഞാൻ അഭിമാനത്തോടെ പ്രകടിപ്പിക്കാറുണ്ട്.
15. ഗണിതശാസ്ത്രത്തിലെ എന്റെ നിലവാരം മോശമാണെന്ന് ആരെങ്കിലും പറഞ്ഞാൽ എനിക്ക് നിരാശ തോന്നാറുണ്ട്.
16. മെച്ചപ്പെട്ട ഗണിതശാസ്ത്ര പഠനത്തിന് എനിക്ക് ലഭിക്കുന്ന അവസരങ്ങൾ അപര്യാപ്തമാണ്.
17. ഗണിതശാസ്ത്ര ക്ലാസ്സിൽ അംഗീകരിക്കപ്പെടണമെന്ന് എനിക്ക് നിർബന്ധമാണ്.
18. ഒരു ഗണിത പ്രശ്നം ചെയ്തു കഴിഞ്ഞാൽ അടുത്തതും ഉടനെ ചെയ്യണമെന്ന് എനിക്ക് തോന്നാറുണ്ട്.
19. ഗണിതശാസ്ത്രത്തിൽ ഉന്നത നിലവാരം പുലർത്തുന്നവരെ ഞാൻ ബഹുമാനിക്കുന്നു.
20. ഗണിതശാസ്ത്രത്തിൽ ഞാനായിരിക്കണം ഒന്നാമൻ എന്ന് എനിക്ക് നിർബന്ധമാണ്.
21. ഗണിതശാസ്ത്ര പഠനത്തിൽ മറ്റുള്ളവർ എന്നെ മാതൃകയാക്കേണ്ടതാണ്.
22. ഗണിതശാസ്ത്രത്തിൽ ഒന്നാമനെങ്കിൽ കൂടിയും കൂടുതൽ ശ്രദ്ധയോടെ ഞാൻ ഗണിതശാസ്ത്രം പഠിക്കാറുണ്ട്.
23. ഗണിതശാസ്ത്ര സംബന്ധിയായ പ്രവർത്തനങ്ങളിൽ നേതൃസ്ഥാനം എനിക്കായിരിക്കും.
24. ഗണിതശാസ്ത്ര പഠനത്തിലൂടെ ജീവിത വിജയം നേടാം എന്ന് എനിക്ക് ഉറപ്പുണ്ട്.
25. ഗണിതശാസ്ത്ര ക്ലാസ്സിൽ ആരുടേയും ശ്രദ്ധയിൽപെടാതെ ഏറ്റവും പിന്നിൽ ഇരിക്കാനാണ് എനിക്കിഷ്ടം.
26. ഗണിതശാസ്ത്രത്തിൽ എത്രത്തോളം ഉന്നത പഠനം ആകാമോ അത്രയും നടത്തണെന്നാണ് എന്റെ മോഹം.
27. സമർത്ഥരായ കുട്ടികളെ ഗണിതശാസ്ത്ര മത്സരങ്ങളിൽ പരാജയപ്പെടുത്താൻ ഞാൻ കഠിന പ്രയത്നം ചെയ്യാറുണ്ട്.
28. ഗണിതശാസ്ത്രത്തിൽ മിടുക്കരായവരോടൊപ്പം മത്സരിക്കുന്നതാണ് എനിക്കിഷ്ടം
29. എന്റെ പ്രകടനം മറ്റുള്ളവരുടേതിനേക്കാൾ മോശമാകുമോ എന്ന ഭയംമൂലം ഗണിതശാസ്ത്രവുമായി ബന്ധപ്പെട്ട മത്സരങ്ങളിൽ ഞാൻ പങ്കെടുക്കാറില്ല.
30. ഗണിതശാസ്ത്ര സംബന്ധിയായ മത്സര പരീക്ഷകളിൽ ഞാൻ പങ്കെടുത്ത് സമ്മാനം വാങ്ങാറുണ്ട്.
31. ബോർഡിൽ കണക്കു ചെയ്യാൻ അധ്യപകൻ/അധ്യാപിക നിർദ്ദേശിച്ചാൽ ആദ്യം മുന്നോട്ടു ചെല്ലുന്നത് ഞാനായിരിക്കും.

32. പാഠ്യപദ്ധതിയിൽ ഇല്ലാത്തതാണെങ്കിലും ഗണിതശാസ്ത്രവുമായി ബന്ധപ്പെട്ട കാര്യങ്ങൾ മനസ്സിലാക്കാൻ ഞാനിഷ്ടപ്പെടുന്നു.
33. ഗണിതശാസ്ത്ര പഠനത്തിൽ എനിക്ക് ലഭിക്കുന്ന ചെറിയ പ്രോത്സാഹനം പോലും എനിക്ക് പ്രചോദനമാകാറുണ്ട്.
34. ഗണിതശാസ്ത്രത്തിലെ എന്റെ അറിവിനെ വർദ്ധിപ്പിക്കാനുതകുന്ന അവസരങ്ങൾ ഞാൻ പരമാവധി ഉപയോഗപ്പെടുത്താറുണ്ട്.
35. ഗണിതശാസ്ത്രത്തിലുള്ള എന്റെ ഒന്നാം സ്ഥാനം നഷ്ടപ്പെടാതിരിക്കുവാൻ ഞാൻ പ്രയത്നിക്കുന്നു.
36. വളരെക്കുറച്ചു മാത്രമേ പഠിച്ചിട്ടുള്ളൂ എങ്കിലും പഠിച്ച ഭാഗങ്ങൾ വ്യക്തമായി മനസ്സിലാക്കണം എന്ന് എനിക്ക് നിർബന്ധമാണ്.
37. കഠിന പ്രയത്നത്തിന്റെ ഫലമാണ് ഗണിതശാസ്ത്രത്തിലുള്ള എന്റെ നേട്ടം
38. ഗണിതശാസ്ത്രത്തിൽ ഉന്നത വിജയം നേടുന്നതിന് ഉതകുന്നതാണോ എന്റെ പഠന രീതി എന്ന് എനിക്ക് സംശയം തോന്നാറുണ്ട്.
39. ഗണിതശാസ്ത്രത്തിലെ സംശയങ്ങൾ കൂട്ടുകാർ എന്നോടു ചോദിച്ചിരുന്നെങ്കിൽ എന്ന് ഞാൻ ആഗ്രഹിക്കാറുണ്ട്.
40. ഗണിതശാസ്ത്ര ക്ലാസ്സിൽ അദ്ധ്യാപകന്റെ എല്ലാ ചോദ്യങ്ങൾക്കും ഉത്തരം പറയാൻ കഴിയുന്നത് എനിക്ക് മാത്രമായിരിക്കണം എന്നു ഞാൻ ആഗ്രഹിക്കുന്നു.
41. ഗണിതശാസ്ത്രത്തിൽ പിന്നോക്കം നിൽക്കുന്ന കുട്ടികളെ സഹായിക്കാൻ അദ്ധ്യാപകൻ എന്നെ ചുമതലപ്പെടുത്തണം എന്നാണ് എന്റെ ആഗ്രഹം.
42. ഗണിതശാസ്ത്ര പ്രവർത്തനങ്ങളിൽ നേതൃസ്ഥാനം എനിക്കാകണമെന്ന് ഞാൻ ആഗ്രഹിക്കുന്നു.

APPENDIX XIV(b)

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION 2000

SCALE OF ACHIEVEMENT MOTIVATION IN MATHEMATICS

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Instruction:

This is to measure secondary school pupils striving to attain expected goals by lerning 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 adament 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 appreciation.

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 teacher to ask me to help those who are poor in Mathematics
42. I want to be the leader in all the mathematical activities.

APPENDIX XV

DEPARTMENT OF EDUCATION 1996
UNIVERSITY OF CALICUT

MATHEMATICS INTEREST INVENTORY

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Vijayakumari. K.
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Department of Education

Instruction:

This is to find how far secondary school students are interested in activities related to Mathematics. 35 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. Making a garden.
   B. Making kitchen garden.
   C. Making differnt types of geometrical figures.

3. A. Reading children's publications like Poompatta, Balarama etc.
   B. Reading magazines on Mathematics.
   C. Reading books on Science Fictions.

4. Listening radio programme on
   A. Mathematics
   B. Hindi lessons
   C. Non-formal education.

5. Discuss with others about
   A. Current political issues
   B. Modern scientific inventions
   C. The scope of modern Mathematics

6. A. Solving mathematical problems
   B. Conducting scientific experiments
   C. Enriching English vocabulary.

7. Learning

   A. Rules of different games
   B. The working of machines
   C. Mathematical games.

8. In magazines and other publications

   A. Attempt word puzzles
   B. Find out answers to mathematical puzzles
   C. Colour pictures.

9. On holidays
   A. Watch films
   B. Play games
   C. Do mathematical problems.

10. A. Helping parents in preparing the family budget
    B. Purchasing the household things
    C. Helping in household chores.

11. A. Observing birds
    B. Identifying geometrical figures present in nature.
    C. Observing the sky.

12. A. Experimenting with instruments
    B. Making different patterns using geometrical figures
    C. Making card board models of different countries.

13. In the school, help in conducting

    A. Sports meet
    B. Mathematics exhibition
    C. Arts festival

14. Taking part in

    A. Literary meetings
    B. Mathematical club
    C. Political meetings

15. Preparing a chart of

    A. Mathematical formula
    B. The contributions of renowned scientists
    C. Famous writers and their works

16. To discuss with friends about

    A. The ways and means of making the learning of Mathematics interesting.
    B. Health issues
    C. The environmental issues

17. A. Making a library on literary works
    B. Making a library of Mathematics
    C. Making a library of History

18. Helping the brother/sister in learning

    A. Languages
    B. Mathematics
    C. Science

19. To see

    A. Sports meet
    B. Cultural programme
    C. Mathematical exhibitions

20. A. Preparing description on modern scientific inventions
    B. Writing an article on the influence of language.
    C. Writing an essay on the importance of Mathematics in daily life.

21. Delivering a speech on

    A. Political issues
    B. The utility of Mathematics
    C. The benefit of Science.

22. 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

23. Taking part in

    A. Mathematics quiz
    B. Science quiz
    C. Quiz on History

24. Daily learn

    A. Science
    B. Mathematics
    C. Social Sciences

25. Understanding the usage of

    A. Language dictionary
    B. Mathematical dictionary
    C. Science dictionary

26. Doing higher studies in

    A. Science
    B. Literature
    C. Mathematics

27. A. Solving difficult mathematical problems
    B. Conducting Scientific experiments
    C. Locating countries and places in the world map

28. Listening the description regarding

    A. The progress of Science
    B. The cultural progress of humanity
    C. The contribution of Mathematics to the modern world.

29. 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 excercises.

30. Reading the biography of

    A. The famous mathematician Srinivasa Ramanuja
    B. The great leader Mahatma Gandhi
    C. The poet Rabindranath Tagore

31. Reading books on

   A. Ancient Indian Mathematics
   B. Astronomy
   C. Plants and Animals

32. Obtaining a job on

   A. Teaching
   B. Construction and operation of machines
   C. Operating computers

33. During holidays learn

   A. Typewriting
   B. Computer
   C. Cycling

34. 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.

35. Being a member of

   A. Literary association
   B. Sports Club
   C. Mathematics club.

APPENDIX XVI

MATHEMATICS INTEREST INVENTORY

't' Values of the set of Activities in the Draft Inventory

Statement No.	t-values
1	2.69
2	2.34
3	3.25
4	5.35
5	6.28
6	1.52
7	11.50
8	5.76
9	5.76
10	2.71
11	2.92
12	4.09
13	6.76
14	7.29
15	3.79
16	3.78
17	4.09
18	7.29
19	3.25
20	1.29
21	4.18
22	4.10
23	6.76
24	5.39
25	8.38
26	8.93
27	3.56
28	3.10
29	3.39
30	3.78
31	3.81
32	2.72
33	3.47
34	3.66
35	5.76

DEPARTMENT OF EDUCATION 2000
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MATHEMATICS INTEREST INVENTORY

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നിർദ്ദേശങ്ങൾ:

നിങ്ങൾ സാധാരണയായി ചെയ്യാനിഷ്ടപ്പെടുന്ന പ്രവൃത്തികൾ A, B, C എന്ന് മൂന്നുവീതമുള്ള 35 ഗണങ്ങളായി തന്നിരിക്കുന്നു. ഓരോ ഗണത്തിലേയും മൂന്നു പ്രവൃത്തികളും ചെയ്യുന്നതിന് നിങ്ങൾക്ക് ഒരുപോലെ സ്വാതന്ത്ര്യവും സാഹചര്യങ്ങളും ഉണ്ടെങ്കിൽ അവയിൽ നിങ്ങൾ ഏറ്റവും ഇഷ്ടപ്പെടുന്ന/ മുൻതൂക്കം കൊടുക്കുന്ന പ്രവൃത്തി ഏതാണ് എന്ന് തീരുമാനിക്കുക. പ്രത്യേകം തന്നിരിക്കുന്ന ഉത്തര കടലാസിൽ ക്രമമനുസരിച്ച് നിങ്ങൾ ചെയ്യാനിഷ്ടപ്പെടുന്ന / മുൻതൂക്കം കൊടുക്കുന്ന പ്രവൃത്തിയെ സൂചിപ്പിക്കുന്ന അക്ഷരത്തിന് (A, B, C) ചുറ്റുമുള്ള വൃത്തത്തിൽ 'X' എന്ന ചിഹ്നം രേഖപ്പെടുത്തുക.

1
- A വിവിധ രാജ്യങ്ങളിലെ നാണയങ്ങൾ ശേഖരിച്ച് സൂക്ഷിക്കുക
- B ജ്യാമിതീയ രൂപങ്ങളുടെ ചിത്രങ്ങൾ ശേഖരിക്കുക
- C വിവിധതരം സ്റ്റാമ്പുകൾ ശേഖരിക്കുക

- A ബാലരമ, പൂമ്പാറ്റ തുടങ്ങിയ കുട്ടികളുടെ പ്രസിദ്ധീകരണങ്ങൾ വായിക്കുക
- B ഗണിതശാസ്ത്ര മാസികകൾ വായിക്കുക
- C ശാസ്ത്ര കൗതുകങ്ങൾ (Science fiction) പ്രതിപാദിക്കുന്ന പ്രസിദ്ധീകരണങ്ങൾ വായിക്കുക

3 റേഡിയോവിൽ കൂടി
- A ഗണിതശാസ്ത്ര പരിപാടികൾ കേൾക്കുക
- B ഹിന്ദിപാഠം കേൾക്കുക
- C അനൗപചാരിക വിദ്യാഭ്യാസ പരിപാടി കേൾക്കുക

4 സഹപാഠികളുമായി
- A ആനുകാലിക രാഷ്ട്രീയാനുഭവങ്ങളെ പറ്റി ചർച്ച ചെയ്യുക
- B ആധുനിക ശാസ്ത്രീയ കണ്ടുപിടുത്തങ്ങളെ പറ്റി ചർച്ച ചെയ്യുക
- C ആധുനിക ഗണിതശാസ്ത്രത്തിന്റെ സാധ്യതകളെ പറ്റി ചർച്ച ചെയ്യുക

5
- A വിവിധ കളികളുടെ നിയമങ്ങൾ പഠിക്കുക
- B യന്ത്രങ്ങളുടെ പ്രവർത്തനങ്ങൾ പഠിക്കുക
- C കണക്കിലൂടെയുള്ള കളികൾ പഠിക്കുക

6 മാസികകളിലും മറ്റു പ്രസിദ്ധീകരണങ്ങളിലും വരുന്ന
- A പദപ്രശ്നം ചെയ്യുക
- B ഗണിതശാസ്ത്രവുമായി ബന്ധപ്പെട്ട വിഷമപ്രശ്നങ്ങൾക്ക് (puzzles) ഉത്തരം കണ്ടെത്തുക
- C ചിത്രങ്ങൾക്ക് നിറം കൊടുക്കുക

7 ഒഴിവുദിനങ്ങളിൽ
- A സിനിമ കാണുക
- B കളികളിൽ ഏർപ്പെടുക
- C ഗണിത പ്രശ്നങ്ങൾ ചെയ്യുക

8
- A വീട്ടിലെ വരവു ചിലവു കണക്കുകൾ തയ്യാറാക്കുവാൻ അച്ഛനമ്മമാരെ സഹായിക്കുക
- B വീട്ടിലെ സാധനങ്ങൾ വാങ്ങിക്കൊണ്ടു വരിക
- C വീട്ടുപണികളിൽ സഹായിക്കുക
  (വീട്ടുപകരണങ്ങൾ റിപ്പേർ ചെയ്യുക/കേടുപാടുകൾ തീർക്കുക)

9
- A പക്ഷികളെ നിരീക്ഷിക്കുക
- B പ്രകൃതിയിലെ ജ്യാമിതീയ രൂപങ്ങൾ കണ്ടെത്തുക
- C വാനനിരീക്ഷണം നടത്തുക

10
A വിവിധതരം ലഘുയന്ത്രങ്ങൾ നിർമ്മിക്കുക
B വിവിധ ജ്യാമിതീയ രൂപങ്ങൾ ചേർത്ത് പുതിയ പാറ്റേണുകൾ ഉണ്ടാക്കുക
C വ്യത്യസ്ത രാജ്യങ്ങളുടെ കാർഡ് ബോർഡ് മാതൃകകൾ നിർമ്മിക്കുക

11 സ്കൂളിൽ
A കായിക മത്സരങ്ങൾ നടത്താൻ സഹായിക്കുക
B ഗണിതശാസ്ത്രമേള സംഘടിപ്പിക്കുവാൻ സഹായിക്കുക
C കലാ മത്സരങ്ങൾ നടത്താൻ സഹായിക്കുക

12
A സാഹിത്യ സദസ്സുകളിൽ പങ്കെടുക്കുക
B ഗണിതശാസ്ത്ര സദസ്സുകളിൽ പങ്കെടുക്കുക
C രാഷ്ട്രീയ മീറ്റിംഗുകളിൽ പങ്കെടുക്കുക

13
A ഗണിതശാസ്ത്ര സൂത്രവാക്യങ്ങളുടെ ചാർട്ട് തയ്യാറാക്കുക
B പ്രശസ്ത ശാസ്ത്രജ്ഞന്മാരുടെ സംഭാവനകൾ ചാർട്ട് രൂപത്തിൽ തയ്യാറാക്കുക
C പ്രശസ്ത എഴുത്തുകാരും അവരുടെ കൃതികളും അടങ്ങുന്ന ചാർട്ട് തയ്യാറാക്കുക

14
A ഗണിതശാസ്ത്ര പഠനം രസകരമാക്കുന്നതെങ്ങനെ എന്ന് കൂട്ടുകാരുമായി ചർച്ച ചെയ്യുക
B പലതരം രോഗങ്ങളെക്കുറിച്ചും അവയ്ക്കു കാരണങ്ങളായ രോഗാണുക്കളെ കുറിച്ചും സഹപാഠികളുമായി ചർച്ച ചെയ്യുക
C പരിസ്ഥിതി പ്രശ്നങ്ങളേയും അവയുടെ പരിഹാര മാർഗ്ഗങ്ങളേയും പറ്റി കൂട്ടുകാരുമായി ചർച്ച ചെയ്യുക

15
A സാഹിത്യ കൃതികളുടെ ലൈബ്രറി ഉണ്ടാക്കുക
B ഗണിതശാസ്ത്ര ലൈബ്രറി ഉണ്ടാക്കുക
C ചരിത്ര പുസ്തകങ്ങളുടെ ലൈബ്രറി ഉണ്ടാക്കുക

16 സഹോദരന്റെ/സഹോദരിയുടെ
A ഭാഷാപഠനത്തിൽ സഹായിക്കുക
B ഗണിതശാസ്ത്ര പഠനത്തിൽ സഹായിക്കുക
C ശാസ്ത്ര പഠനത്തിൽ സഹായിക്കുക

17
A കായികമേള കാണുക
B കലാപ്രദർശനം കാണുക
C ഗണിതശാസ്ത്ര പ്രദർശനം കാണുക

18
A രാഷ്ട്രീയ പ്രസംഗം നടത്തുക
B ഗണിതശാസ്ത്ര സംബന്ധിയായ പ്രസംഗം നടത്തുക
C ശാസ്ത്രത്തിന്റെ നേട്ടങ്ങളെക്കുറിച്ച് പ്രസംഗിക്കുക

19
A ഫാക്ടറിയിലെ യന്ത്രങ്ങളുടെ പ്രവർത്തനം നേരിൽ കണ്ടു മനസ്സിലാക്കുക
B ഫാക്ടറിയിലെ ഉൽപാദനവും ചെലവും തമ്മിലുള്ള ബന്ധം മനസ്സിലാക്കുക
C ഫാക്ടറിയിലെ ഉൽപന്നങ്ങൾ ഏതെല്ലാം വിധത്തിൽ സമൂഹത്തിന് ഉപയോഗപ്പെടുന്നു എന്ന് കണ്ടെത്തുക

20
A ഗണിതശാസ്ത്ര പ്രശ്നോത്തരി (quiz)യിൽ പങ്കെടുക്കുക
B ശാസ്ത്ര സംബന്ധിയായ പ്രശ്നോത്തരിയിൽ പങ്കെടുക്കുക
C ചരിത്ര സംബന്ധിയായ പ്രശ്നോത്തരിയിൽ പങ്കെടുക്കുക

21
A ദിവസവും സയൻസ് പഠിക്കുക
B ദിവസവും ഗണിതശാസ്ത്രം പഠിക്കുക
C ദിവസവും സാമൂഹ്യശാസ്ത്രം പഠിക്കുക

22
A ഭാഷാനിഘണ്ടു ഉപയോഗിക്കുന്നവിധം മനസ്സിലാക്കുക
B ഗണിതശാസ്ത്ര നിഘണ്ടു ഉപയോഗിക്കുന്നതെങ്ങനെ എന്ന് മനസ്സിലാക്കുക
C ശാസ്ത്ര നിഘണ്ടു ഉപയോഗിക്കേണ്ടതെങ്ങനെ എന്ന് മനസ്സിലാക്കുക

23
A ശാസ്ത്ര വിഷയങ്ങളിൽ ഉന്നത പഠനം നടത്തുക
B സാഹിത്യത്തിൽ ഉപരി പഠനം നടത്തുക
C ഗണിതശാസ്ത്രത്തിൽ ഉന്നത പഠനം നടത്തുക

24
A സങ്കീർണ്ണങ്ങളായ ഗണിതപ്രശ്നങ്ങൾ നിർദ്ധാരണം ചെയ്യുക
B ശാസ്ത്ര പരീക്ഷണങ്ങൾ നടത്തുക
C ഭൂപടത്തിൽ വ്യത്യസ്ത രാജ്യങ്ങളുടെ സ്ഥാനം കൃത്യമായി കണ്ടെത്തുക

25
A ശാസ്ത്രീയ പുരോഗതിയെ പററിയുള്ള വിവരണങ്ങൾ കേൾക്കുക
B മനുഷ്യന്റെ സാംസ്കാരിക പുരോഗതിയെ പററിയുള്ള വിവരണങ്ങൾ കേൾക്കുക
C ആധുനിക ലോകത്തിൽ ഗണിതശാസ്ത്രത്തിന്റെ സംഭാവനകളെക്കുറിച്ചുള്ള വിവരണങ്ങൾ കേൾക്കുക

26
A ശാസ്ത്ര പരീക്ഷണങ്ങൾ നടത്തുന്ന രീതികൾ കണ്ടുപിടിക്കുക
B ഗണിതശാസ്ത്ര ഉപകരണങ്ങൾ കൃത്യതയോടെ ഉപയോഗിക്കുന്നത് എങ്ങനെ എന്ന് കണ്ടു പഠിക്കുക
C വ്യായാമം ചെയ്യുന്ന രീതികൾ കണ്ടുപഠിക്കുക

27
A പ്രശസ്ത ഗണിതശാസ്ത്രജ്ഞനായ ശ്രീനിവാസരാമാനുജന്റെ ജീവചരിത്രം വായിക്കുക
B പ്രശസ്ത നേതാവായ മഹാത്മാഗാന്ധിയുടെ ജീവചരിത്രം വായിക്കുക
C പ്രശസ്ത കവിയായ രവീന്ദ്രനാഥ ടാഗോറിന്റെ ജീവചരിത്രം വായിക്കുക

28
A പുരാതന ഇന്ത്യൻ ഗണിതശാസ്ത്രത്തെക്കുറിച്ച് പ്രതിപാദിക്കുന്ന പുസ്തകം വായിക്കുക
B നക്ഷത്രങ്ങളേയും ഗ്രഹങ്ങളേയും പററി പ്രതിപാദിക്കുന്ന പുസ്തകം വായിക്കുക
C സസ്യ-ജന്തു ജാലങ്ങളെ സംബന്ധിച്ച പുസ്തകം വായിക്കുക

29
A അധ്യാപകൻ/അധ്യാപിക ആവുക
B യന്ത്ര നിർമ്മാണവുമായി ബന്ധപ്പെട്ട ജോലി ലഭിക്കുക
C കമ്പ്യൂട്ടറുമായി ബന്ധപ്പെട്ട ജോലി ലഭിക്കുക

30 ഒഴിവുകാലങ്ങളിൽ
A ടൈപ്പ് റൈററിംഗ് പഠിക്കുക
B കമ്പ്യൂട്ടർ പഠിക്കുക
C സൈക്ലിംഗ് പഠിക്കുക

31
A പ്രകൃതിയിൽ സാധാരണ കാണുന്ന സസ്യങ്ങളുടെ ശാസ്ത്രീയ നാമങ്ങൾ പഠിക്കുക
B നിത്യോപയോഗ സാധനങ്ങളുടെ (ഉദാ:- ഉപ്പ്, അലക്കുകാരം, പഞ്ചസാര etc) ശാസ്ത്രീയ നാമം ഏതെന്ന് മനസ്സിലാക്കുക
C വീട്ടാവശ്യത്തിനുപയോഗിക്കുന്ന വസ്തുക്കളിൽ ഗണിത രൂപത്തിലുള്ളവയെ തിരിച്ചറിയുക

32 സ്കൂളിലെ
A സാഹിത്യ സമാജത്തിൽ അംഗമാകുക
B സ്പോർട്സ് ക്ലബ്ബിൽ അംഗമാകുക
C ഗണിതശാസ്ത്ര ക്ലബ്ബിൽ അംഗമാകുക

APPENDIX XVII(b)

DEPARTMENT OF EDUCATION 2000
UNIVERSITY OF CALICUT

MATHEMATICS INTEREST INVENTORY

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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 Poompatta, Balarama etc.
   B. Reading magazines on Mathematics.
   C. Reading books on Science Fictions.

3. Listening radio programme on
   A. Mathematics
   B. Hindi lessons
   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. Literary 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 Sciences

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 excercises.

27. Reading the biography of
    A. The famous mathematician Srinivasa Ramanuja
    B. The great 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 XVIII

LIST OF SCHOOLS SELECTED FOR THE SAMPLE

Sl. No.	Name of School	Revenue District	Locale	Type of manage-ment	Single/ Co-ed.	Number of students		
						Boys	Girls	Total
1.	St. Joseph H.S.S., Trivandrum	Trivandrum	Urban	Private	Single	43	0	43
2.	L.M.S.H.S. Vattappara	Trivandrum	Rural	Private	Single	0	41	41
3.	G.H.S. Yeroor	Kollam	Rural	Govt.	Co-ed.	18	27	45
4.	C.P.H.S.S. Kuttikkadu	Kollam	Rural	Private	Co-ed.	16	28	44
5.	G.N.B.H.S. Kodakara	Thrissur	Rural	Govt.	Single	41	0	41
6.	G.G.V.H.S. Kodakara	Thrissur	Rural	Govt.	Single	0	53	53
7.	Chendapuraya H.S. A.R. Nagar	Malappuram	Rural	Private	Co-ed.	24	25	49
8.	S.P.B.S. Ramanattukara	Malappuram	Rural	Private	Co-ed.	26	26	52
9.	F.H.S.S. Feroke	Calicut	Rural	Private	Co-ed.	0	58	58
10.	St. Joseph H.S.S. Calicut	Calicut	Urban	Private	Single	37	0	37
11.	G.H.S. Thottada	Kannur	Rural	Govt.	Co-ed.	23	26	49
12.	Muncipal High School	Kannur	Urban	Govt.	Co-ed.	17	35	52

APPENDIX XIX

CONTINGENCY TABLES
(Mathematical Giftedness X Psychological Variables)

1. Problem Solving Ability in Mathematics

Groups	High	Low	Total
MG	0 27.4	45 17.6	45
MNG	343 315.6	176 203.4	519
Total	343	221	564

2. Abstract Reasoning

Groups	High	Low	Total
MG	6 25.5	39 19.5	45
MNG	313 293.5	206 225.5	519
Total	319	245	564

3. Achievement Motivation in Mathematics

Groups	High	Low	Total
MG	0 22.7	45 22.3	45
MNG	284 261.3	235 257.7	519
Total	284	280	564

4. Mathematics Interest

Groups	High	Low	Total
MG	2 23.9	43 21.1	45
MNG	297 275.1	222 243.9	519
Total	299	265	564

5. Attitude towards Mathematics

Groups	High	Low	Total
MG	10 22.7	35 22.3	45
MNG	274 261.3	245 257.7	519
Total	284	280	564

6. Self-Concept in Mathematics

Groups	High	Low	Total
MG	8 23.3	37 21.7	45
MNG	284 268.7	235 250.3	519
Total	292	272	564

7. **Mathematics Anxiety**

Groups	High	Low	Total
MG	38 23.2	7 21.8	45
MNG	253 267.8	266 251.2	519
Total	291	273	564

8. **Introversion**

Groups	High	Low	Total
MG	26 26.3	19 18.7	45
MNG	304 303.7	215 215.3	519
Total	330	234	564

9. **Masculinity**

Groups	High	Low	Total
MG	20 23.8	25 21.2	45
MNG	278 274.2	241 244.8	519
Total	298	266	564