CHAPTER IV

RESEARCH DESIGN AND PROCEDURE
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REFERENCES
CHAPTER IV
RESEARCH DESIGN AND PROCEDURE

4.1 INTRODUCTION:

This part of the research usually consists of three parts: subjects, procedures and data analysis. The subject’s section details the population from which the researcher plans to select the sample. Variables that are frequently used, depending on the type of research include: chronological age, grade level, socio-economic status, sex, race, IQ, mental age, academic achievement level and other pertinent attributes of the targeted population. The procedure section outlines the research-plan. It describes in detail what will be needed, and what data-gathering devices will be used. (Best, John W., 1989, Pp. 39-40).

4.2 STATEMENT OF THE PROBLEM:

A CRITICAL STUDY ON ACHIEVEMENT OF SECONDARY CLASS STUDENTS IN MATHEMATICS IN TINNEVELLY EDUCATIONAL DISTRICT.

4.3 OPERATIONAL DEFINITIONS:

CRITICAL STUDY:

By this the investigator means an in-depth study on factors associated with the problems in question. That is, the study probes in detail into mental and emotional characteristics of the chosen population to establish their influence on achievement in mathematics, after surveying the stated problem - achievement in mathematics.

MENTAL CHARACTERISTICS:

By this, the investigator means the following: Intelligence, Numerical Ability, Verbal Reasoning and Cognitive Style. Operationally, they are the scores obtained on the standardized tools: Passalong test for intelligence, Numerical ability test, Reasoning ability test and a test for Cognitive style prepared and validated by Passalong, George Stephen, (Km) Sadhna Bhatnagar and Joyciline Shermila respectively.

EMOTIONAL CHARACTERISTICS:

By this the investigator means the following: Interest in Mathematics, Achievement Motivation, School Anxiety and Self-Esteem. Operationally, they are the
the scores obtained on Mathematical Interest Inventory, Achievement Motivation Inventory, Test for School Anxiety and Self Esteem Inventory prepared and validated by L.N. Debye, Robinson, Boxall and Rosenberg respectively.

ACHIEVEMENT IN MATHEMATICS:

By this, the investigator means the performance of the chosen population in different areas of mathematics at different levels of learning mathematics. Operationally it is the score obtained on the Achievement test in Mathematics prepared and validated by the investigator.

SECONDARY CLASSES:

In the educational system being followed in the state of Tamilnadu, primary level consists of classes from standard I to IX, middle school level from standard VI to VIII, secondary level standards IX and X, the higher secondary level standards XI and XII.

By secondary classes therefore the investigator means the standards IX and X in the government schools – completely under the control of the State Government – as well as management schools – managed by private bodies getting grant-in-aid from the state government. In both types of school the medium of instruction is Tamil—the mother tongue.

TINNEVELLY EDUCATIONAL DISTRICT:

The Tinnevelly Revenue District has been divided into the three educational districts: - Tinnevelly Central Educational District, Cheranmahadevi Educational District and Tenkasi Educational District. In the present study, Tinnevelly Educational District includes Tinnevelly Central Educational District and Cheranmahadevi Educational District, chosen randomly by putting a lot.

4.4 SIGNIFICANCE OF THE STUDY:

Achievement in Mathematics has been studied in relation to a number of variables both cognitive and affective. Studies in the past decade have confirmed that intelligence and socio-economic background are major contributors to achievement in mathematics (Singh, 1986; Nilima Kumari, 1984; Gabhar, 1981; Jabbal, 1981; Kabu, 1980; Nalini Devi, 1976). Factors responsible for poor achievement or failure have also caught the attention of researchers. Manika (1983)
found language mastery was an important factor in the acquisition of concepts in mathematics. Nilima Kumari (1984) studied the conservation of number and substance in relation to intelligence and socio-economic status revealing significant positive relationships. Reasoning power, space visualizations, attitude towards mathematics were found significantly related to achievement in mathematics (Patel, 1984). In Rajput’s (1984) study, achievement motivation was found to have no bearing upon achievement. Gakhar (1981), identified variables of educational environment as responsible for acquisition of mathematical concepts. Kaliyar’s (1979) study reveals that boys and girls didn’t differ in mathematics achievement. Also numerical reasoning and numerical ability occupied a prominent place among the five cognitive functions studied in relation to achievement in mathematics.

So far it is found that majority of studies have concentrated on a few variables such as intelligence, socio-economic status, teacher’s qualification, class size, encouragement to teacher by the head, use of audio-visual aids, feed back etc. However the investigator feels that some of the mental and emotional characteristics may also have significant influence over achievement in mathematics. So the investigator includes in her study the following mental characteristics - interest in mathematics, achievement motivation, school anxiety and self-esteem. Also the present study focuses on the following background variables - teacher’s attitude towards change (innovative / non-innovative) and the classroom environment (progressive / non-progressive), which may have important bearing on the achievement in mathematics. On completion of this study, it is hoped that the investigator will be able to give a clear picture about the mental and emotional characteristics that may have significant impact over the achievement in mathematics. In addition to this, the deciding nature of the background features: gender (Boys/Girls), type of school (Government/Management), locality of school (Rural/Urban), religion (Hindu/Christian/Muslim), nature of school (Boys/Girls/Coed), parental educational status (Low/Moderate/High), order of birth (First/Middle/Last) and social status (SC/ST, MBC, BC and OC) will also be understood. Moreover, the study may provide a clear picture of the problem areas in the teaching and learning of mathematics so as to enable the framers of the curriculum
FIGURE 4.1
ACHIEVEMENT IN MATHEMATICS

CONTENTS

1. NUMBER SYSTEM
2. SET LANGUAGE
3. ALGEBRA
4. STATISTICS
5. MATRICES
6. APPLICATION
7. MENSURATION
8. GEOMETRY
9. CONSTRUCTION
10. GRAPHS
11. COMPUTER PROGRAMMING
12. THEORETICAL GEOMETRY
13. LOGARITHM
14. TRIGONOMETRY
15. ANALYTICAL GEOMETRY

BLOOM'S STAGES OF LEARNING MATHEMATICS

1. KNOWLEDGE
2. UNDERSTANDING
3. APPLICATION
and the practitioners in the schools to adopt a realistic approach in the teaching and learning of mathematics.

4.5 VARIABLES USED:

In this study, the investigator included Achievement in Mathematics as the dependent variable whereas Intelligence, Numerical Ability, Reasoning Ability, Cognitive Style, Interest in Mathematics, Achievement Motivation, School Anxiety, Self Esteem, Teacher's attitude towards change and classroom environment as independent variables.

4.6 POPULATION:

All the standard IX and X students in all the 72 high / higher secondary schools following the state board syllabus whose medium of instruction is Tamil in Tinnevelly Educational District form the population of the study.

4.7 SAMPLE:

By stratified random sample, the investigator selected the sample from the population to get more accurate representation. The population was stratified into different strata and from each stratum about 5% of the population was taken randomly.

Table 4.1
Sample

<table>
<thead>
<tr>
<th>Standard</th>
<th>Category</th>
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<tr>
<td>Secondary classes</td>
<td>Total</td>
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</tr>
<tr>
<td>Secondary classes</td>
<td>Male</td>
<td>1501</td>
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<td>Secondary classes</td>
<td>Female</td>
<td>1399</td>
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<tr>
<td>Secondary classes</td>
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<td>Secondary classes</td>
<td>Urban</td>
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<td>Secondary classes</td>
<td>Government</td>
<td>1457</td>
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<tr>
<td>Secondary classes</td>
<td>Management</td>
<td>1443</td>
</tr>
<tr>
<td>Secondary classes</td>
<td>OC</td>
<td>452</td>
</tr>
<tr>
<td>Secondary classes</td>
<td>BC</td>
<td>1036</td>
</tr>
<tr>
<td>Secondary classes</td>
<td>MBC</td>
<td>666</td>
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<tr>
<td>Secondary classes</td>
<td>SC/ST</td>
<td>746</td>
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<td>Secondary classes</td>
<td>Hindu</td>
<td>1657</td>
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<tr>
<td>Secondary classes</td>
<td>Christian</td>
<td>714</td>
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<tr>
<td>Secondary classes</td>
<td>Muslim</td>
<td>529</td>
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<tr>
<td>Secondary classes</td>
<td>Girl's School Students</td>
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<td>Coed. School Students</td>
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<td>1144</td>
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<tr>
<td>Secondary classes</td>
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4.8 RESEARCH TOOLS:

The investigator for studying the dependent variable in relation to independent variables, which seem to influence the dependent variable, used the following tools.

Table 4.20
Research tools

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Tool</th>
<th>Author &amp; Year</th>
<th>Reliability</th>
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</thead>
<tbody>
<tr>
<td>1.</td>
<td>Achievement test in Mathematics for std IX</td>
<td>The Investigator (1998)</td>
<td>0.82</td>
</tr>
<tr>
<td>2.</td>
<td>Achievement test in Mathematics for std X</td>
<td>The Investigator (1998)</td>
<td>0.64</td>
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<tr>
<td>3.</td>
<td>Passalong Test for Intelligence</td>
<td>W.Q. Alexander</td>
<td>-</td>
</tr>
<tr>
<td>4.</td>
<td>Numerical Ability Test</td>
<td>Dr. George Stephen (1997)</td>
<td>0.695</td>
</tr>
<tr>
<td>5.</td>
<td>Reasoning Ability Test</td>
<td>Dr. Sadhna Bhatnagar</td>
<td>0.75</td>
</tr>
<tr>
<td>7.</td>
<td>Mathematical Interest Inventory</td>
<td>L.N. Deboy</td>
<td>0.73</td>
</tr>
<tr>
<td>8.</td>
<td>Achievement Motivation</td>
<td>Robinson (1961).</td>
<td>0.65</td>
</tr>
<tr>
<td>9.</td>
<td>School Anxiety Test</td>
<td>Boxall (1961).</td>
<td>0.83</td>
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<td>10.</td>
<td>Self-esteem Inventory</td>
<td>Rosenberg (1964).</td>
<td>0.77</td>
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<td>11.</td>
<td>Teacher’s Attitude towards Change</td>
<td>Georgiades (1967).</td>
<td>0.65</td>
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</tbody>
</table>

4.9 OBJECTIVES:

PART -- A
PRIMARY OBJECTIVES

1. To find out the level of achievement of secondary classes (standard IX and X together), standard IX and X students (i.) in mathematics – in general; (ii.) in different areas of mathematics and (iii) as per Bloom’s stages of learning.

2. To find out the level of achievement of secondary classes (standard IX and X together), standard IX and X students (i.) in mathematics – in general; (ii.) in different areas of mathematics and (iii) as per Bloom’s stages of learning with regard to (a.) Classroom Environment (progressive/non-progressive); (ii.) teacher’s attitude towards change (innovative /non-innovative); and (iii.) background characteristics (gender, social status, religion, type of school, nature of school, locality of school, family educational status, order of birth).

PART – B
SECONDARY OBJECTIVES
SECTION –I
1. To study the impact of the following mental characteristics: (i.) Intelligence (ii.) Numerical ability (iii.) Verbal reasoning and (iv.) Cognitive style of secondary classes (standard IX and X together), standard IX and X students over achievement (i.) in mathematics – in general; (ii.) in different areas of mathematics and (iii) as per Bloom’s stages of learning.

2. To study the impact of the following mental characteristics: (i.) Intelligence (ii.) Numerical Ability (iii.) Verbal reasoning and (iv.) Cognitive Style of the following Background characteristics: gender, social status, religion, type of school, nature of school, locality of school, family educational status and order of birth of Secondary class students over achievement (i.) in mathematics - in general (ii.) in different areas of mathematics and (iii.) as per Bloom’s Stages of learning.

SECTION – II

1. To study the impact of the following emotional characteristics (i.) Interest in mathematics (ii.) School anxiety (iii.) Self esteem and (iv.) Achievement motivation of secondary classes (standard IX and X together), standard IX and X students over achievement (i.) in mathematics – in general; (ii.) in different areas of mathematics and (iii) as per Bloom’s stages of learning.

2. To Study the impact of the following emotional characteristics: (i.) Interest in Mathematics (ii.) School Anxiety (iii.) Self Esteem and (iv.) Achievement Motivation of the following Background characteristics: gender, social status, religion, type of school, nature of school, locality of school, family educational status and order of birth of Secondary class students over achievement (i.) in mathematics - in general (ii.) in different areas of mathematics and (iii.) as per Bloom’s Stages of learning.

PART -- C

TERTIARY OBJECTIVES

1. To find out the nature of the following mental characteristics: (i.) Intelligence (ii.) Numerical Ability (iii.) Verbal reasoning and (iv.) Cognitive Style of secondary class students in predicting achievement (i.) in mathematics - in general (ii.) in different areas of mathematics and (iii.) as per Bloom’s Stages of learning.
2. To find out the nature of the following emotional characteristics: (i.) Interest in Mathematics (ii.) School Anxiety (iii.) Self Esteem and (iv.) Achievement Motivation of Secondary class students in predicting achievement (i.) in mathematics - in general (ii.) in different areas of mathematics and (iii.) as per Bloom’s Stages of learning.

4.10 HYPOTHESES:

PART -- A

PRIMARY HYPOTHESES

SECTION -- I

PERCENTAGE ANALYSIS

1. Achievement of Secondary classes, Standard IX and X students in mathematics—in general and as per Bloom’s stages of learning is average.

2. Achievement of standard IX students in the following areas: (i.) Number system (ii.) Set language (iii.) Algebra (iv.) Mensuration (v.) Application (vi.) Statistics (vii.) Geometry (viii.) Construction (ix.) Graphs and (x.) Computer programming of mathematics is average.

3. Achievement of standard X students in the following areas (i.) Number system (ii.) Mensuration (iii.) Set Theory (iv.) Logarithm (v.) Algebra (vi.) Matrices (vii.) Statistics (viii.) Trigonometry (ix.) Analytical geometry (x.) Theoretical geometry (xi.) Geometry (xii.) Graphs and (xiii.) Computer programming of mathematics is average.

4. Secondary classes, Standard IX and X students are average in their mental characteristics (i.) Intelligence (ii.) Numerical Ability (iii.) Verbal Reasoning and (iv.) Cognitive Style.

5. Secondary classes, Standard IX and X students are average in their emotional characteristics: (i.) Interest in Mathematics (ii.) School Anxiety (iii.) Self esteem and (iv.) Achievement Motivation.

SECTION -- II

DIFFERENTIAL ANALYSIS

CLASSROOM ENVIRONMENT
1. There is no significant difference between the students of (i.) Secondary classes (ii.) Standard IX and (iii.) Standard X studied in progressive and non-progressive classrooms in terms of achievement in mathematics – in general and as per Bloom’s stages of learning.

2. There is no significant difference between the students of Standard IX in progressive and non-progressive classrooms in terms of achievement in mathematics in the following areas: (i.) Number system (ii.) Set language (iii.) Algebra (iv.) Mensuration (v.) Application (vi.) Statistics (vii.) Geometry (viii.) Construction (ix.) Graphs and (x.) Computer programming of mathematics.

3. There is no significant difference between the students of Standard X in progressive and non-progressive classrooms in terms of achievement in mathematics in the following areas: (i.) Number system (ii.) Mensuration (iii.) Set Theory (iv.) Logarithm (v.) Algebra (vi.) Matrices (vii.) Statistics (viii.) Trigonometry (ix.) Analytical geometry (x.) Theoretical geometry (xi.) Geometry (xii.) Graphs and (xiii.) Computer programming of mathematics.

SECTION — II

TEACHER’S ATTITUDE TOWARDS CHANGE

1. There is no significant difference between the students of (i.) Secondary classes (ii.) Standard IX and (iii.) Standard X of innovative and non-innovative teachers in terms of achievement in mathematics – in general and as per Bloom’s stages of learning.

2. There is no significant difference between the students of Standard IX of innovative and non-innovative teachers in terms of achievement in mathematics in the following areas: (i.) Number system (ii.) Set language (iii.) Algebra (iv.) Mensuration (v.) Application (vi.) Statistics (vii.) Geometry (viii.) Construction (ix.) Graphs and (x.) Computer programming of mathematics.

3. There is no significant difference between the students of Standard X of innovative and non-innovative teachers in terms of achievement in mathematics in the following areas: (i.) Number system (ii.) Mensuration (iii.) Set Theory (iv.) Logarithm (v.) Algebra (vi.) Matrices (vii.) Statistics (viii.) Trigonometry (ix.) Analytical geometry (x.) Theoretical geometry (xi.) Geometry (xii.) Graphs and (xiii.) Computer programming of mathematics.

SECTION — III
BACKGROUND CHARACTERISTICS

1. There is no significant difference in the students who may differ in gender, social status, religion, type of school, nature of school, locality of school, parental educational status, and birth order of (i.) Secondary classes (ii.) Standard IX and (iii.) Standard X in terms of achievement in mathematics – in general and as per Bloom’s stages of learning mathematics.

2. There is no significant difference in the students who may differ in the following background characteristics: - gender, social status, religion, type of school, nature of school, locality of school, family educational status and birth order of Standard IX in terms of achievement in mathematics in the following areas: (i.) Number system (ii.) Set language (iii.) Algebra (iv.) Mensuration (v.) Application (vi.) Statistics (vii.) Geometry (viii) Construction (ix.) Graphs and (x.) Computer programming of mathematics.

3. There is no significant difference in the students who may differ in the following background characteristics: - gender, social status, religion, type of school, nature of school, locality of school, family educational status and birth order of Standard X in terms of achievement in mathematics in the following areas: (i.) Number system (ii.) Mensuration (iii.) Set Theory (iv.) Logarithm (v.) Algebra (vi.) Matrices (vii.) Statistics (viii) Trigonometry (ix.) Analytical geometry (x.) Theoretical geometry (xi.) Geometry (xii.) Graphs and (xiii.) Computer programming of mathematics.

PART -- B
SECONDARY HYPOTHESES

SECTION-- 1
MENTAL CHARACTERISTICS

1. The following mental characteristics (i.) Intelligence (ii.) Numerical ability (iii.) Verbal reasoning and (iv.) Cognitive style do not have significant impact over the students of (i) Secondary classes (ii.) Standard IX and (iii.) Standard X in terms of achievement in mathematics – in general and as per Bloom’s stages of learning.

2. The following mental characteristics (i.) Intelligence (ii.) Numerical ability (iii.) Verbal reasoning and (iv.) Cognitive style do not have significant impact over the students of Standard IX in terms of achievement in mathematics in the following areas: (i.) Number system (ii.) Set language (iii.) Algebra (iv.) Mensuration (v.)
Application (vi.) Statistics (vii.) Geometry (viii) Construction (ix.) Graphs and (x.) Computer programming of mathematics.

3. The following mental characteristics (i.) Intelligence (ii.) Numerical ability (iii.) Verbal reasoning and (iv.) Cognitive style do not have significant impact over the students of Standard X in terms of achievement in mathematics in the following areas: (i.) Number system Mensuration (iii.) Set Theory (iv.) Logarithm (v.) Algebra (vi.) Matrices (vii.) Statistics (viii.) Trigonometry (ix.) Analytical geometry (x.) Theoretical geometry (xi.) Geometry (xii.) Graphs and (xiii.) Computer programming of mathematics.

4. The following mental characteristics: (i.) Intelligence (ii.) Numerical Ability (iii.) Verbal reasoning and (iv.) Cognitive Style do not have significant impact over the students of Secondary classes with regard to achievement in mathematics - in general and as per Bloom’s Stages of learning who may differ in the following Background characteristics: gender, social status, religion, type of school, nature of school, locality of school, family educational status and order of birth.

SECTION --II

EMOTIONAL CHARACTERISTICS

1. The following emotional characteristics (i.) Interest in mathematics (ii.) School anxiety (iii.) Self esteem and (iv.) Achievement motivation do not have significant impact over the students of (i.) Secondary classes (ii.) Standard IX and (iii.) Standard X in terms of achievement in mathematics – in general and as per Bloom’s stages of learning.

2. The following emotional characteristics (i.) Interest in mathematics (ii.) School anxiety (iii.) Self esteem and (iv.) Achievement motivation do not have significant impact over the students of Standard IX in terms of achievement in mathematics in the following areas: (i.) Number system (ii.) Set language (iii.) Algebra (iv.) Mensuration (v.) Application (vi.) Statistics (vii.) Geometry (viii) Construction (ix.) Graphs and (x.) Computer programming of mathematics.

3. The following emotional characteristics (i.) Interest in mathematics (ii.) School anxiety (iii.) Self esteem and (iv.) Achievement motivation do not have significant impact over the students of Standard X in terms of achievement in mathematics in the following areas: (i.) Number system Mensuration (iii.) Set Theory (iv.)
4. The following emotional characteristics: (i.) Interest in Mathematics (ii.) School Anxiety (iii.) Self Esteem and (iv.) Achievement Motivation do not have significant impact over the students of Secondary classes with regard to achievement in mathematics - in general and as per Bloom’s Stages of learning who may differ in the following Background characteristics: gender, social status, religion, type of school, nature of school, locality of school, family educational status and order of birth.

PART – C
TERTIARY HYPOTHESES
SECTION -- I
MENTAL CHARACTERISTICS AS PREDICTORS

1. The chosen mental characteristics: (i.) Intelligence (ii.) Numerical Ability (iii.) Verbal reasoning and (iv.) Cognitive Style are not significant predictors of the students of Standard IX with regard to achievement in mathematics - in general, in the following areas: (i.) Number system (ii.) Set language (iii.) Algebra (iv.) Mensuration (v.) Application (vi.) Statistics (vii.) Geometry (viii) Construction (ix.) Graphs and (x) Computer programming and as per Bloom’s Stages of learning.

2. The chosen mental characteristics: (i.) Intelligence (ii.) Numerical Ability (iii.) Verbal reasoning and (iv.) Cognitive Style are not significant predictors of the students of Standard X with regard to achievement in Mathematics - in general, in the following areas: (i.) Number system (ii.) Mensuration (iii.) Set Theory (iv.) Logarithm (v.) Algebra (vi.) Matrices (vii.) Statistics (viii.) Trigonometry (ix.) Analytical geometry (x.) Theoretical geometry (xi.) Geometry (xii.) Graphs and (xiii.) Computer programming of mathematics and as per Bloom’s Stages of learning.

SECTION— II
EMOTIONAL CHARACTERISTICS AS PREDICTORS

3. The chosen emotional characteristics: (i.) Interest in Mathematics (ii.) School Anxiety (iii.) Self Esteem and (iv.) Achievement Motivation
are not significant predictors of the students of Standard IX with regard to achievement in mathematics - in general, in the following areas: (i.) Number system (ii.) Set language (iii.) Algebra (iv.) Mensuration (v.) Application (vi.) Statistics (vii.) Geometry (viii) Construction (ix.) Graphs and (x) Computer programming and as per Bloom’s Stages of learning.

4. The chosen emotional characteristics: (i.) Interest in Mathematics (ii.) School Anxiety (iii.) Self Esteem and (iv.) Achievement Motivation are not significant predictors of the students of Standard X with regard to achievement in mathematics - in general, in the following areas: (i.) Number system (ii.) Mensuration (iii.) Set Theory (iv.) Logarithm (v.) Algebra (vi.) Matrices (vii.) Statistics (viii.) Trigonometry (ix.) Analytical geometry (x.) Theoretical geometry (xi.) Geometry (xii.) Graphs and (xiii.) Computer programming of mathematics and as per Bloom’s Stages of learning.

4.11 LIMITATIONS:

A large number of factors may influence one’s achievement in mathematics. They may be intellectual, emotional, and social characteristics. In the present study, though the investigator is aware of all these factors related to achievement in mathematics, she has included only a few in the present investigation owing to their relevance and also the feasibility of handling those variables in a short span of time.

Moreover, the investigator has chosen only the population available in a part of the revenue district, Tinnevelly. Therefore the findings of the study may face these constraints at the time of generalization.

4.12 STATISTICAL MEASURES USED:

4.12.1 Mean
\[ \text{Mean} = \frac{\sum X}{N} \]
\[ \sum X = \text{Sum of the Items} \]
\[ N = \text{Total Number of Items}. \]
(Best, John. W., 1992, P. 348)

4.12.2 Standard Deviation:
\[ \sigma = \sqrt{\frac{N\sum X^2 - (\sum X)^2}{N^2}} \]
where \( \sum X^2 = \text{Sum of squares of X} \)
\( (\sum X)^2 = \text{Square of sum of X} \)
\[ N = \text{Total number of items}. \]
(Best, John. W., 1992, P. 349)

4.12.3 Percentage:
4.12.4 Coefficient of Correlation:
\[ r = \frac{N \sum XY - (\sum X) (\sum Y)}{\sqrt{N \sum X^2 - (\sum X)^2} \sqrt{N \sum Y^2 - (\sum Y)^2}} \]

(Best, John. W., 1992, P. 350)

- \(X\) = Items in one distribution
- \(Y\) = Items in other distribution
- \(\sum XY\) = Sum of \(XY\)
- \(\sum X\) = Sum of the items in \(X\)
- \(\sum Y\) = Sum of the items in \(Y\)
- \(\sum X^2\) = Sum of the squares of items in \(X\)
- \(\sum Y^2\) = Sum of the squares of items in \(Y\)
- \(N\) = Total number of items

4.12.5 t-Test:
\[ t = \frac{X_1 - X_2}{\sqrt{\sigma_1^2 / N_1 + \sigma_2^2 / N_2}} \]

(Best, John. W., Research in Education, 1992, P: 272)

- \(\sigma_1, \sigma_2\) = Standard Deviations of the two groups
- \(N_1, N_2\) = Total Number of items in each group
- \(X_1, X_2\) = Means of two groups

4.12.6 Analysis of Variance (F-test):
\[ F = \frac{MS_b}{MS_w} \]

Where \(MS_b = SS_b / df_b\)

\[ SS_b = \left\{ \left( \sum X_1^2 \right) / n_1 + \left( \sum X_2^2 \right) / n_2 + \ldots \right\} - \left( \sum X \right)^2 / N \]

\[ MS_w = SS_w / df_w \]

\[ SS_w = \left\{ \sum X_1^2 + \sum X_2^2 + \ldots \right\} - \left\{ \left( \sum X_1 \right)^2 / n_1 + \left( \sum X_2 \right)^2 / n_2 + \ldots \right\} \]

(Best, John. W., 1992, P: 352)

- \(SS_w\) = Sum of squares within sets
- \(SS_b\) = Sum of squares between sets
- \(MS_b\) = Means squares between sets
- \(MS_w\) = Means squares within sets
- \(df_b\) = Degrees of freedom between sets
- \(df_w\) = Degrees of freedom within sets
REFERENCES
