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INSIGHTFUL RESEARCHES IN EDUCATION

Dr. M.S. Geetha
Chief Editor

**COUNCIL FOR TEACHER EDUCATION FOUNDATION (CTEF), KERALA
PUBLICATIONS**

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CHIEF EDITOR



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

VIJAYAKUMARI K

1. Introduction

Any educational system with the primary focus on the prosperity of nation should concentrate on individual development which can be made possible 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.

India had 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 special needs deserve special strategies, a similar consensus is absent in the case of gifted and talented students (Willard-Holt, 1997).

The problems of suppressed potentials, which are often hidden, will affect not only the individuals concerned but the society too. Gallagher (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 social tragedy, the extent of which is difficult to measure, but which is surely great.

The dual purposes of providing special education to gifted include provide them with opportunities for maximum cognitive development and fulfilment 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.

A child is considered gifted when his superior ability contributes greatly to the well-being 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 Greece held the orator and the artist in high esteem. The Romans gave esteem respect to the lawyer, 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. The creative energies of gifted children need to be activated and guided in the initial stage itself, or else they can be lost and prove dangerous. Here lies the master role of educators and teachers. A delay in identification and provision of enrichment programmes can even lead to retardation in the abilities of such students.

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 have 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 (1964-1966) has emphasized the need of search separately for each special talent whether in Mathematics, Science, Literature, Fine arts, Sports or Technology.

1.1. Need and significance of the study

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 backbone and key of all sciences, over any other discipline. The Report of National Advisory Committee on Mathematics Education of America (NACOME) 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, as reported by Buch (1991), include those on an enrichment programme in Biology for talented youth (Vashishtha, 1979), the social and academic problems of creative teenagers pursuing different curriculum (Roy, 1982), need patterns, achievement and adjustments of mentally superior children (Singh, 1983), the characteristics and problems

of the intellectually gifted children (Khan, 1986) and adjustment problems of creative male and female children (Dhar, 1987). Use of SOI model in the study of levels of giftedness was analysed by Khire (1997).

Mathematical Giftedness is well studied in the west (Kissanne 1986; Weiner & Robinson, 1986; Miller, 1990) 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 the other reasons. Also merit scholarships are available to bright students in some Indian schools. Navodhaya Vidyalayas, as recommended by National Policy on Education (NPE, 1986)²⁰ are stated in every districts for the education of bright children but the selection procedures include 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 and hence the significance of the study.

1.2 Statement of the problem

Bearing in mind the famous idiom ‘strike while the iron is hot’, identification and nurturing of the talents at the school level itself is inevitable, especially at the secondary level, which is the crucial period in the academic development of the individual. Moreover, 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. In this context the investigator decided to conduct this study is entitled as **Some Psychological variables contributing to Mathematical Giftedness of Secondary School Pupils of Kerala.**

1.3 Definition of key terms

The following definitions are given below for the major key terms of the title:

i. Psychological variables

The term ‘psychological variables’ stands for a set of cognitive variables and affective variables. Oxford Advanced Learner’s Dictionary (1995) gives the meaning of the term ‘psychological as that related to the mental and emotional state of a person. The dictionary meaning of the term variable is that which can vary or to be varied.

ii. Contributing

The dictionary meaning of ‘contributing’ is ‘help to cause’ or ‘bring about’ (Oxford Advanced Learner’s Dictionary, 1995).

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

As such the contributing variables of Mathematical Giftedness were identified by the statistical treatment to the measure of the variables like Two tailed test of significance, of mean difference test of independence, Discriminant Analysis and Factor Analysis.

iii. Mathematical giftedness

In the present study Mathematical Giftedness is defined as the high presence of characteristics viz., Mathematical Abilities and Mathematical Creativity. Pupils are identified as Mathematically Gifted, who scored seventy percent or above in Test on Mathematical Abilities and scored high in the Test of Mathematical creativity.

Pupils were treated as Mathematically Non-gifted if their score in the Mathematical Abilities is below 70 percent and/or the score in the Test of Mathematical Creativity is low.

iv. Secondary School pupils

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

1.4 Objectives of the study

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.

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

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.

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.

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 explained.

5. 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.

1.5 Hypotheses of the study

The major hypothesis 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.

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

2. Variables of the study

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

3. Methodology

3.1. Method adopted

Survey method was followed in the study.

3.2. Sample for the study

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

3.3 Tools and materials used for the study

The data for the study was collected using the tools discussed below.

i. Test of Mathematical Abilities (Sumangala & Malini,1993)

Mathematical ability as a combination of five basic abilities in the working Mathematical problems with ease and accuracy. The test has 62 items under five subtests based on Reversibility, Generalization, Curtailment, Flexibility and Information gathering. The time limit for the whole test to answer is 60 minutes. Reliability of the test was ensured through test-retest method and construct validity of the test was established.

ii. Test of Mathematical Creativity (Sumangala,1993)

Mathematical Creativity is the ability of pupils to think divergently and to produce number of original and rational responses to specific stimulus situations. The test has seven such situations and is to be responded in 32 minutes. Reliability was tested through test- retest method and criterion related validity was ensured empirically.

iii. Test of Problem Solving Ability in Mathematics (Vijayakumari & Sumangala,1993)

The working definition set for the preparation of this test is that a 'Problem' is a perplexing question which can often be attacked in several ways and can be solved using Mathematics. The test contains 31 items under three parts. The reliability of the test was ensured by test-retest method and criterion related validity was established.

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

This test is a subtest of the 'Test of Mathematics Aptitude' and it includes 15 items under four on Analogy, five on Series and six on Classification. The time limit set for the test is eight minutes Test- retest reliability coefficient and criterion related validity coefficient were reported and the test is reliable and valid to measure Abstract reasoning.

v. Scale of Achievement Motivation in Mathematics (Sumangala & Vijayakumari,1995)

This scale is used to measure the striving of secondary school pupils to attain expected

goals by learning mathematics, the components included being Work ethic, Acquisitiveness, Dominance, Pursuit of excellence, Competitiveness, Status aspirations and Mastery. It is a 3 point Likert type scale with 42 items. Test- retest method was used to test reliability and concurrent validity was established.

vi. Mathematics Interest Inventory (Sumangala & Vijaya kumari, 1995)

This inventory was used 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 and contains 32 sets of activities. Reliability of the inventory was ensured through test-retest method and construct validity was also established empirically.

vii. Scale of Attitude towards Mathematics (Sumangala & Sunny, 1987)

This is a five-point Likert type attitude scale, having 30 items. Reliability of the scale was ensured through test-retest method and criterion related validity was established empirically.

viii. Scale of Self Concept in Mathematics (Sumanmgala & Malini, 1993)

This scale is a type of Likert's Attitude scale and consists of 24 statements. 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. Reliability of the scale is ensured through test-retest method and construct validity as well as criterion related validity were established empirically.

ix. Scale of Mathematics Anxiety (Sumangala & 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. It consists of 29 statements the responses to which are to be scored in the direction of debilitating anxiety. Reliability was ensured using test-retest method and construct as well as criterion related validity were established empirically.

x. The Kerala Introversion - Extraversion Scale (Nair, 1976)

The introverted behaviour is measured through behavioural patterns indicating thinking inwardly, reflectiveness, observant nature, meditateness 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 item can be responded in three ways Agree (A), Undecided (U), and Disagree (D). The validity of the scale is ensured by test-retest method and concurrent validity of the scale is established empirically.

xi. The Kerala Masculinity - Femininity Scale (Nair, 1979)

The psychological construct 'Masculinity-Femininity', a personality construct measured using 'The Kerala Masculinity-Femininity Scale' and it is based on items of some personality tests like Guilford-Zimmerman Temperament Survey for use in Indian culture. The scale measures aspects like masculinity of 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). The test - retest reliability coefficient of the scale is reported as 0.83. The criterion related validity was established.

3.4 Procedure of the study

After finalizing the sample and the tools to be used, the investigator prepared a schedule for collecting data directly by herself. Prior to data collection enough copies of the different booklets and the respective response sheets were made. At the time of administration, all 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, booklets and response sheets were distributed one by one. The investigator explained the procedure of marking responses for each tool and the rules and procedure of responding was also strictly followed. All the 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.

The response sheets of all the tools were scored as per the respective scoring scheme. Incomplete answer sheets were primarily rejected and data that are complete in all respects were considered for scoring and hence for final statistical analysis. Though the initial sample size was 1200, rejection of incomplete cases resulted in the reduction of sample size to 564 and this comprised the final sample of the study.

4. Statistical techniques used

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

- Two tailed test of significance of mean difference between two large independent groups

- ii. Chi-square test of independence
- iii. Discriminant function analysis (Direct method)
- iv. Factor analysis (Principal component method followed by varimax rotation).

5. Findings of the study

In order to identify the psychological variables which contribute significantly to Mathematical Giftedness, the investigator employed four statistical treatment to the collected data. Each statistical treatment together with the major results obtained are summarized below.

- 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
 - a. Problem Solving Ability in Mathematics (CR = 12.622).
 - b. Abstract Reasoning (CR = 9.589).
 - c. Achievement Motivation in Mathematics (CR = 9.024)
 - d. Mathematics Interest (CR = 7.534).
 - e. Self-Concept in Mathematics (CR = 5.341)
 - f. Mathematics Anxiety (CR = -4.527) and
 - g. 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).

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

- a. Problem Solving Ability in Mathematics ($\chi^2 = 75.897$, $C = 0.344$)
- b. Achievement Motivation in Mathematics ($\chi^2 = 49.600$, $C = 0.284$)
- c. Mathematics Interest ($\chi^2 = 46.312$, $C = 0.275$)
- d. Abstract Reasoning ($\chi^2 = 37.191$, $C = 0.249$)
- e. Self-Concept in Mathematics ($\chi^2 = 22.634$, $C = 0.196$)
- f. Mathematics Anxiety ($\chi^2 = 21.128$, $C = 0.190$)

- g. Attitude towards Mathematics ($t = 15.482, C = 0.163$).
- Introversion ($t = 0.011$) and Masculinity ($t = 1.382$) are found to be not significantly associated with Mathematical Giftedness.
- 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

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

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

- a. Problem Solving Ability in Mathematics
- b. Abstract Reasoning
- c. Achievement Motivation in Mathematics.
- d. Mathematics Interest
- e. Attitude towards Mathematics
- f. Self Concept in Mathematics
- g. Mathematics Anxiety
- h. Introversion and
- i. Masculinity

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

- a. The chi-square value (168.342) with nine degrees of freedom is greater than the needed value for significance at 0.01 level
- b. The eigen value is 0.353
- c. 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,

- a. Problem Solving ability in Mathematics (0.904)

- b. Abstract Reasoning (0.556)
- c. Mathematical Anxiety (-0.358)
- d. Mathematics Interest (0.357)
- e. Achievement Motivation in Mathematics (0.339)
- f. Self-Concept in Mathematics (0.313)
- g. 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 Introversion (0.085) and Masculinity (0.017).
- The psychological factor structures of Mathematically Gifted and Non-gifted pupils were derived using Principal component Method of Factor Analysis followed by Varimax rotation.
- 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

- a. Problem Solving Ability in Mathematics
- b. Abstract Reasoning
- c. Attitude towards Mathematics
- d. 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.

- a. Self-Concept in Mathematics
- b. Achievement Motivation in Mathematics
- c. Attitude Towards Mathematics
- d. Mathematics Interest

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

- a. Masculinity
- b. Mathematics Interest

c. Absence of Mathematics Anxiety

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

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

- a. Self-Concept in Mathematics
- b. Achievement Motivation in Mathematics'
- c. Attitude towards Mathematics
- d. Mathematics Interest
- e. 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 Problem Solving Ability in Mathematics and 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.

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

- a. Number of factors evolved
- b. The variables present/absent in the factors
- c. Percent of variance accounted for by the factors to the battery of psychological variables.

6. Educational implications

- The two groups Mathematically Gifted and Non-gifted are significantly different in the case of seven variables viz., Problem Solving Ability in Mathematics, Abstract Reasoning, Achievement Motivation in Mathematics, Mathematics Interest, Self-Concept in Mathematics, Mathematics Anxiety and Attitude towards Mathematics. These Seven variables have significant association with Mathematical Giftedness.

- Relationship of Problem Solving Ability in Mathematics, Achievement Motivation in Mathematics, Mathematics Interest and Abstract Reasoning with Mathematical Giftedness are found to be high/moderate.
- The variables Problem Solving Ability in Mathematics, Abstract Reasoning, Achievement Motivation in Mathematics, Mathematics Interest, Self-Concept in Mathematics, Mathematics Anxiety and Attitude towards Mathematics have high loadings or contribute much to the function which was found to be significantly efficient to discriminate between Mathematically Gifted and Non-gifted.
- Factor structures of Mathematically Gifted and Non-gifted groups re different in terms of Number of factors, Variables present/absent in the factor and 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 Mathematics" which is loaded by the variables Problem Solving Ability in Mathematics, Abstract Reasoning, Achievement Motivation in Mathematics and Attitude towards Mathematics.
- The next important factor is "commitment in Mathematics" which is loaded by Self-Concept in Mathematics, Achievement Motivation in Mathematics, Attitude towards Mathematics and Mathematics Interest.
- 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.
- In a nutshell, the variables, Problem Solving Ability in Mathematics, Abstract Reasoning, Achievement Motivation in Mathematics, Mathematics Interest, Self-Concept in Mathematics, Mathematics Anxiety and Attitude towards Mathematics are the major contributing variables to mathematical Giftedness, as for these seven variables,
- Mathematically Gifted and Non-gifted pupils are significantly different.
- Significant association exists with Mathematical Giftedness
- Discriminant weights found in the linear function are high.
- 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 areas, Mathematics Anxiety was found to be a negative contributor. That is low level of anxiety variable results in high levels of Mathematical Giftedness and vice versa.

7. Conclusion

The conclusions arrived at made the investigator to perceive the following implications in the field of education.

- In the normal Mathematics classroom a good and active teacher can note the differences among students in the expression of psychological characteristics like interest, self-confidence, anxiety, ability to solve problems, see relations in the abstract ideas etc. 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 cannot 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.

- 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 problems in addition to the normal ones so as to cope with their ability.
- Instead of practicing 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 sought to detect the erring phases and help for becoming better problem solvers.
- 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.

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.

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.

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.

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.

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.

- 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.
- 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.
- 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.

- Some special enthusiasm and creative thinking is necessary for the teachers to transform the non-gifted to gifted. Therefore, teachers be given service programmes orienting the needs of enriching the talented; identifying and the talents.
- Mathematically gifted students themselves may vary in their level of giftedness; variations in the level of contributing variables. This variations should be realized and experiences should be provided for rectification.

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