Chapter 3

METHODOLOGY

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3.1 INTRODUCTION

In this chapter, the investigator has discussed the methodology adopted for the present study. Population and sample selection is described at each stage. Details about construction of the tools like Achievement test, Parallel test and the Diagnostic test for the students of standard VIII have been described. Phases of the study are also elucidated here. The procedure for data collection and data analysis is described in brief towards the end since each would be detailed out in the following chapters.

3.2 POPULATION AND SAMPLING

3.2.1 Population

The population of the study is standard VIII students of all English medium schools, which are following the Gujarat Secondary and Higher Secondary Education Board, Gandhinagar Syllabus.

3.2.2 Sample

In the present study the investigator used multi-stage sampling technique. In the first stage two schools were randomly selected out of all the four English Medium (Appendix K) schools following Gujarat State Secondary and Higher Secondary Education Board Syllabus from the Anand and Vallabh Vidyanagar city. In the second stage out of the total five divisions of the two randomly selected schools the one was selected as an experimental group and the one was selected as a control group. All students of selected classes were included in the sample. Thus, it was cluster sampling.

The study involved samples for various purposes at different stages. They are as follows:

3.2.2.1 For Error Identification

From the four schools of Anand and Vallabh Vidyanagar city two schools viz. I.B.Patel English Teaching School and Salvation Army English Medium School were selected randomly for the error identification. Sample for error

identification consisted of all the two hundred and fifty-eight students of both the schools.

3.2.2.2 For Diagnosis and Remediation

From the total of five divisions one division with the lowest mean score on the achievement test was selected as an experimental group and the one out of the remaining four divisions was selected randomly as a control group for the diagnosis and remediation of Learning Difficulties.

The mean score of all the five groups on the pre-test was as below:

Table – 2

Mean Score Of The Five Groups

Group No.	Mean score
1	46.36
2	49.47
3	45.70
4	46.71
5	36.24

ANOVA was applied to the mean-scores of the above five groups. The result of the ANOVA is displayed in the table below.

Table - 3
ANOVA Output
(Mean-scores of the five groups)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4193.833	4	1048.458	3.302	.012
Within Groups	80340.353	253	317.551		
Total	84534.186	257			

The value of 'F' was 3.302 significant at .02 level. So, it was found using ANOVA that there was a significant difference between the mean scores of all the five groups. So the group number five with the lowest mean score was

selected as an experimental group for the diagnosis and remediation of the learning difficulties.

Also, ANOVA was applied to the remaining four groups. The result is displayed in the table below.

Table -4

ANOVA Output					
(Mean-scores of the four groups)					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	464.648	3	154.883	.437	.727
Within Groups	76887.543	217	354.320		
Total	77352.190	220			

The value of 'F' was 0.437 which was not significant. So, it was found using ANOVA that there was no significant difference among the mean scores of the remaining four group so one group was selected randomly using lottery method as a control group i.e. group number four was selected as a control group.

Sample for diagnosis and remediation of the learning difficulties consisted of students wherein the size of the experimental group was thirty-seven students and the size of the control group was fifty-seven students. Three of the students could not continue due to the irregular presence during the treatment and two students did not appear for the post-test in case of the experimental group. Five students did not appear for the post-test in case of control group. Finally, there were thirty-two students in experimental group and fifty-two students in control group.

3.3 TOOLS FOR DATA COLLECTION

The tools used in the study were Achievement test, Diagnostic Test, and Parallel test for achievement. All tools were prepared by the investigator and the details of the tools are as follows:

3.3.1 Achievement Test

The Achievement test was prepared by the investigator on the fundamental topics of Geometry for the students of standard VIII. Achievement test was prepared and administered for the following purposes:

- To measure the achievement of the students in geometry
- To identify the errors made by the students
- To provide the scores of the students on pre-test

3.3.1.1 Procedure of Preparing Achievement test

The units selected for the achievement test were viz. Point, Line, and Concept of Distance; Line Segment and Ray; Plane; Angle. The achievement test was prepared by keeping in mind the three aspects i.e. Content analysis, level of Instructional objectives and type of Questions. For the objectivity factor all the questions in the achievement test were objective type and one mark each. In total there were 100 items in the achievement test. There were six major questions and the format of the Achievement test was as follows:

Table – 5

Format of the Achievement Test

Sr. No.	Q. No.	Title of the question	Topics	No. of items	Marks
1	I	Fill in the blanks – Multiple Choice	Miscellaneous	40	40
2	II - A	Refer the figure and answer the questions	Number-line, distance, and Betweenness	05	05
3	II - B	Refer the figure (based on) and answer the questions	Line, Line-segment and Ray	15	15
4	II - C	Refer the figure and answer the questions	Plane	10	10
5	II - D	Refer the figure and answer the questions	Angle	15	15

6	III	Represent the geometrical statements by appropriate figure	Miscellaneous	15	15

The following tables (Tables 5 and 6) describes the layout of the blue-print framed to direct the preparation of the achievement test.

Table – 6
Objective-wise Weightage for Achievement Test

Sr. No.	Level of Objective	Marks	Weightage
1	Knowledge	21	21
2	Comprehension	53	53
3	Application	26	26

Table – 7
Content-wise Weightage for Achievement Test

Sr. No.	Topics	Marks	Weightage
1	Line	05	05
2	Relationship between point and line, Collinear and non-collinear points	09	09
3	Intersection of lines	09	09
4	Distance and Betweenness	07	07
5	Line-segment and congruent line-segments	04	04
6	Mid-point of Line-segment and bisector of a line-segment	05	05
7	Intersection of line-segments	04	04
8	Relationship between line and line-segment	03	03
9	Ray	03	03
10	Intersection of Rays	03	03

11	Opposite rays	02	02
12	Relationship between line and ray	03	03
13	Plane	03	03
14	Co-planar and non-coplanar points	04	04
15	Co-planar and Skew lines	03	03
16	Intersection of planes, Intersection of plane and line	03	03
17	Half planes / Partitions of plane by a line	05	05
18	Angle	05	05
19	Interior and exterior of an angle / Partitions of plane by an angle	05	05
20	Bisector of an angle	02	02
21	Types of angles	02	02
22	Types of pairs of an angle	09	09
23	Cross-Bar Theorem	02	02

The first draft of the achievement test (Appendix C) prepared by the investigator on the basis of the above outline was sent to the four experts (Appendix J) for the validation of the achievement test and their expert comments regarding the appropriate instructions and framing of items, content coverage and distribution. Suggestions given by the experts regarding the framing of the items are listed in a tabular form as follows:

Table – 8

Suggestions by Experts for Modifications in the Achievement Test

Item No.	Item	Suggestion
I- 7	Two distinct lines intersect in one point. Then they are_____ lines.	If two distinct lines intersect in one point, then they are_____ lines.
I- 5	Two distinct points P, Q are on both lines ℓ_1 and ℓ_2, then ℓ_1	Two distinct points P, Q are on both the lines ℓ_1 and ℓ_2. So ℓ_1

	$\underline{\quad}\ell_2.$	$\underline{\quad}\ell_2.$
I- 15	For D-E-F-G, $\overline{DE} \cap \overline{EG}$ = _____.	For D-E-F-G, $\overline{DF} \cap \overline{EG}$ = _____.
I- 24	For plane α, it contains atleast _____ non-collinear points.	A plane α contains atleast _____ non-collinear points.
I- 32	If D is in the _____ of an angle $\angle ABC$, then $\overrightarrow{BD}$ intersects $\overline{AC}$. (interior, exterior, union)	If D is in the _____ of an angle $\angle ABC$, then $\overrightarrow{BD}$ intersects $\overline{AC}$. (interior, exterior, intersection)
I- 38	The bisector of $\angle MON$ is $\overrightarrow{OP}$. If m$\angle MOP$ = 45°, then $\angle MOP$ is _____ to $\angle MON$.	The bisector of $\angle MON$ is $\overrightarrow{OP}$. If m$\angle MOP$ = 45°, then $\angle MOP$ is _____ to $\angle PON$.
II[A]- 3	What will be $\overline{AE}$?	What will be AE?
II[A]- 4	For the point F, if A-F-E and $\overline{AF}$ =4, then what will be the number corresponding to F?	For the point F, if A-F-E and AF=4, then what will be the number corresponding to F?
II[B]- 6	If T is a mid-point of $\overline{SU}$ & numbers corresponding to S & U are -6 & 7 respectively, then what is the number corresponding to T?	If T is a mid-point of $\overline{SU}$ & numbers corresponding to S & U on ℓ_2 are -6 & 7 respectively, then what is the number corresponding to T?
II[C]- 1	Which points are in the plane α?	Which all points are in the plane α?
II[C]- 6	Is P, Q & S coplanar points?	Are P, Q & S coplanar points?
II[D]- 10	Which are the complementary angles?	Which is the complementary angle to an $\angle ABE$?
II[D]- 12	Is $\angle ABD$ & $\angle ABL$ linear pair of angles?	Is $\angle ABD$ & $\angle ABL$ a linear pair of angles?

III- 1	$P \notin \overleftrightarrow{AB}$ but $Q \notin \overrightarrow{BP}$.	$P \notin \overleftrightarrow{AB}$ but $Q \in \overrightarrow{BP}$.
III- 8	P,Q,R & P,S,T are non-collinear triplets; but P,Q,S & P,R,T are not.	P,Q,R & P,S,T are non-collinear triplets; but P,Q,S & P,R,T are collinear points.

There were few suggestions regarding the general symbolic language of the Achievement test and the instructions which were as follows:

- Use same symbols in the items as those used in the figures i.e. use 'ℓ', 'ℓ_1', 'ℓ_2' instead of '/', '/$_1$', '/$_2$'.

- Use small letter for representing line i.e. in one of the items 'L' was used instead of 'ℓ'.

- A common instruction was given for all the parts ([A],[B],[C],[D]) of Question II i.e. "Look at the following figures and answer the respective questions:" which was to be given separately for each part of the Question- II as each question was on separate page with the respective figure.

- In Question II[C] the instruction should also mention that "Here α & β are parallel planes". So, the item no. II[C]- 2, "Are planes α & β parallel?" was replaced by "What is the intersection of the line ℓ and $\overleftrightarrow{PS}$?".

The above modifications were discussed with the guide and were incorporated in the final draft of the Achievement test (Appendix D). The test was prepared based on the instructional objectives of different levels i.e. Knowledge level, Understanding level and Application level. Each item of the test was related to the instructional objective (Appendix B). This aspect helped the investigator in identifying the errors committed by the students.

3.3.2 Parallel Test for Achievement

The Parallel test to the achievement test was prepared by the investigator on the fundamental topics of Geometry for the students of standard VIII. Parallel test was prepared and administered to the students. The purpose of

the parallel test was to obtain the post-scores of the students for experimental and control group. The first draft of the parallel test (Appendix H) was prepared on the similar lines of Achievement test by the expert and was given to two experts (Appendix J) for verifying its validity. There were no major changes suggested by the experts except four minor printing mistakes as follows:

- The options in the question I -14 were to be changed from (2,1, 2) to (0,1,2).
- In question II[A] – 6 the line 'ℓ_2' was to be replaced by line 'ℓ_1'.
- In question II[D] – 1 the $\angle$ DAB was to be replaced by $\angle$ DAF.
- In question III – 4 '{R}' was to be replaced by '{O}'.

The above changes were implemented and the final draft of the parallel test (Appendix I) was prepared by the investigator. There were 100 items in the parallel test. In total there were six major questions and the format of the parallel test was similar to the format of the achievement test (see table - 4).

3.3.3 Diagnostic Test

The Diagnostic test was prepared by the investigator on the fundamental topics of Geometry for the students of standard VIII. Diagnostic test was prepared and administered for the following purposes:

- To identify the learning difficulties in geometry faced by the students
- To provide the directions for the remedial measures for the students to overcome the learning difficulties in geometry.

3.3.3.1 Procedure of Preparing Diagnostic test

The units selected for the Diagnostic test were viz. Point, Line, and Concept of Distance; Line Segment and Ray; Plane; Angle. Investigator met four experienced teachers teaching mathematics in standard VIII and discussed on the most frequent mistakes and errors committed by the students in geometry based on their own experiences and observations. Further note-books of the students of standard VIII and twenty answer books were also

examined. The repetitively committed errors in geometry by the students were worked out. Also, the commonly occurring errors in standard VIII geometry by the students were identified based on the responses of the students in the achievement test. The items in the diagnostic tests were framed based on these observations and the diagnostic test was prepared by the investigator. Each question was framed in such a way that it addresses to the learning outcomes very minutely so that the responses can be analyzed in terms of probable incorrect answers and its causes. Also, in each question the similar items were asked in different ways to confirm the probable cause of the error committed by the students and identify the learning difficulties in geometry faced by the students.

The first draft of the Diagnostic test (Appendix F) was given to the four experts (Appendix J) in the field of Mathematics Education to ensure the appropriateness of the items in the diagnostic test and verify the validity of the diagnostic test. The suggestions given by the experts are represented in a tabular form as follows:

Table – 9
Suggestions by Experts for Modifications in the Diagnostic Test

Item No.	Item	Suggestion
V- 13	Which is the congruent line-segment to $\overline{AO}$?	Which is the congruent line-segment to $\overline{AC}$? ·
VI- 10	How many planes pass through three distinct points?	How many planes pass through three distinct non-collinear points?
VI- 14	What is the intersection of two distinct lines?	What is the intersection of two distinct intersecting lines?
VI- 18	What is the intersection of two distinct planes?	What is the intersection of two distinct intersecting planes?

VIII - 1	Which points are coplanar with respect to plane X?	Which all points are coplanar with respect to plane X?
VIII - 2	Which points are coplanar with respect to plane Y?	Which all points are coplanar with respect to plane Y?
VIII - 3	Which points are coplanar with respect to plane Z?	Which all points are coplanar with respect to plane Z?
VIII - 4	List the points that are coplanar to the point R?	List all the points that are coplanar to the point R.
VIII - 11	Are lines $\overleftrightarrow{AB}$ and $\overleftrightarrow{CE}$ coplanar?	Are lines $\overleftrightarrow{AB}$ and $\overleftrightarrow{QS}$ coplanar?

There were few suggestions regarding the figure drawn and the number of items in the question as follows:

For the figure in Question – IX, instead of the slanting line $\overleftrightarrow{OR}$ it was to be changed to vertical line.

For Question – IX[A] the number of items should be reduced from five to two.

The final draft of the Diagnostic test (Appendix G) was prepared by the investigator after discussing the suggestions given by the experts and incorporating the required modifications. There were eleven major questions and total of one hundred and sixty-two items in the diagnostic test. All the items were open-ended. It included the combination of objective and subjective types of items but all the questions were to be answered in brief. The format of the Diagnostic test is as follows:

Table – 10

Format of the Diagnostic Test

Q. No.	Title of the question	Topics	No. of items
I	Group the following as defined & undefined terms	Point, Line, Line-segment, Ray	02
II	Define the following terms	Miscellaneous	06

III	Observe the figure and select the appropriate symbol ($\in$, $\notin$, $\subset$, $=$, $\neq$) to make the statement correct with reference to the given figure	Relationship between Point, Line, Line-segment, Ray and its symbolic representation	32
IV	Draw a figure representing the following situations	Miscellaneous	21
V	Answer the following questions based on the figure below	Number-line, Distance, and length of the line-segments	14
VI	Answer the following questions	Miscellaneous	28
VII	Answer the following questions based on the figure below	Intersection of Line, line-segment and ray with different combinations	18
VIII	Answer the following questions based on the figure below	Plane	11
IX	[A] Look at the following figure below and answer the following questions [B] Fill up the table below having the arms & vertices of the corresponding angles.	Angle	12
X	Refer the figure below and select appropriate option(s) for the given pair of angles (Put a mark '✓' in the table against the selected options)	Types of pairs of angles	11
XI	Answer the following questions based on the same figure above	Types of angles	07

3.4 <u>DESIGN OF THE STUDY</u>

The present study is Survey and Experimental study. Initial phase of the study was a survey of errors and achievement of standard eighth students in geometry. Experimental design involves a comparison of the effects of particular treatment with that of no/different treatment. In the present study the treatment was diagnosis and remediation of the learning difficulties. The treatment was the independent variable and the dependent variable was the test-scores of the students. There are three foremost categories for the experimental design viz. Pre-experimental design, Quasi-experimental design and True experimental Design. Pre-experimental design is the least effective as it provides either no control group or no way of equating the groups that are used. Quasi-experimental design provides a less satisfactory degree of control as the equivalence of the groups is not assured, used only when randomization is not feasible. True experimental design is a better design as it employs randomization to provide for control of equivalence of groups and exposure to treatment. For the present study the investigator used a true experimental, control group, pre-test and post-test design.

$$R \ O_1 \ X \ O_2 \qquad X \text{ gain} = O_2 - O_1 \qquad O_1 \ O_3 = Pretests$$
$$R \ O_3 \ X \ O_4 \qquad C \text{ gain} = O_4 - O_3 \qquad O_2 \ O_4 = Posttests$$

R – random assignment of groups

X – exposure of a group to an experimental variable

C – exposure of a group to the control condition

O – test administered

3.4.1 Control of the Experimental Validity

According to Best and Kahn (2003) true experimental, control group, pre-test and post-test design is a strong design, but there may be a possibility of the influence of the influence of the effect of testing and the interaction with the control variable. This was controlled by not revealing to the students of both the groups about the purpose of the pre-test and not making them aware that it's going to be followed by the treatment. Also, it was not known and decided by the investigator before the pre-test that which is the experimental

group and which is the control group. Further the groups selected were geographically located at a distance in two different campuses so that the subjects of two different groups had no interaction with each other.

During the entire study the care was taken by the investigator to achieve the experimental validity to the optimum level. The true experimental design was used to carry out the study so that quite many factors affecting the experimental validity are controlled. Also, the groups selected were of same standard and the randomization itself took care of the threats to the experimental validity viz. Maturation, Testing, interference of prior treatment, interaction of selection and treatment. The tests used were validated by the experts and the investigator personally administered both the tests in both the groups which took care of unstable instrumentation. At the same time the treatment of remedial measures were also given by the investigator in the natural setting of the classroom which could control the artificiality of the experimental setting. Investigators do not know the subjects and had no interaction with both the groups before carrying out the study so there was no scope of experimenter bias. Both the groups were selected as a whole irrespective of their pre-test scores so there was no question about statistical regression. There was a loss of five students in both the groups, in case of experimental group three students were not regularly present during the remedial programme and two did not appear for the post-test whereas in case of control group five students did not appear for the post-test. So, the loss experienced by both the groups was similar hence the experimental mortality was constrained.

3.4.2 Phases of the Study

The present study was conducted in six phases as below.

PHASE I: Construction of Achievement Test

An achievement test was prepared by the investigator based on the content analysis for the topics and subtopics from the selected four units of geometry. Each item was related to the specific instructional objective.

PHASE II: Identification of Errors

The achievement test was administered to all the two hundred and fifty-eight students. The responses of the students were studied and the common errors in geometry committed by the students were identified i.e. the errors committed by the students in terms of the instructional objectives associated to each item of the achievement test were located. The identification of errors was done with the help of error identification table.

PHASE III: Construction of the Diagnostic Test

Commonly occurring errors in standard VIII geometry were identified based on the error identification along with the opinion of mathematics teachers, observation of the internal tests' answer books of the students and their notebooks. The investigator prepared a diagnostic test based on the commonly occurring errors.

Each item was framed in such a way that the responses can be analyzed in terms of incorrect answers and its probable cause.

PHASE IV: Identification of Learning Difficulties

The diagnostic test was administered on the experimental group i.e. thirty-seven students and the responses obtained were studied. This phase included the two major tasks as follows:

Studying Errors

For each particular item the errors were studied by the investigator in terms of the incorrect responses. So, related to each item there will be a list of incorrect answers.

Error analysis

Based on the errors studied by the investigator an error analysis was carried out using the error analysis sheet for each item i.e. analysis was carried out in terms of the categorization of errors committed by the students (what kind of errors?) and the investigator inferred the probable cause for the error. The

analysis led to the identification of the learning difficulties faced by the students in attempting the item correctly.

PHASE V: Remediation of Learning Difficulties

Remedial measures in accordance with the identified learning difficulties associated with the topics and subtopics of the units of geometry were given by the investigator to the students of experimental group.

Remediation was done through:

Small group teaching and group activities

Discussion

Problem solving

Use of teaching aids

Mathematical models and

Manipulatives

Remedial programme was conducted for 40 hours duration spread over seven weeks. Details about the remedial programme are provided in chapter-IV.

PHASE VI: Impact of the Remedial measures

In this phase the parallel test to the achievement test was administered to the control and experimental group. Retesting was done on the students after providing remedial measures. Comparing the marks of the students on pre-test and post-test the impact of the remedial measures was established.

3.5 DATA COLLECTION

The data was collected by the investigator in different phases as follows:

PHASE I: Achievement Test

Investigator met the principals of the selected schools and obtained the permission for administering the achievement test. Investigator prepared the achievement test and personally administered the achievement test to the standard VIII students of the schools. The data regarding the errors

committed were collected in terms of the correct or incorrect responses of the students on the items of the achievement test. The score of the students was considered as the score on pre-test.

PHASE II: Observation of Answer-sheets and Note-books and Informal Talk with Teachers

Investigator met mathematics teachers teaching to VIII standard students at school level. Through the informal talk the data were collected from them in form of the opinion regarding the commonly occurring errors by the VIII standard students in four units of geometry, i.e.

Point, Line, and Concept of Distance

Line Segment and Ray

Plane

Angle

The data regarding the commonly occurring errors by the students in the above four units was collected through the observation of the internal tests' answer books of the average and low achieving students and their notebooks.

The diagnostic test was prepared by the investigator based on the data collected.

PHASE III: Diagnostic Test

For diagnosis and remediation of learning difficulties the investigator met the principal of the school selected as experimental group and obtained the permission for administering the diagnostic test and execution of the study. The diagnostic test was personally administered in the school.

The data were collected in terms of the responses to the test questions given by the standard VIII students of the experimental group, which were analyzed.

PHASE IV: Remedial Programme and Parallel test for Achievement

The remedial programme was implemented to the students of the experimental group for twenty days, two hours daily, spread over seven weeks.

The parallel test to the achievement test was administered as the post-test to the students of both the groups, experimental and control group.

The data were collected in form of the responses given by the students of both the groups on the parallel test, which were scored to get the data of their scores on the post-test.

The data collection was done during the period from January 2008 to April 2008. The schedule for the implementation of the tools was as follows:

Table – 11

Schedule for the Implementation of the Tools

Tools	Date of Administration	Group
Achievement Test	22 -01-2008	School - I
Achievement Test	24-01-2008	School -II
Diagnostic Test	04-02-2008	Experimental
Parallel Test	01-04-2008	Control
Parallel Test	02-04-2008	Experimental

3.6 DATA ANALYSIS

Firstly, the data collected in terms of the responses of the students on Achievement was analyzed using the error identification table and the errors related to each item were identified.

3.6.1 Error Identification table

The table below was designed and used by the investigator to locate and identify the errors committed by the students in terms of the instructional objectives of the units in geometry, as each item is related to the instructional objective.

Table - 12

Error Identification table

Students (Sr. No.)	Que. No. / Unit			Que. No. / Unit			Total Score	Total Errors
	Sub Q.N./ Topic	...	...	Sub Q.N./ Topic	...	...		
1.	'√' or blank							
2.								
.								
Total no. of correct responses								
Total no. of incorrect responses								

As the items in the test were of one mark each, so either student attempted the item correctly or failed to attempt correctly and accordingly in the error identification table under the each item when attempted correctly '√' was entered or else was left blank.

Then the learning difficulties related to each topic and subtopic were identified based on analysis of the responses given by the students on the diagnostic test with the help of the error analysis sheet as follows.

3.6.2 Error Analysis Sheet

The table below represents the type of sheet that was designed by the investigator to list down the categorization of errors with respect to each item and to identify the learning difficulties with respect to each topic and subtopic by inferring the probable cause of the error. The probable causes for the errors were based on the lack of understanding related to the previous

and basic concepts, the misconceptions held by the students, and no clarity about the concept addressed.

Table - 13

Error Analysis Sheet

Question Item

Correct Answer		No. of Students
		...
Incorrect Answers	Probable Cause	
1	1	...
2	2	...
:	:	:

The data collected in terms of the responses of the students on Achievement test, Diagnostic test were analyzed quantitatively in terms of the mean and percentages. It was analyzed qualitatively in terms of the description of the errors and learning difficulties based on the error identification table and the error analysis sheet. After studying the learning difficulties as above the necessary remedies were provided to the students.

ANOVA was used to find the significant difference in achievement on pre-test among the five divisions of two randomly selected schools.

For seeing the impact of remedial measures, data collected from achievement test administered as pre-test and parallel test administered as post-test to the students of experimental and control group were analyzed using ANCOVA and pre-test score was used as covariate.