Chapter V
Diagnosis

CHAPTER - V
DIAGNOSIS

5.1 Introduction

The present chapter is a detailed description about the diagnosis. The entire process from selection of items to error analysis of the diagnostic test is included. This chapter also includes the construction of a five part questionnaire. This questionnaire was used, to gather information regarding the home background, study habits, school experiences, personal background, suggestions, from the backward students.

The sample for the diagnostic test and the questionnaire is also described. The modus operandi of the test construction and questionnaire has been given in all details. The chapter ends with the type of errors, number of errors, in a brief background of the sample.

5.2 Process of Diagnosis

The investigator followed the five steps of diagnosis, according to Ross (1947). These steps were found to be in agreement with other approaches to diagnosis i.e., Brueckner and Bond (1955), Hildreth (1936), Cooney, et.al. (1975). The five steps of diagnosis according to Ross are:

i. Who are the pupils having trouble ?
ii. Where are the errors located ?
iii. Why do the errors occur ?
iv. What remedies are suggested ?
v. How can errors be prevented ?

The diagnosis in the present study was done in the following manner:

i. Diagnostic test construction
ii. Administration of the diagnostic test
iii. Scoring and analysis of the responses of the diagnostic test

iv. Construction of the Questionnaire, for home background and variables
v. Administration of the questionnaire
vi. Analysis of the responses of the questionnaire.
vii. Selecting sample for case study from diagnostic test sample
viii. Conducting remedial programme
ix. Interviewing the cases
x. Interviewing the parents of the cases
xi. Interviewing the randomly chosen mathematics teachers

5.2.1 Purpose of the Diagnostic Test

The diagnostic test was constructed by the investigator. It was required to elicit the errors in the areas where majority of errors lie also different types of errors. Though many diagnostic tests exist, this diagnostic test was constructed to suit to the particular needs. The test needed to have items in which students were found to be deficient in the standardized test and also items suggested by teachers, researchers. Hence a diagnostic test was constructed to suit the specific requirements.

5.2.2 Construction of the Diagnostic Test

Items for the diagnostic test were selected from the standardized test, other diagnostic tests in mathematics, research evidence, opinion of the teachers.

The items in the standardized test which got least correct responses, those items which gave common errors were included in the diagnostic test. Those test items were word problems, linear equations, adding and subtracting of rational numbers. The prerequisites for these topics were analysed and items were included in the diagnostic test. Research evidences were also considered during test construction.

5.2.3 Revisions of the First Draft

The revisions in the construction of the diagnostic test were as follows:

The first draft had one hundred and nine items in nine categories. The first draft of the diagnostic test is given in Appendix-D. The categories were:

I. TEST OF BASIC SKILLS IN ARITHMATIC
   A) ADD
   B) SUBTRACT
   C) MULTIPLY
   D) DIVIDE
   E) FILL IN THE BLANKS
II. TEST OF BASIC IN ALGEBRA
III. TEST OF FRACTIONS
IV. TEST OF MONOMIAL – BINOMIAL MULTIPLICATION
V. TEST OF BINOFIAL - BINOMIAL MULTIPLICATION
VI. TEST OF INDICES
VII. TEST OF BRACKET EXPANSION
VIII. TEST OF LINEAR EQUATIONS
IX. TEST OF RATIONAL NUMBERS

The revisions in each category are given below:

I. TEST OF BASIC SKILLS IN ARITHMATIC

The sub-heading was changed to 'ADD THE FOLLOWING' instead of 'ADD', likewise for other sub-headings.

One of the items on addition was changed to horizontal placing of numbers instead of vertical. Similarly, for one item under subtraction and multiplication, one of the items in division was dropped and replaced by a three digit dividend and one digit divisor.

II. TEST OF BASICS IN ALGEBRA

Items asking for examples of variables and constants, were dropped. The items under sub-category, Add the following, simplify, fill in the blanks were re-arranged.

The item a = _____ x a was changed to 5 x b x c = _____.

The item _____ x _____ = 2d was replaced by ab = _____ x _____.

The item 3y + 3d = _____ x _____ was replaced by 3(y + d) = _____ + _____.

III. TEST OF RATIONAL NUMBERS

Item IX moved to III in the second draft. The items under this category were identifying the numerators, identifying rational numbers. The items asking for examples of positive rational number and negative rational number were dropped. 'Which are the numerators in the following. Put a tick '✓' on it like this' was the instruction instead of 'Which are the ..... following.'

IV. TEST OF FRACTIONS

There were no changes in this category.

V. TEST OF INDICES

This category was moved from VI to V in the second draft. All the items under 'With integer as base' were maintained, except, 'Give three examples of odd integers' was replaced by 'Pick out the odd integers from the following:'

Item B) x) under 'With variable as base' was dropped.

VI. TEST OF MONIMIAL – BIONOMIAL MULTIPLICATION

All the items were maintained.

VII. TEST OF BINOMIAL-BINOMIAL MULTIPLICATION

All the items were maintained.

VIII. TEST OF BRACKET EXPANSION.

IX. TEST OF LINEAR EQUATIONS

All the items were maintained except items (vii).

5.2.4 Revisions of the Second Draft

The test after the first revision was administered on a sample of five students of eighth standard, backward in mathematics, randomly chosen. The tryout version had hundred and nine items. Some changes had to be them on the test due to the clarifications ask by the testees. The changes were regarding the instructions of a few test items. Thus the second revision of the diagnostic test consisting of hundred and nine items in nine categories was ready. Enough space were provided for rough work along the test item. The test had to be answered in the test paper itself. The second draft of the test is given in Appendix-E.

5.2.5 Final Administration

The revised test was administered on a sample of one hundred and sixty students from four schools. The schools were of different managements. A convent school, two private schools one government school. The students included in the sample were those found backward on the standardized test. Only those students who scored below thirty percentile (5.864).

5.2.6 Scoring and Analysis

The scoring of the test papers were done by the investigator using scoring key. One mark for correct response and no mark for wrong response. The item numbers were tabulated against individual names, schoolwise. The table gave the number of correct and wrong, responses, schoolwise. The percentage of errors for each items was computed for the total sample.

Each test paper was examined for errors committed. Common errors were identified and listed schoolwise. The error analysis gave the content areas where majority of errors were made. The analysis also revealed the kind of errors or the misconceptions involved. The percentages of the correct responses and the least correct responses are give in (Table 5.2.6.1) and (Table 5.2.6.2) respectively.

Table 5.2.6.1

Percentage of Correct Responses on Diagnostic Test

Item No.	Item	Percentage
1.	Test of Basic Skills in Arithmetic	
A.i.	351 + 879	90%
A.ii.	432 + 18	93%
A.iii.	200 + 564	94%
A.iv.	267 + 951 + 419	62%
B.i.	47 - 31	95%
B.ii.	523 - 215	74%
B.iii.	649 - 15	86%
B.iv.	780 - 187	56%
C.i.	10 x 5	89%
C.ii	810 x 20	65%

C.iii.	935 x 127	36%
C.iv.	13 x 12 _____	72%
D.i.	36 ÷ 6 =	93%
D.ii.	525 ÷ 5 =	25%
D.iii.	48 ÷ 8 =	80%
D.iv.	1500 ÷ 3 =	39%
D.v.	125 ÷ 4	14%
E.i.	4 x _____ = 1	1%
E.ii.	5 ÷ _____ = 1	62%
E.iii.	$\frac{1}{9}$ x _____ = 1	26%
E.iv.	$\frac{2}{7} \div \frac{2}{7} =$ _____	21%
II.	**TEST F BASICS IN ALGEBRA**	
A.i.	a + a = _____	7%
A.ii.	a + b + a + b + b	2%
A.iii.	xy + xy + 1 = _____ + _____	4%
A.iv.	2y + 3x + x + y + 5x = _____ + _____	0%
A.v.	$x^2 + x^2 + x^2$ = _____	1%
A.vi.	a + b = _____ + _____	43%

B.i	$\frac{b \times b \times b}{b \times b} =$ _____	12%
B.ii.	$\frac{a \times b \times c \times a}{2 \times a \times b \times b} =$ _____	5%
C.i.	$5 \times b \times c =$ _____	57%
C.ii.	$4y =$ _____ $\times y$	36%
C.iii.	$ab =$ _____ x _____	51%
C.iv.	_____ x _____ $= 2d + 2c$	0%
C.v.	$3(y + d) =$ _____ + _____	26%
D.i.	31, x, ab, $\frac{1}{2}$, 2.5, t, -4, $\frac{b}{c}$, q, 10, r, m, 100, n, pq	
III.	**TEST OF RATIONAL NUMBERS**	
i.	$\frac{6}{7}$, $\frac{12}{5}$, $\frac{11}{13}$, $\frac{2}{9}$, $\frac{5}{12}$	20%
ii.	$\frac{3}{4} \times \frac{2}{2} =$ _____	28%
iii.	5, $\frac{-1}{4}$, $\frac{7}{9}$, 64, - 10, $\frac{-2}{5}$, - 3, $\frac{6}{11}$, - 25, 31, $\frac{-2}{7}$, - 12, 15, $\frac{9}{13}$	2%
IV.	**TEST OF FRACTIONS**	
A.1.i.	$\frac{1}{3} + \frac{1}{3} + \frac{1}{3} =$	24%
A.1.ii.	$\frac{1}{4} + \frac{1}{4} =$	22%

A.1.iii.	$\frac{2}{5} + \frac{4}{5} =$	22%
A.1.iv.	$\left(\frac{-1}{6}\right) + \left(\frac{-5}{6}\right) =$	7%
A.1.v.	$\left(\frac{-2}{3}\right) + \frac{5}{3} =$	8%
2.	$\left(\frac{-2}{3}\right) - \left(\frac{-1}{3}\right) =$	11%
3.	$\frac{3}{7} \div \frac{3}{7} =$ _____	17%
B.1.i	$\frac{1}{4} + \frac{1}{3} =$	1%
B.1.ii	$\frac{2}{5} + \frac{3}{4} =$	1%
B.1.iii	$\left(\frac{-2}{3}\right) + \frac{1}{4} =$	0%
2.	$\left(\frac{-1}{5}\right) - \left(\frac{-1}{6}\right) =$	2%
3.	$\frac{3}{5} \div \frac{6}{7} =$	1%
V.	**TEST OF INDICES**	
A.1.i	$1^3 \times 1^2 = 1(\ \ ) =$ _____	39%
A.1.ii.	$2^5 \times 2^5 \times 2^5 = 2^{(\ \ )}$	32%
A.1.iii	$3 \times 3 \times 3 \times 3 \times 3 \times 3 = 3^{(\ \ )}$	36%
A.1.iv.	$5 \times 5 \times 5 =$ _____	11%
A.1.v.	$(-1) = (-1) =$ _____	10%
A.1.vi	$3^{(-2)} \times 3^{(-2)} = (\ \ \ \ )^{(\ \ )}$	( )
A.1.vii	$(-4) \times (-4) \times (-4) \times (-4) = (\ \ \ \ )^{(\ \ )}$	14%
2.	$2^6 =$ _____ (Write in expanded form)	41%

3.	4^5 , 7^3 , 2^6 , 10^4	11%
4.	$(2^3)^4 = 2^{(\ )}$	21%
5.	26, 6, 9, 0, 4, 11, 17, 22, 33, 46, 100, 73	4%
B.i	$a \times a = a^{(\ )}$	80%
B.ii.	$a \times a \times a \times ab = a^{(\ )} b^{(\ )}$	43%
B.iii.	$xy \times xy = (xy)^{(\ )}$	64%
B.iv.	$(xy)^2 = x^{(\ )} y^{(\ )}$	41%
B.v.	$xy \times yz = xz =$	34%
B.vi.	$b^2 \times b^3 \times b^4 = b^{(\ )}$	36%
B.vii.	$\left(\frac{a}{b}\right)^2 = \frac{a^{(\ )}}{b^{(\ )}}$	58%
B.viii.	$\frac{X^4}{Y^4} = \left(\frac{x}{y}\right)^{(\ )}$	33%
B.ix.	$a^2 b^2 c^2 = (\quad)^{(\ )}$	28%
B.x.	$c \times c \times 2c = (\quad)^{(\ )}$	0%
C.1.i.	$\frac{1}{5} \times \frac{1}{5} \times \frac{1}{5} \times \frac{1}{5} =$ _____	4%
C.1.ii	$\left(\frac{-2}{5}\right) \times \left(\frac{-2}{5}\right) = (\quad)^{(\ )}$	14%
C.1.iii	$\left(\frac{2}{3}\right)^4 \times \left(\frac{2}{3}\right)^5 = (\quad)^{(\ )}$	14%
C.2.i.	$\left(\frac{-1}{4}\right)^3 =$ _____	17%
C.2.ii.	$\left(\frac{1}{3}\right)^2 =$ _____	12%
C.2.iii.	$\frac{1}{2^3} = 2^{(\ )}$	4%
C.2.iv.	$\frac{3^5}{4^5} =$	36%
C.2.v.	$\left(\frac{4^2}{3^2}\right)^5 = \left(\frac{4}{3}\right)^{(\ )}$	7%

VI.	**TEST OF MONOMIAL – BINOMIAL MULTIPLICATION**	
i.	$a(x + 1)$	27%
ii.	$(a + b)2c$	23%
iii.	$(3x + y)\, z$	22%
iv.	$a(b + c)$	23%
v.	$(2x + 3y)\, 3r$	18%
vi.	$x(y - z)$	22%
VII.	**TEST OF BINOMIAL – BINOMIAL MULTIPLICATION**	
i.	$(x + 1)\,(x + 1)$	5%
ii.	$(a + b)\,(a + b)$	3%
iii.	$(2a + 1)\,(3a + 1)$	1%
iv.	$(3y - x)\,(2y + x)$	1%
VIII.	**TEST OF BRACKET EXPANSION**	
i.	$(a + b)^2$	28%
ii.	$(x + 1)^2$	21%
iii.	$(a + b)^3$	13%
iv.	$(x + 2)^3$	11%
IX.	**TEST OF LINEAR EQUATIONS**	
i.	If $x + 1 = 0$ then $x =$ _____	3%
ii.	If $a = (-2)$ then $a + 2 =$ _____ $+ 2$	16%
iii.	Put '2' in place of 'x' in $x + 3$ $\therefore$ $x + 3 =$ _____ $+ 3$	28%
iv.a.	If $y = 3$ then $y + 2 =$ _____ $+ 2$	22%
iv.b.	If $y = -1$ then $y + 2 =$ _____ $+ 2$	11%
v.	If $3 - x = 0$, then $x =$ _____	( )
vi.	Put '(- 1)' in place of 'b' in $1 + b$ $\therefore$ $1 + b = 1 +$ _____	11%
vii.	If $2x = 1$ then $x =$ _____	3%
viii.	If $a + 1 = 2$ then $a =$ _____	28%
ix.	If $2 + 3b = 8$ then $b =$ _____	7%

Table 5.2.6.2

Items with Least Correct Responses

Item No.	Item	Percentage
1.	**TEST OF BASIC SKILLS IN ARITHMETIC**	
D.ii.	$525 \div 5 =$	25%
D.v.	$125 \div 4$	14%
E.i.	$4 \times$ _____ $= 1$	1%
E.iv.	$\frac{2}{7} \div \frac{2}{7} =$ _____	21%
II.	**TEST F BASICS IN ALGEBRA**	
A.i.	$a + a =$ _____	7%
A.ii.	$a + b + a + b + b$	2%
A.iii.	$xy + xy + 1 =$ _____ + _____	4%
A.iv.	$2y + 3x + x + y + 5x =$ _____ + _____	0%
A.v.	$x^2 + x^2 + x^2 =$ _____	1%
B.i	$\frac{b \times b \times b}{b \times b} =$ _____	12%
B.ii.	$\frac{a \times b \times c \times a}{2 \times a \times b \times b} =$ _____	5%
C.iv.	_____ x _____ $= 2d + 2c$	0%
D.i.	31, x, ab, $\frac{1}{2}$, 2.5, t, -4, $\frac{b}{c}$ q, 10, r, m, 100, n, pq	7%

III.	**TEST OF RATIONAL NUMBERS**	
iii.	$5, \frac{-1}{4}, \frac{7}{9}, 64, -10, \frac{-2}{5}, -3, \frac{6}{11}, -25, 31, \frac{-2}{7}, -12, 15, \frac{9}{13}$	2%
IV.	**TEST OF FRACTIONS**	
A.1.iv.	$\left(\frac{-1}{6}\right) + \left(\frac{-5}{6}\right) =$	7%
A.1.v.	$\left(\frac{-2}{3}\right) + \frac{5}{3} =$	8%
2.	$\left(\frac{-2}{3}\right) - \left(\frac{-1}{3}\right) =$	11%
3.	$\frac{3}{7} \div \frac{3}{7} =$ _____	17%
B.1.i	$\frac{1}{4} + \frac{1}{3} =$	1%
B.1.ii	$\frac{2}{5} + \frac{3}{4} =$	1%
B.1.iii	$\left(\frac{-2}{3}\right) + \frac{1}{4} =$	0%
2.	$\left(\frac{-1}{5}\right) - \left(\frac{-1}{6}\right) =$	2%
3.	$\frac{3}{5} \div \frac{6}{7} =$	1%
V.	**TEST OF INDICES**	
A.1.iv.	$5 \times 5 \times 5 =$ _____	11%
A.1.v.	$(-1) = (-1) =$ _____	10%
A.1.vi	$3^{(-2)} \times 3^{(-2)} = (\quad)^{(\quad)}$	0%
A.1.vii	$(-4) \times (-4) \times (-4) \times (-4) = (\quad)^{(\quad)}$	14%

3.	4^5 , 7^3 , 2^6 , 10^4	11%
5.	26, 6, 9, 0, 4, 11, 17, 22, 33, 46, 100, 73	4%
B.x.	c x c x 2c = ( )( )	0%
C.1.i.	$\frac{1}{5}$ X $\frac{1}{5}$ x $\frac{1}{5}$ x $\frac{1}{5}$ = _____	4%
C.1.ii	$\left(\frac{-2}{5}\right)$ X $\left(\frac{-2}{5}\right)$ = ( )( )	14%
C.1.iii	$\left(\frac{2}{3}\right)^4$ X $\left(\frac{2}{3}\right)^5$ = ( )( )	14%
C.2.iii.	$\frac{1}{2^3}$ = 2( )	4%
C.2.v.	$\left(\frac{4^2}{3^2}\right)^5 = \left(\frac{4}{3}\right)^{(\ )}$	7%
VI.	**TEST OF MONOMIAL – BINOMIAL MULTIPLICATION**	
v.	(2x + 3y) 3r	18%
VII.	**TEST OF BINOMIAL – BINOMIAL MULTIPLICATION**	
i.	(x +1) (x + 1)	5%
ii.	(a + b) (a + b)	3%
iii.	(2a + 1) (3a + 1)	1%
iv.	(3y – x) (2y + x)	1%
IX.	**TEST OF LINEAR EQUATIONS**	
i.	If x + 1 = 0 then x = _____	3%
ii.	If a = (- 2) then a + 2 = _____ + 2	16%
iv.b.	If y = -1 then y + 2 = _____ + 2	11%
v.	If 3 – x = 0, then x = _____	0%
vi.	Put '(- 1)' in place of 'b' in 1 + b ∴ 1 + b = 1 + _____	11%
vii.	If 2x = 1 then x = _____	3%
ix.	If 2 + 3b = 8 then b = _____	7%

5.3 Construction of the Questionnaire

5.3.1 Purpose of the Questionnaire

In order to develop the backdrop of the scene of the backward, a questionnaires was constructed for the backward students. It consisted of questions pertaining to the home background, opinion regarding mathematics teachers, mathematics test book, difficult and easy topics in mathematics, frequency of failure, suggestions for handling backward student's provisions for backward students expectations from teachers, study habits.

5.3.2 Item Selection and Procedure

Item pertaining to the various categories were constructed by the investigator. A total of items were constructed. These items were put under different categories. The questionnaires was given to various language experts.

After having decided the purpose of the questionnaire and the sample the next aspect of importance of the question of the questionnaire. The questionnaire was constructed after having attained a thorough grasp of the field and of the purpose of the questionnaire responses. The investigator also considered the age and ability of the respondents. Care was taken to avoid questions pertaining to data found elsewhere readily. Every item was ensured to serve purpose or else eliminated. This can be found in the revision in 5.3.3 and 5.3.4. The structure, the alternatives, of each item was revised to making responding easy. Questions pertaining to the same such topic more grouped together to give the questionnaire a semblance of order. The more general questions were put first, then more detailed and specific. The questionnaire went through number of revisions in the hands of researchers and language experts. This were also revisions based on pilot study feedback and comparing with other questionnaires. In order to demand less of the time and energy, and to harness the interest of the respondent, the investigator tried to keep the questionnaire of average length. The items were framed to give a human touch rather than being stereo type and impersonal. The respondents being students open questions were kept to the minimum. Though open questions give more leeway in stating one's position it increases the risk of misinterpretation. Close questions help

keep the question are to a reasonable length and encourage response. Majority of the items were provided with alternatives, minimizing the risk of misinterpretation.

The language of the items were kept as clear, direct and simple to convey meaning to the respondent without confusion. The validation of the questionnaire was done by establishing content validity - i.e., each question was related to the topic under investigation; there was adequate coverage of the overall topic; the questions were clear and ambiguous.

5.3.3 Revisions in the First Draft

The changes brought about in the construction of the Home Background and Personal Details questionnaire, from first draft to second draft. The first draft of the questionnaire is given in Appendix-F.

Heading

The first draft was named Questionnaire. The language experts suggested the name Information Schedule for Drawing a Profile of Students weak in School Mathematics. This also was a note in brackets. (Your information will not be shown to any one.) This can be seen in the second draft.

The categories in the first draft were as given below:

A. General Information
B. Family Background
C. School Career
D. Out of School activities involvement
E. Study Habits
F. Difficulties as perceived by students
G. Changes expected by students for better understanding of mathematics
H. Attitude/Interest of the students.

The suggestions and changes category wise are given below:

A. General Information

'Gender' in the first draft was changed into 'Male/Female' in the second draft. An additional sub-category 'Mother tongue' was also added.

B. Family Background

Sub-categories of 'Sister', 'Brother' were dropped and sub-category 'Any other member staying in the family' was changed to 'Any other earning member'.

C. School Career

Instead of sub-categories being in the brackets like (Place and name of the school) and (Medium, place and name of the school) they were given separate slots like

'Place'

'Name of the school'

'Medium'

'Number of schools changed, if any: _____' was provided with a series of three numbers; 1, 2, 3.

D. Out of School Activities Involvement

The sub-categories were provided with number series in the second draft to facilitate writing responses.

E. Study Habits

The item 'Number of hours spent for studying mathematics at home' was changed to 'Number of hours spent usually for studying mathematics in a day at home _____ hours', 'Do you study mathematics everyday' was dropped. The items with options were provided with instruction 'tick any one', in the second draft.

F. Difficulties as Perceived by Students

The item 'When did you fail in mathematics for the first time' was changed to 'Did your ever fail in mathematics?' Also the options were changed to 'Y/N'. 'If yes, when _____, in the second draft 'How did you feel when you failed in mathematics' was changed to 'What do you feel when you fail in mathematics' and 'not bothered' was added to the options for this item. All the items with different options were given the instruction 'tick any one'. The item 'What do you do when you fail' got changed to 'What do you usually do when you fail?', 'Which topics in mathematics do you feel are difficult for you' was changed to 'Which topics are difficult for you in mathematics'. 'Do you think you have any problem in learning mathematics' was changed to 'Do you think you have any different type of problem in learning mathematics?' 'Have you enjoyed solving mathematics problems' was dropped.

'Do you discuss the problem with your teacher' was changed to 'Do you discuss any kind of mathematics problems with your teacher'. 'Do you feel shamed or scared to go to the mathematics teacher?' was changed to 'How do you feel when you go to the mathematics teacher for clearing doubts?' and options were provided.

G. Changes Expected by Students for Understanding of Mathematics

The item 'What change will help you to learn mathematics better?' was changed to 'What changes .... better'. Instruction 'tick any one' was also provided. More options were added to item (1) and (2).

'Would you like to find the correct answer yourself' was changed to 'Do you like finding the correct answer yourself ?' 'Would you like your mathematics teacher to correct your mathematics note book' was dropped.

H. Attitude/Interest of the Students

'What do you like about your school?' was changed to 'What do you like the most about your school?' 'Which subjects do you like?' was changed to 'Which academic / school subjects do you like?' 'Which languages do you like?' was dropped. Three items, 'What do you like to read in the newspaper?', 'Which serials do you like to watch?', 'Do you like to solve puzzles?' were dropped. Instead three items, 'Do you think you can learn mathematics?', 'Is mathematics important for your future?', 'Do you enjoy solving mathematics problems?'

5.3.4 Revisions in the Second Draft

The second draft of the questionnaire is given in Appendix-G.

The second draft was administered on five eighth standard students, identified as backward by the mathematics teacher. After the administration the questionnaire underwent the following changes. These changes were done after seeing the responses are referring similar questionnaires.

Heading

The name was changed to 'Home Background and Personal Details'. The names of the categories were also changed.

A. PERSONAL DETAILS
B. HOME BACKGROUND
C. FACILITIES AVAILABLE AT HOME
D. DIFFICULTIES PERCEVIED BY THE STUDENT
   i. SUBJECT RELATED
   ii. STUDENT RELATED
E. HOME AND STUDENT RELATED
F. STUDY HABITS
G. CHANGES EXPECTED BY STUDENTS FOR BETTER UNDERSTANDING OF

Changes were as follows:

A two line letter to the student was given as the header, above the heading

*A. **Personal Details***

All the items under GENERAL INFORMATION were retained. Instead of 'Mother tongue', it was 'Languages known :

i) spoken _____, _____.

i) spoken and written _____, _____.

Another item added was 'Place of residence', included in the third draft.

*B. **Home Background***

The items under this were almost same except for the questioning mode. Instead of the headings and a blank the questions were descriptive with elaborate options. 'Occupation of your father':

Business	Agriculture	Teaching	Bank job	Office job
( )	( )	( )	( )	( )

Instructions to put 'X' in the bracket was given below the heading.

'Type of family' was dropped in the third draft.

*C. **Facilities Available at Home***

This category was not present in the second draft. Two of the categories dropped from the second draft totally were, SCHOOL CAREER, OUT - OF - SCHOOL ACTIVITIES INVOLVEMENT.

In this category items regarding, type of house, electrification of house and separate room to study were added.

*D. **Difficulties Perceived by the Student***

In this category all the items as in F of second draft were included although in a modified manner. The item dropped were 4, 5 7, 11, 12, 15 of F.

Rather than asking the respondents difficult topics, in the third draft various topics were given to be identified as 'easy' and 'difficult'.

The items 1, 2, 3 of F in second draft were merged as one item in the third draft.

The items of F in second draft were further sub-categorised as subject related, teacher related, home and student related.

Items regarding explanation given by mathematics teacher, solve difficult problems, difficult homework, teacher encouragement, were included in the third draft under Teacher related.

Under Home and Student related, sub-category, help obtained from family members, time available in domestic work, which were not found in the second draft were included.

E. Study Habits

All the items under E in the second draft were included. The items were elaborately presented, like, instead of 'Do you study mathematics by reading or writing or both?', the item was 'How do you study mathematics at home?'

	Always	Sometimes	Never
Writing	( )	( )	( )
Reading	( )	( )	( )
Reading & writing	( )	( )	( )

Three more items were added in the third draft, dealt with asking doubts, rote memorizing mathematics, reading of text-books.

G. *Changes Expected by Students for Better Understanding of Mathematics*

All the items of G in second draft were included except for 1, 6, 9. Items pertaining to mathematics teacher were shifted to D in the third draft.

Items about the changes with regard to text-book, teaching methods, examination, homework were included in the third draft.

5.4 Administration of the Questionnaire

The final version of the questionnaire is given in Appendix-H.

The questionnaire was once again revised to made changes in some items. Finally the questionnaire with fifty-two items was administered. The questionnaire was administered on the same sample selected for diagnostic test. The questionnaires were given to the selected sample in school to fill in the responses at home. The questionnaires were collected back at the respective schools.

5.5 Questionnaire Responses

The items of the questionnaires were tabulated. The responses of each individual was indicated. The analysis gave a picture of the home background, opinion, difficulties faced by the students, with respect to mathematics teaching, text-books, teachers. The responses were regrouped in order to arrive at some conclusions. The percentages of the responses were computed and are given below.

5.5.1 Analysis of Responses to the Questionnaire

1. Languages known (spoken & written)

   English – Konkani 26.58%
   English – Hindi 20.25%
   English – Marathi 16.45%
   Hindi – Konkani 1.26%
   Hindi – Marathi 8.86%
   Konkani – Marathi 8.86%

2. Number of family members

   4 members – 26.58%, more than 4 members 64.56%

3. Occupation (father)

Office - 43.03%, Business - 20.25%, Bank - 1.26%, Teacher - 16.45%, Labour - 5.06%, Advocate - 1.26%, Nothing - 2.53%, Others - 10.12%

4. Occupation (mother)

Housewife - 73.42%, Office - 10.12%, Teacher - 6.32%, Business - 1.26%, Others - 1.26%, Agriculture - 3.74%, Labourer - 1.26%

5. Electrified House – 87.34%

6. Separate room for oneself – 40.5%

7. a. Difficulties perceived by the student

Subjects Related

Topics	Easy	Difficult
Brackets	70%	19%
Exponents	60%	16.45%
Identities	54%	45.5%
Negative numbers	59%	31.6%
Fractions	50%	43%
Linear equations	43%	50.6%
Word problems	25%	62%

7. b. Failure in 8^{th} 49%

i) Feeling associated

- angry 22%, sad 64%, nervous 28%

ii) Reasons given

- not understanding - 71%, not able to remember - 66% language problem - 5%

7. c. Revision of previous topics required

- exponents - 24%, positive and negative nos. - 21.5%, L.C.M. - 8.86

7. d. Difficulties perceived by the student

Teacher related

i) Kind of help for students weak in mathematics

- Teach slowly - 7%, repeat explanation - 38%, explain more - 34%

ii) Discussed doubts with mathematics teacher - 59%

iii) Understand explanation given in the class - 69%

iv) Teacher gives extra helps to weak students - 69%

v) Sufficient explanation given by mathematics teacher - 47%

vi) Teachers solved difficult problem - 84.81%

vii) Difficult home work - 26.58%

viii) Teacher encourage to score high - 75.9%

7. e. Difficulties perceived by the student

Home and students related

i) Help from family members - 51%

ii) Parent encouragement to score high - 86%

iii) Sufficient time to study at home - 92.40%

iv) Help parents in domestic work - 65.82%

v) Feel tired at home - 39.24%

8. Study habits

a. Numbers of hours / day in studying mathematics (1hr - 32%, 3hrs - 4%, 2 hrs - 6%)

b. Mode of studying mathematics

i) Reading (sometimes - 36%, always - 5%, never - 10%)

ii) Writing (always - 41%, sometimes - 25%, never - 3.79%)

iii) Reading and writing (always - 35%, sometimes - 34%, never - 6.32%)

c. TV on while studying (sometimes - 46.83%, never - 41.77%)

d. Checks methods text book - 25%

e. Study mathematics alone (sometimes - 51%, never - 17.72%)

f. Study mathematics with friends (sometimes - 49%, always - 26%, never - 10.12%)

g. Feeling while studying mathematics

i) Happy (always - 35%, sometimes - 30%, never - 0%)

ii) Boring (sometimes - 38%, never - 25%, always - 0%)

iii) Nervous (always - 4%, sometimes - 28%, never - 22%)

iv) Sleepy (always - 0%, sometimes - 0%, never - 29%)

h. Attend tuitions - 33%

i. (N.A.)

j. (N.A.)

l. Rote memorize mathematics

i) Solved problems - 58%

l. Read mathematics text book - 25.32%

9. Changes expected by students for better understanding of mathematics.

a. Preference of period to study mathematics - evening - 34.18%, morning - 22.78%, afternoon - 20.25%

b. Preference of numbers of periods - more than 1 period - 44.3%

c. Likes to find correct answer oneself - 78%

d. Solve mathematics problem by own method - 50.6%

e. Feel like changing the text book - (Yes) - 17.72%

f. N.A.

g. N.A.

h. Do you think the home work given is appropriate ? (Yes) - 10.12%

i. Changes suggested in examination for weak students

i) More time - 15%

ii) Easy question and more time - 29%

iii) English question - 24%

j. Explanation required to be in Konkani - 28%

5.5.2 Summary Based on Response Analysis

The responses to the questionnaire were analysed sub-categorywise. The percentages were computed for each sub-category. Some sub-categories had no responses. The response analysis is given in 5.5. The analysis showed that about sixty percent of the students could speak and write English along with Hindi, Konkani or Marathi. Only twenty eight percent felt the need for explanation of mathematics in Konkani. However sixty two percent found word problem as a difficult topic. The interview excerpts of majority of teachers showed need for use of Konkani or Hindi or Marathi as essential for explaining mathematics. The analysis showed sixty four point five six percent of the sample belonged to families with more than four numbers and only twenty six point five eight percent belonged to four member family. This showed that the sample belonged to joint families or large families. The occupation of father in about fifteen point one percent cases was either labour or other vocations. The majority of the sample of about eight two percent had father's occupation as office / business / teaching. This showed that there was sound educational background in the family. This was reflected in the eight six percent claiming encouragement from parents and fifty our percent claiming help from parents. The views of the teachers was however, contrary to this. According to them parents were not taking responsibilities and did not even come to school to collect the results. Coming to the difficulties faced by the students, twenty six point five eight percent found homework to be difficult and forty seven percent found explanation given in the class by mathematics teacher as sufficient. This was clearly seen in the suggestions by thirty eight percent to repeat explanation and thirty four percent to explain more. The topics found to be easy by the students, made the investigator puzzled. These were the very topics where large number of errors occurred. The reasons given for failure in eighth standard were seventy one percent for not understanding and sixty six percent for not able to remember. This again draws the attention to the explanation given by the teachers and the study habits.

They definitely require more explanation and study habits to enhance memory. Keeping T.V. on while studying mathematics, was found in forty six point eight three percent cases. Writing while studying mathematics was found to be forty one percent and reading and writing was found to be thirty five percent. Thus, there seemed to be more thrust upon writing. Only forty two percent was found to be spending one hour or more in studying mathematics at home. Hence time spent on studying mathematics was less. The sample showed a kind of healthy feeling while studying mathematics. There was no response for 'never feeling happy' 'and always feeling bored' while studying mathematics. The message conveyed was that the students backward in mathematics did not have a strong negative feeling towards mathematics. However, rote memorization was opted by fifty eight percent and only twenty five percent read the text-book. It points at faulty study habits, marks oriented examination system, alien text books. Changes expected by them for better understanding of mathematics were thought – provoking. Most striking were seventy eight percent preferring to find correct answer oneself and fifty percent preferring to solve mathematics problem by own method. This may be found contrary to the common belief that the homework given and appropriate. They also expected changes in examination to suit the students backward in mathematics.

5.6 Common Errors from the Diagnostic Test

In this discussion the focus is on the various errors committed on the diagnostic test, by the backward students. The discussion includes the errors, description of the errors, and the probable reasons for the errors.

Error I: Q.1 D $525 \div 5 = 15$

Here the error is, failing to place the zero, 105. This fundamental operation is introduced in the lower classes, precisely in standard four. This is a very common error. This is not an error developed in the eighth standard. This has been formed and carried forward without any interference.

Error II: Q.1.E. $\frac{2}{7} \div \frac{2}{7} = \frac{4}{49}$ or 0

This is a case of overlooking mathematical operation symbols. This kind of error can give rise to many doubts about the deficiency level.

Error III: Q.1.D. (iv) $1500 \div 3 = 5$

Here the error is the failing to put two zeros, 500. This indicates faulty fundamental operations.

Error IV: Q.1.B. (ii) $\begin{array}{r} 523 \\ -\,215 \\ \hline 312 \end{array}$ (iv) $780 - 187 = 600$

In this error there is clear indication of confusion regarding subtraction. No awareness of borrowing. Mere recognition of greater and smaller number. Vertical and horizontal placements made no difference.

Error V: Q.2.A(I)

i. $a + a = a^2$

ii. $a + b + a + b + b = a^2 + b^2,\ a^2 + b^2$

iii. $xy + xy + 1 = xy^2 + 1$

iv. $x^2 + x^2 + x^2 = x^6$

These errors show faulty conceptualisation of the law of indices. Almost all those of who committed these errors, gave correct response for Q. 5B (i) $a \times a = a^2$. Hence the operation sign of '+', 'x' meant nothing, to them.

Error VI: Q.2 B (i) $\dfrac{b \times b \times b}{b \times b}$ $\dfrac{b^3}{b^2}$

(ii) $\dfrac{a \times b \times c\, a}{2 \times a \times b \times b}$ $\dfrac{a^2\, bc}{2ab^2}$

The question was asked for simplification. The response may appear to be partially correct. Since it was simplified by very few, it is being considered as an error.

Error VIII: Q.2C (iv) $\underline{2d} \times \underline{2c} = 2d + 2c$

Expected response was $2(d + c)$. This reveals the deficiency about properties of real numbers, distributive property.

Error VIII: Q.2D.

The question required to encircle the variables from a mix of numbers and variables. Some of respondents did not attempt while some encircled both.

Error IX: Q.IV AI

i. $\frac{1}{3} + \frac{1}{3} + \frac{1}{3} = \frac{3}{9}$

ii. $\frac{1}{4} + \frac{1}{4} = \frac{1}{8} = 2$

iii. $\left(\frac{-2}{3}\right) + \left(\frac{5}{3}\right) = \frac{-7}{6}$

These kind of errors indicate lack of understanding of adding fractions, adding positive and negative fractions. These are concepts introduced in standard six and seven. Even a simplification like $\frac{2}{4} = \frac{1}{2}$ is not done correctly, is alarming.

Error X: Q. IV A(3) $\frac{3}{7} \div \frac{3}{7} = \frac{0}{0}, \frac{9}{49}$

This error is similar to ERROR II. This shows two types of errors. Misunderstanding division for subtraction and multiplication. Not aware of the fact that a number divided by itself gives one.

Error XI: Q. IV B 2 $\left(\frac{-1}{5}\right) - \left(\frac{-1}{6}\right) = \frac{-0}{6} ; \frac{0}{11}$

This error shows a total confusion regarding negative numbers and adding of fractions.

Error XII: Q.V.A. 1 (i) $1^3 \times 1^2 = 1^6$

(ii) $2^5 \times 2^5 \times 2^5 = 2^{125}$

If ERROR V is compared with this, one can see the lack of basics in law of indices, precisely the operation between bases.

Error XIII: Q.V A I (vi) $3^{(-2)} \times 3^{(-2)} = 9^4 ; 3^4$

The error shows lack of clarity about law of indices and sign conventions.

Error XIV: Q.V A (4) $(2^3)^4 = 2^7$

Confusion in laws of indices.

Error XV: Q. VA (2) $2^6 = 3$ (write in expanded form)

This error shows tendency to do any operation on two numbers found in proximity. This must have appeared like 6/2.

Error XVI. Q. VA 1.(v) $(-1) \times (-1) - 0$

No regard about mathematical operation or sign convention.

Error XVII: Q. VA (3)

Pick out the bases in the following.

4^5, 7^3, $2\sqrt{}^6$, $10\sqrt{}^4$

Here the error was, not identifying all the bases.

Error XVIII: Q.V A (5)

26 (6), 9, 0, 4, (11), 17, 22, 33, 46 (100), 73

Unable to identify an odd integers.

Error XIX. Q.V.B. (viii) $\frac{x^4}{y^4} = \left(\frac{x}{y}\right)^8 ; \left(\frac{x}{y}\right)^{16}$

Unclear about the law of indices. Unable to use brackets

Error XX: Q. VB (ix) $a^2 b^2 c^2 = (abc)^6 ; (abc)^8$

Adding the indices instead of taking it common. This shows inability to use brackets.

Error XXI: Q.B.1 C (I) $x \begin{matrix} 10 \\ 5 \\ \hline 15 \end{matrix}$

Adding instead of multiplying

Error XXII: Q.1 C (iv) $\begin{array}{r} 13 \\ \times\ 12 \\ \hline 26 \end{array}$

Multiplying with one number only.

Error XXIII: Q.1. C (iv) $\begin{array}{r} 13 \\ \times\ 12 \\ \hline 115 \end{array}$

Adding the units place.

Error XXIV: Q.VI (i) $a(a + 1) = ax + 1$

(ii) $(a + b)\ 2c = a + b2c$

(iii) $(3x + y)\ z = 3x + yxz$

(iv) $a(b + c) = ab + c$

(v) $(2x + 3y)\ 3x = 2x + 3y \times 3x$

(vi) $x(y - z) = xy - z$

Not employing distributive property completely, but partially.

Error XXV: Q. VII (iii) $(2a + 1)(3a + 1) = 6a^2 + 2$

Not employing distributive property completely, but partially.

Error XXVI: Q. VIII. (i) $(a + b)^2 = a^2 + b^2$; $(ab)^2$

$(a + b) + (a + b)$; ab^2

(ii) $(x + 1)^2 = x^2 + 1$; $x1^2$

(iii) $(a + b)^3 = (a \times a \times a + b \times b \times b)$; $a^3 + b^3$; ab^3

(iv) $(x + 2)^3 = x^3 + 2^3$; $x2^3$

Here there is a pattern in the error. Two kinds of errors. One, the squares of the variables are added, while in the other the variables are multiplied and power to the latter variable. This clearly shows disregard for brackets and operation sign. If symbols do not mean anything to the student what fundamental can one expect.

Error XXVII: Q.IX (i) If $x + 1 = 0$ then $x = 0$ or 1

This error reveals total ignorance of equality and substitution.

Error XXVIII: Q. IX (iv) a. If $y = 3$ they $y + 2 = y + 2$

Q.IX (iii) Put 2 in place of x in $x + 3 \therefore x + 3 = \underline{x} + 3$.

Here substitution has been misunderstood. Even the simple language could not make a difference.

Error XXIX: Q. IX (vii) If $2x = 1$ then $x = \underline{3}$

No understanding of multiplication equality. A free hand with numbers.

Error XXX: Q. IX (viii) If $a + 1 = 2$, then $a = \underline{3a}$ or $\underline{1a}$

An error, similar to XXIX but for the use of the variable. Except for $a = 3a$ itself is unbalanced. Even then, value of a cannot be 1a, it has to be a constant.

Error XXXI: Q. IX (ix) If $2 + 3b = 8$, then $b = \underline{3}; \underline{8}; \underline{13b}$

Here $b = 3$, shows a straight addition $2 + 3 + 3 = 8$, though it is mathematically wrong. Incase of 13b, $8 + 2 + 3$, which is again mathematically wrong. This however brings to light, total ignorance or neglect of fundamental operations and lack of awareness about equality.

5.7 Summary Based on Types of Errors on the Diagnostic Test

The errors committed are such, that put a big doubt on what the students know. They are confused with fundamental operations, brackets, equality, sign convention. These deficiencies do not seem to have developed in one year. They are a result of years of neglect. The surprising factor is how did the students move up to the eighth standard. It is surely due to promotion policy. But the fault is felt to be with the students. The errors that have been identified show very clearly the extent of lack of fundamentals. In a number of cases the fundamental operations itself are not clear. The errors also bring another striking factor about the thoughtlessness in response. The errors that are cited have not developed in standard eight. They must have developed in the lower classes. Errors based on place value, addition,

multiplication, subtraction, division, use of brackets, makes one frightened to think of introducing any new concept/ topic. How will the teacher explain, anything ? The respondents have not developed any kind of mathematical thinking - the relationship between the answer and the question; what is asked and the response. If distributive property is not clear how will the expansion of brackets be clear. Without knowing laws of indices. One cannot imagine to learn any algebra. Even the basic like $a + a = 2a$, $a \times a = a^2$, $a + b = \neq ab$, not known at eighth standard, is a good ground to perpetuate algebra deficiency. The most striking errors were errors II, IV, VI, XI. Misunderstanding fundamental operation symbols leaves hardly any scope of mathematical conceptualization. The very core of mathematics being relationship between entities and the symbolic representation. The very reason for these faulty conceptualization is the manner in which mathematics is presented, taught, evaluated. The immense stress on tenth standard i.e., relevance for tenth mathematics, leaves very little room for conceptualization. Teachers have expressed their opinion to concentrate on topics only relevant for passing tenth standard. Rote memorization and drill is used as a major tool with very less understanding. The major defect cited is lack of basics. Every teacher feels it should have been done in lower classes. In fact it needs to be verified at every level. Do the students possess the minimum, to be able to understand the new topics ? This could be followed by remedial classes. Again testing. Then the new topics could be introduced. This requires elaborate planning, to ensure the pace for various groups. It cannot be left only for the concerned teacher. It has to be the part of the school curriculum itself. Errors XXV, XXVI show total ignorance about use of brackets. Errors XXIX, XXX, XXXI, reveal faulty conceptualization of basics of an equation and use of symbols / variables, operations. The percentages of correct responses (refer Table 5.2.6.1) and the least correct responses (refer Table 5.2.6.2) reveal the areas of backwardness. Division, adding of variables, identifying variables, were the most difficult areas. Identifying of rational numbers,. Adding fractions with same and different denominations, sign conventions, multiplying indices with integer as base, identifying add integers, binomial – binomial multiplcation, linear equations were also the difficult areas. What mathematics did the students possibly know ? They did not know even identifying add integers, rational numbers, adding fractions. Learning algebra would

be impossible under such circumstances. Rethinking needs to be done about the teaching methods, explanations, introduction of fundamentals. Mathematical thinking has to be infused into mathematical learning. Rote memorizing and drill has to be discouraged and instead discussions using mathematical symbols along with student's own language should be encouraged. What do the symbols mean, which operations are involved, is the response correct questions such as these should be answered by the students. The direct presentation method generally followed all levels, snubs any kind of thinking from taking place. Winter (1991), Sjostrom (2000), Sashidharan (1992) Dienes (1970) give ample evidence to the harm and eventually mathematically ignorant citizenry, of not nurturing mathematical thinking i.e., logical thinking.