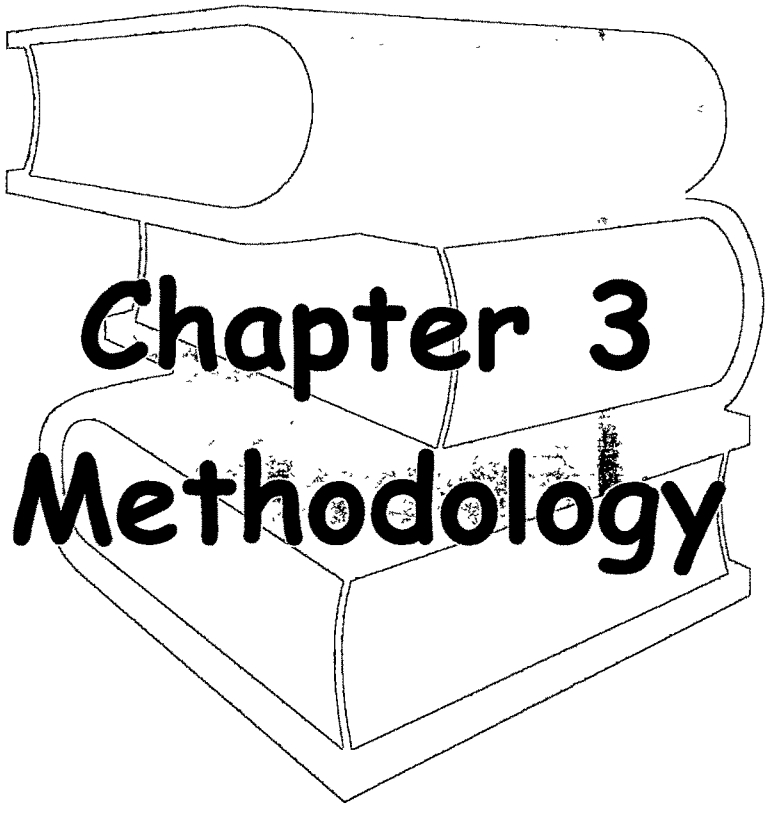

Chapter 3
Methodology

CHAPTER III
METHODOLOGY

3.1 INTRODUCTION

In this chapter, the investigator has discussed the methodology adopted for the present study. Population and sample selection has been described in detail for each stage. Details about construction of the tools like information schedule for students, questionnaire for the students of class X, questionnaire for teachers of Mathematics of class X, questionnaire for parents, prerequisite and unit tests for all chapters of class X – preparation procedure of the pilot test and the final achievement test have been described. Nature of the study, phases of the study and the programme schedule held during the year has been described. At last, the procedure for data collection and data analysis is also enumerated in brief.

3.2 POPULATION AND SAMPLING

In the present study the investigator used multi–stage sampling technique. In the first stage out of 111 Gujarati medium schools of Baroda city (Appendix 2) following Board syllabus, thirty schools were randomly selected. This covered thirty schools of six different centres of Baroda city; formed by Board, viz. twelve schools from Alkapuri, six from Sayajigunj, two from Raopura, one from Mandvi, seven from Karelibaug and two from Makarpura (Appendix 3). In the second stage seventy students were randomly selected from seven hundred and nineteen students who were low achievers i.e. who scored fifty or less than fifty marks in Mathematics based on their achievement in class IX (Appendix 4). In the third stage all the teachers i.e. thirty teachers teaching Mathematics in the selected schools were taken (Appendix 5). In the fourth stage the parents of all the students i.e. seventy parents were involved in the sample (Appendix 6).

3.3 TOOLS USED

Following tools have been used for the present study:

3.3.1 Information Schedule for Students

The purpose of the information schedule constructed and administered by the investigator was to collect information regarding personal details, family details and the result of class IX in Mathematics.

After deciding the three aspects the first draft of information schedule was ready with ten questions. In which six questions were related to personal details of the students, one question was related to the result of mathematics of class IX of the students and three questions were for family details. The information schedule for students included open ended, close ended and mixed type of questions.

The first draft was sent to the experts (Appendix 7A [English] & 7B [Gujarati]) for their expert comments regarding appropriation of its language, content and instruction. Suggestions regarding language, content and regarding instructions were carried out as per the following details.

1) Item no. 3 and 4 were merged i.e. name and address of schools were merged
2) Item no. 5: How you reach the school means the mode of transportation to school. This item was deleted from the first draft as this item was not related to the purpose of the tool.
3) Item no. 7: "Mention your activities other than curricular", was dropped and refrained as "Are you involved in activities other than curricular? Yes ( ), No ( ),
4) Instruction was added below the category 'personal details' as per the experts' comment. The instructions added in the second draft were as under
    a. Kindly provide the following information (write in the space provided)
    b. Kindly show your response by putting a '√' in the bracket for the items against the appropriate alternative.

5) Following instructions were added below the category family details
    a. Kindly provide the following information (write in the space provided).
    b. Kindly show your response by putting a '√' in the bracket for the items against the appropriate alternative.
6) Item no 9 and item no 10 were dropped and the same were referred in item no. 7 as follows:
    a. Father's Name: _____
       Education: _____
       Occupation ( ) Service ( ) Business ( )
    b. Mother's Name: _____
       Education: _____
       Occupation ( ) Service ( ) Housewife ( ) Business ( )
    c. Total monthly income of the family
       Less than Rs. 2000 ( )
       Rs. 2001 to Rs. 5000 ( )
       Rs. 5001 to 10,000 ( )
       Rs. 10,001 to Rs. 20,000 ( )
       Rs. 20,001 and above ( )

Based on experts suggestions second draft of the information schedule was constructed which had seven items instead of ten items.

Now for the pilot study second draft of the information schedule was administered to five students of class X other than the students of the sample. Purpose of this administration was to know whether the students find any difficulty in responding to items with respect to language, instructions, etc. and as there was no change regarding the language, content and the instructions, the second draft itself became the final draft (English and Gujarati) of information schedule for the students. (Appendix 8A [English] & 8B [Gujarati])

3.3.2 Questionnaire for the Students of Class X

The purpose of the questionnaire for the students of class X was to collect information about causes of low achievement in mathematics and to identify the factors related to low achievement in mathematics. For the

preparation of questionnaire for the students of class X, the investigator followed the steps mentioned by Mouly (1970) in his book "The Science of Educational Research". **First step** in preparation of questionnaire was to attain a thorough grasp of the field, the objectives of the study and the nature of the data needed. In the present study the investigator referred some books and related articles of Mathematics to have in–depth knowledge about the study. Investigator has gone through the detailed review of related literature, which showed that there were some questionnaires, which can help the investigator to frame an ideal questionnaire to cope–up with the purpose.

In the **Second stage** in preparation of questionnaire an unstructured interview was held with few students of class X, who were familiar with the field. Here the investigator, met the students of different schools of class X and discussed with them regarding the needed aspects regarding the questionnaire. Then the investigator met the teachers of the schools also and had taken some required information regarding framing the questionnaire. The investigator also discussed with students and teachers regarding some important aspects to cope–up with the objectives of the study. The investigator noted down in the diary the important points related to framing the questionnaire such as time required for the class work and home work, study habits, difficulties in home work, interest in the subject, attitude of the students and the teachers, regarding the chapters of class X, facilitates available at home, help of parents in the subject of mathematics, etc. Such information provides a path for preparing a questionnaire for the students.

In the **Third step** quality of the questionnaire was taken into consideration, some new questions and aspects were added which were really helpful to collect information from the students of class X regarding the causes of low achievement in mathematics and identifying factors related to low achievement in mathematics.

In the **Fourth step** investigator made the rough outline of the questionnaire, in which the investigator decided the following nine aspects and total ninety three questions of open ended, close ended and mixed type.

Table – 4:

Dimensions of Questionnaire (First Draft) for the Students of Class X

No.	Aspects	No. of Questions
1.	Interest and difficulty in the subject mathematics	17
2.	Classroom work	9
3.	Home work	10
4.	Examination	16
5.	Previous result and its feedback	5
6.	Changes demanded by students	6
7.	Study habits	23
8.	Facilities available at home	4
9.	Text book related questions	3
	Total	93

In the **fifth step** content of questionnaire was discussed with the guide and after discussion the first draft was ready. In the first draft of the questionnaire for the students of class X, there were nine aspects and ninety three questions (Appendix 9A [English] & 9B [Gujarati]).

In the **sixth step** first draft of the questionnaire for the students of class X was sent to the subject experts for validation and their expert comments regarding language, content and instructions.

Suggestions regarding language content and instructions received from experts were examined closely and the same were incorporated in the questionnaire after the discussion with guide.

Based on the discussion new questions were added and three aspects were also added. Total one hundred forty one questions were there in the second draft. Necessary changes were incorporated as per the instructions given by the experts and new aspects were added in it according to the suggestions given by the experts which were as follow. Table No. 5 shows aspect–wise details and questions.

Table – 5:

Dimensions of Questionnaire (Final Draft) for the Students of Class X

No.	Aspects	No. of Questions First Draft	No. of Questions Final Draft
1.	Interest and difficulty in the subject mathematics	17	17
2.	Classroom work	9	10
3.	Home work	10	10
4.	Examination	16	16
5.	Previous result and its feedback	5	5
6.	Changes demanded by students	6	6
7.	Friends and Parents	–	10
8.	Study habits	23	23
9.	Marks deduction	–	14
10.	Facilities available at home	4	4
11.	Syllabus, blue print and examination structure (text book related questions)	3	5
12.	Increase in achievement	–	21
	Total	**93**	**141**

According to the suggestion of experts, the following changes were carried out. Three aspects namely (1) Friends and Parents, (2) Marks deduction and (3) Increase in achievement were added. Ten questions were included in "Friends and Parents", fourteen questions were included in "Marks Deduction" and twenty one questions were included in "Increase in Achievement".

One question was added to "Classroom work" aspect and two questions were added to "Syllabus, Blue Print and Examination Structure) aspect. Thus second draft of a questionnaire was constructed by the investigator which included total twelve aspects and one hundred forty one questions.

For the purpose of pilot study questionnaires were administered among the five students of class X, who were not the part of the sample. All the students were able to fill in it without any problem related to its language, content matter and instructions provided.

On the basis of the pilot study since there was no need to bring any further changes, the second draft itself became the final draft (English and Gujarati) of a questionnaire for the students of class X (Appendix 10A [English] & 10B [Gujarati]).

3.3.3 Questionnaire for the Teachers of Mathematics of Class X

The purpose of the questionnaire for the teachers of Mathematics of class X was designed – to identify the factors related to low achievement in mathematics and study the problems in teaching–learning mathematics from teachers. For the preparation of questionnaire for the teachers of class X, the investigator followed the steps mentioned by Mouly (1970) in his book "The Science of Educational Research". In the **first step** in preparation of questionnaire is to attain a thorough grasp of the field, the objectives of the study and the nature of the data needed. In the present study, the investigator referred some books and related articles of Mathematics to have in–depth knowledge about the study.

In the **second stage** for the preparation of questionnaire an unstructured interview was held with the teachers teaching Mathematics in class X and who were familiar with the field but not the part of the sample. Here the investigator, having some ideas in mind met the teachers of different schools of class X and discussed with them regarding the needed aspects regarding the questionnaire. The investigator also discussed with the students and the teachers regarding some important aspects regarding teaching–learning process of Mathematics in the classroom to cope–up with the objectives of the study. The investigator noted down in the diary the important points related to framing of the questionnaire based on the discussion.

In the **third step** quality of the questionnaire was taken into consideration, some new questions were added which were really helpful to identify the factors related to low achievement in Mathematics and also related to teaching–learning process.

In the **fourth step** the investigator made a rough outline of the questionnaire, in which the investigator decided to include two major aspects – (i) factors responsible for low achievement and (ii) problems in teaching–learning Mathematics. For getting such details from the teachers a

questionnaire was constructed by the investigator regarding the kind of difficulty the students are facing and the reasons for the same, types of efforts needed for enhancing achievement, time allotted by the students and teachers to the subject of mathematics and the method used in teaching mathematics, checking of previous knowledge of students before teaching and need of remedial teaching.

In the **fifth step** copy of rough outline of questionnaire was shown to the guide and after discussion the first draft was ready. In the first draft of the questionnaire for the teachers of class X, there were three aspects and eight questions (Appendix 11A [English] & 11B [Gujarati]).

In the **sixth step** first draft of the questionnaire for the teachers of class X was sent to the subject experts for validation and their expert comments regarding language, content and instructions.

Suggestions regarding language content and instructions were carried out. The suggestions and changes given were incorporated in the questionnaire.

Total six aspects and thirteen questions were included in the second draft. Five new questions were added as per the suggestions given by the experts, which are as follow:

1. What do you believe about supplementary literature (reference material, except text–book) used in mathematics in standard X? (Q.8)
2. Do you use supplementary literature [Reference Material]? Yes ( ) No ( ). (Q.9)
3. Do you take class–test in the school after finishing the chapter? Yes ( ) No ( ). If no, give reasons for that. (Q.11)
4. If test is held sooner after finishing each chapter and errors are corrected, will it be beneficial to the students getting fifty or less than fifty marks? Do you believe Yes ( ) No ( ). If yes, then how? (Q.12)
5. Opinions of teachers about the chapters of mathematics of standard X. Yes ( ) No ( ) (Q.13)

Table 6 shows aspect–wise details and questions but the questionnaire was not prepared aspect–wise.

Table – 6:

Dimensions of Questionnaire (Final Draft) for Teachers of Class X

No.	Aspects	No. of Questions First Draft	No. of Questions Final Draft
1.	Difficulty the students are facing	4	4
2.	Enhancing achievement	–	2
3.	Time allocation for the subject and method used for teaching	3	3
4.	Checking of previous knowledge	1	1
5.	Supplementary Literature	–	2
6.	Teachers opinion about different chapters	–	1
	Total	**08**	**13**

Thus, second draft of a questionnaire was constructed by the investigator which included total six aspects and thirteen questions. Three new aspects were included (1) Enhancing Achievement, (2) Supplementary Literature, (3) Teachers Opinion about Different Chapters.

Two questions were included in the aspect "Enhancing Achievement" aspect, two questions were included in "Supplementary Literature" aspect and one question was included in "Teacher's Opinion about Different Chapters" aspect.

For pilot testing second draft of the questionnaire was administered to the five teachers of mathematics of class X. All the teachers responded to it without any problem regarding its language, content and instructions. These five teachers were selected from the schools from which the students were not selected under sample.

On the basis of the pilot study since there was no need to bring any further changes, the second draft itself became the final draft (English and Gujarati) of the questionnaire for the teachers of class X (Appendix 12A [English] & 12B [Gujarati]).

3.3.4 Questionnaire for the Parents of Students of Class X

The purpose of the questionnaire for parents of the students of class X was designed – to identify the factors related to low achievement of his / her child in mathematics and to study the problems in teaching – learning mathematics from parents. For the preparation of questionnaire for parents of class X, investigator followed the steps mentioned by Mouly (1970) in his book "The Science of Educational Research". In the **first step** in preparation of questionnaire is to attain a thorough grasp of the field, the objectives of the study and the nature of the data needed for the study.

In the **second stage** in preparation of the questionnaire an unstructured interview was held with the parents of the students of class X. Here the investigator, having some ideas in mind met parents of students of class X and discussed with them regarding the purpose of the study. The investigator noted down in the diary the important points related to framing of the questionnaire.

In the **third step** quality of the questionnaire was taken into consideration, some new questions were added which were really helpful to identify the factors, related to low achievement in Mathematics and also related to teaching–learning process.

In the **fourth step** the investigator made the rough outline of the questionnaire, for getting such details from the parents a questionnaire was constructed by the investigator which included aspects regarding regularity, facing difficulty in mathematics, discussion with Mathematics teacher for the child's progress and problems, parent's interest in study of mathematics, efforts of parents for child, examination problems, suggestions from the parents for enhancing achievement in Mathematics, friends influence on the student's study, reasons for low achievement, parents' view regarding child's ability and ability of parents to help the child.

In the **fifth step** copy of questionnaire was shown to the guide and after discussion, the first draft was ready. In the first draft of the questionnaire for the parents of the students of class X, there were ten aspects and twelve questions (Appendix 13A [English] & 13B [Gujarati]).

In the **sixth step** first draft of the questionnaire for the parents of the students of class X was sent to the subject experts for validation and their expert comments regarding language, content and instructions.

Suggestions regarding language content and instructions were carried out. The suggestions and changes given were incorporated in the questionnaire. Total eleven aspects and thirteen questions were included in the second draft. One new question was added as per the suggestions given by the experts, which are as follow:

An addition to options of Yes ( ) and No ( ) were added in questions one and two. And in the question five an extra option of "Any one else ( )" was added.

One new aspect as 'Friend's influence on child' was added and the new question was framed "How are your child's friends in studying mathematics, according to you? Does friend's influence affect your child's study?". Table 7 shows aspect–wise details and questions, but the questionnaire was not prepared aspect–wise.

Table – 7:

Dimensions of Questionnaire (Final Draft) for Parents of Class X

No.	Aspects	No. of Questions First Draft	No. of Questions Final Draft
1.	Regularity	2	2
2.	Difficulty in Mathematics	1	1
3.	Discussion with teacher	1	1
4.	Interest in Study by Father / Mother	1	1
5.	Efforts of Parents	1	1
6.	Exam Related	2	2
7.	Suggestion of Parents	1	1
8.	Reasons for low achievement	1	1
9.	Parents' views	1	1
10.	Ability of Parents to help the child	1	1
11.	Friends' Influence on child	–	1
	Total	12	13

Thus second draft of the questionnaire was constructed by the investigator which included total eleven aspects and thirteen questions.

For pilot testing, the second draft of the questionnaire was administered to the five parents of the students of class X. They were not the parents of sample students. All the parents responded to it without any problem regarding its language, content and instructions. On the basis of pilot study since there was no need to bring any changes, the second draft itself became the final draft (English and Gujarati) of the questionnaire for the parents of the students of class X (Appendix 14A [English] & 14B [Gujarati]).

3.3.5 Prerequisite Tests

Each chapter in mathematics contains some new concepts. There is always vertical relationship in the content of mathematics. As a result if students are not clear with what they have studied earlier, it becomes extremely difficult to learn new content. Thus, it is advisable that before teaching a new concept / topic prerequisite or previous knowledge be tested. In mathematics of class X, there where nineteen chapters, so nineteen tests were prepared and called prerequisite tests.

The basic purpose of such tests was to understand whether the students possess required prerequisite for particular chapter or not. If the students are weak in basic diagnosis of basic for particular chapter is absolutely needed. Keeping this in view prerequisite tests were prepared for each chapter. Based on this, a remedial programme was also planned so that teaching–learning of mathematics could become easy and interesting.

For preparation of such tests, three workshops in three days were conducted. Nine teachers (Appendix 15) teaching mathematics at secondary level having experience of at least five years were invited for the workshop (Appendix 16).

The series of workshops was organized with following purpose:

1. To carry out content analysis of each chapter.
2. To identify prerequisite needed to study particular chapter.
3. To identify probable errors committed by the students in each chapter.
4. To construct a test for prerequisite for each chapter of class X.

Teachers were oriented about purpose of the workshops in the beginning. Various activities like: content analysis of each chapter, identification of prerequisites for each chapter, probable errors committed by students in each chapter were carried out during workshops.

Further few answer books of students of previous years were examined. The purpose behind this was to ascertain the types of errors committed by students in particular chapter.

Based on content analysis, probable errors and actual errors committed by the students' prerequisite tests were prepared.

Each test prepared during workshops was given to the experts for further validation with respect to purpose of test, nature of test items, etc. Necessary modifications were carried out accordingly.

Finally, pilot testing was carried out on five students of class X having low achievement in mathematics. This testing gave an idea that really students commit errors in particular topic. Necessary modifications were carried out as per feed back received from experts and final tests were prepared.

Procedure of preparing Prerequisite Test

In class X the first chapter was "Functions". So prerequisite test was prepared stepwise as under:

In the **first step** of preparing prerequisite test content analysis was made and the following contents were identified, such as set theory, real numbers, equalities and inequalities, angles, identities, logarithms and polynomials.

In the **second step** probable errors and actual errors by examining the answer books were worked out. On the basis of experience of the teachers, probable errors were noted down and on the basis of analysis of student's answer books which were made by the teachers actual errors the students have made were worked out.

In the concept set theory the basic knowledge of set – "Set is an undefined term" is not known to the students. The name of set and which elements are belonging to particular set e.g. N → is a set of natural numbers

which contains the number starting from 1 to infinity, no rational numbers are the elements of N, also 0 is not a member of N. Most of the students take 0 as a member of N which caused an error. While checking the answer books the students made error even in the sign of set, instead of writing "{ }" they write as "} {". On the basis of actual errors found from answer books was "1 is not a prime number" and "2 is the first prime number". Most of the students consider 1 as a prime number and 2 is not a prime number.

Lack of knowledge of indices, where any number raised to 0 is always 1 e.g. $3^0 = 1$, $(-5)^0 = 1$ where as they wrote as $3^0 = 0$, $(-5)^0 = 0$. $(-1)^5 = -1$, $(-1)^6 = 1$ when the base is negative and index is even, answer is positive, and index is odd + answer is negative. After teaching the base of indices the use of logarithms was taught, because students made errors in logarithms.

In case of equalities and inequalities, students made errors in understanding the basic meaning of the sign <, >, ≤ and ≥; students also were unable to understand the meaning of modulus (||) and made errors. Students made errors and got confused in finding the numbers of H.C.F. and L.C.M., they mixed the concept of both. Students are unable to differentiate between H.C.F. and L.C.M.

Complementary angle means sum is 90, supplementary angle means sum is 180. Complementary angle of 30 is (90 – 30) = 60 while supplementary angle of 30 is (180 – 30) = 150. But the supplementary angle of the complementary angle of 30 is (90 – 30) = 60 and (180 – 60) = 120. So the supplementary angle of the complementary angle of 30 is 120. Students also committed errors in expansion of $(x+2)^2$ as x^2+2^2 and x^2+4 were the answers.

In the **third step** total twenty two test questions were included in the first draft. (Appendix 17)

After that in the **fourth step** pilot testing was carried out on five students of class X having low achievement in mathematics. This testing gave an idea that where the students committed errors in area noted in the test questions.

In the **fifth step** as per the experts' comments two questions were omitted from the first draft of the prerequisite test. The questions omitted from

first draft were question number eighteen and nineteen. This two questions were as under:

(18) $2^{-1} + (-1)^2 =$ _____ (Simplify)

(19) $(-2)^{-1} \times (-1)^{-2} =$ _____ (Evaluate)

In **sixth step** final prerequisite test for chapter first "Functions" was prepared which contains twenty questions. Each question contains one mark and so total twenty marks test was prepared.

Using the same steps finally nineteen prerequisite tests (Appendix 18A [English] & Appendix 18B [Gujarati]) were prepared for chapters of mathematics of class X.

3.3.6 Unit Tests

Unit test plays a central role in the evaluation of pupil's progress. Such tests provide direct measures of many important teaching–learning outcomes and indirect evidence, which helps deciding remedial programmes and is also helpful for enhancing achievement of the students. Due to this importance, it is essential to administer unit test after teaching each unit. Each chapter in mathematics contains different aspects and concepts. Moreover, Board has given different weightage to each chapter, according to the blue print given by the Board each chapter has different types of questions. Keeping the above things in mind in series of workshop unit tests were prepared. For the preparation of unit tests for all the chapters of class X, the investigator followed general principles of test construction mentioned by Gronlund (1967) in his book "Measurement and Evaluation in Teaching".

Unit tests were prepared and administered for the following purposes:

1. to measure the achievement in each unit taught to the students
2. to locate the errors made by the students
3. to identify strength and weakness of the students in different chapters
4. to study the reason of errors committed
5. to cater the learning difficulties of the students and
6. to frame the remedial plan and procedure to enhance achievement and so that teaching–learning of mathematics. All this will lead to learning with interest and will boost up confidence in mathematics.

For preparation of such unit tests, series of workshops were conducted. Nine teachers (Appendix 15) teaching mathematics at secondary level having experience of at least five years were invited for the workshop (Appendix 19).

In the beginning of workshop, the purpose of the entire procedure of preparing unit test was explained to all the teachers, after that thorough content analysis was carried out for each chapter of class X. Based on content analysis, concept / content knowledge, blue print given by the Board and weightage given to each chapter was discussed. Along with that the probable errors committed by the students in particular units were also worked out, based on the experience of teachers. Further few answer books of students of previous years were examined. The purpose behind this was to ascertain the types of errors committed by the students in particular area.

Based on content analysis, probable errors and actual errors by examining the answer book were worked out and type of questions in blue print and weightage of marks keeping in mind unit tests were prepared.

Each unit test prepared during workshops was given to experts for further validation with respect to purpose of test, nature of test items, weightage of marks of each question, type of questions given in blue print, etc. Necessary modifications were carried out accordingly.

Finally pilot testing was carried out on five students of class X having low achievement in mathematics. This testing gave an idea that really students commit errors in particular topic. Necessary modifications were carried out as per feed back received from experts and final tests were prepared. Details regarding the tests are given here with.

Procedure of preparing Unit Test

In the class X the first chapter was "Functions". So unit test was prepared stepwise as under:

In the **first step** what type of questions are asked in the board examination from chapter one "Functions" was decided according to the blue print provided by the Secondary and Higher Secondary Education Board and weightage of marks given to each type of question. Details of which are as under:

Type of Question	Marks
1) Fill in the Blanks:	01
2) Solve the Sums:	02

In the **second step** keeping main purpose to diagnose the learning difficulties of students, test questions were noted down. Test questions were selected in such a way that each question measured some learning outcomes and efficiency and inefficiency of the students.

In the **third step** the first draft (Appendix 20) of unit test having eleven test questions – six of two marks and five of one mark each was finalised. All the questions in this test were from chapter "Functions". Each question framed to diagnose different aspects of functions like: representation of functions by Venn diagram, domain and range of a function, representation of the range of a function by Venn diagram, real – valued function and graphs of linear real valued functions.

In the **fourth step** pilot testing was carried out on five students of class X having low achievement in mathematics. The purpose of the pilot test was to check problems regarding language of the test, test items, figures given in it, instructions provided for the questions, space provided in the test paper for calculation or to give answer, etc.

In the **fifth step** as per the experts' suggestions two questions were added to the first draft which were necessary to evaluate students learning of the chapter "Functions". The questions added to the first draft were as under:

Q.1. (7) For $f : N \to Z$, $f(x) = x^2 - 4x + 4$, find $f(x+2)$

Q.2. (6) For $f : R^+ \to R$ $f(x) = \log_{10} x$, $f(1) =$ _____. (1, 0, 0.1)

In the **sixth step** final unit test for chapter first "Functions" was prepared which contained total thirteen questions in the final draft – seven of two marks and six of one mark each, summing up to total twenty marks.

Similarly nineteen unit tests (Appendix 21A [English] & Appendix 21B [Gujarati]) were prepared in the workshop by the teachers of mathematics for the chapters of class X. The details regarding total test items, total marks and schedule of prerequisite and unit tests was listed down (Appendix 22).

3.3.7 Pilot Test

The purpose of the Pilot Test was:

1. to locate the errors made by the students question wise,
2. to locate the chapters in which the students were facing problems,
3. to search out the kind of questions they were not able to attempt well,
4. to check their writing patterns,
5. to check whether they were able to finish the paper in time or not,
6. to create confidence in writing paper of 100 marks and
7. to frame the first remedial revision plan and procedure for enhancing their achievement.

Procedure of Preparing the Pilot Test

In the first step one well experienced, expert teacher was selected to set the pilot test paper. The teacher of mathematics set the pilot test paper based on entire syllabus of mathematics of class X. The pilot test (Gujarati) (Appendix 23) of 100 marks was set as per the blueprint given by the Board. All the five questions, marks of each question and items in it were set as per the model question paper and blue print (Appendix 24). Details of the blue print for question paper for class X Mathematics are as follow:

Title of the subject – Mathematics (028), duration of the paper was three hours, total there were five questions each question of twenty marks summing to total 100 marks, name of the text book from which the paper has to be set was Textbook of Std. X published by Gujarat State Board of School Textbooks. Instructions related to question paper – (i) Total there are five questions; all are compulsory, (ii) Draw figures wherever necessary. Preceding tables 8 to 10 describe the layout of the blue print.

Table – 8:

Objective–wise Weightage (Blue Print of S.S.C. Board)

Sr. No.	Objective	Marks	Weightage
1.	Knowledge	40	40
2.	Comprehension	36	36
3.	Application	20	20
4.	Skill	04	04

Table – 9:

Question–wise Weightage (Blue Print of S.S.C. Board)

Sr. No.	Type of Question	Number of Questions	Marks of each Question	Total Marks	Weightage
1.	Objective	08	01	08	08
2.	Very Short Questions	12	01	12	12
3.	Short Questions	15	02	30	30
4.	Essay Type Questions	10	03	30	30
	Essay Type Questions	05	04	20	20

Table – 10:

Expected Difficulty Value (Blue Print of S.S.C. Board)

Sr. No.	Level of Difficulty	Difficulty Value
1.	Easy	35%
2.	Medium	50%
3.	Difficult	15%

Table – 11:

Content–wise Weightage (Blue Print of S.S.C. Board)

Sr. No.	Subjects	Marks	Weightage
1.	Functions	06	04
2.	Rational Expressions	09	06
3.	Cyclic Expressions	06	04
	Factors based on Std. VIII & IX	06	04
4.	Ratio and Proportion	09	07
5.	Variation	09	07
6.	Quadratic Equations	12	09
7.	Trigonometry	09	07
8.	Height and Distances	03	02
9.	Statistics	12	08
10.	Computing	02	02
11.	Similar Triangles	18	13
12.	Conditions of Similarity		
13.	Similarity and Pythagoras Theorem		
14.	Circle and Chord	24	17
15.	Arc of a Circle		
16.	Circle and its Tangent		
17.	Construction	04	03
18.	Area & Volume	10	07

In the second step this pilot test was given to another expert teacher of mathematics to seek the expert opinion regarding the whole paper and as their was no need to change anything, the pilot test became a final draft of the pilot test.

3.3.8 Final Achievement Test

The purpose of the Final Achievement Test was:

1. to study their achievement in respect of marks out of hundred,
2. to compare the marks of the Final achievement test with the marks obtained by the students in the class IX in mathematics and
3. to determine the effectiveness of the programme by comparing the marks of class IX and class X in mathematics

Procedure of Preparing the Final Achievement Test

In the first step an expert and well experienced teacher was selected to set the final achievement test. The teacher of mathematics set the final achievement test paper based on entire syllabus of mathematics of class X. The final achievement test (Gujarati) (Appendix 25) paper of 100 marks was set as per the blue print given by the Board. The set of model question paper and that of blue print (Appendix 24) was supplied, to the paper setter and accordingly all the five questions were given weightage.

In the second step this final achievement test paper was given to another expert teacher of mathematics for his expert opinion regarding the whole paper and as their was no need to change anything that final achievement test paper became a final draft of final achievement test.

3.4 NATURE OF THE STUDY

This study contains four aspects which are mentioned below in detail:

(a) Survey

In this study the investigator has made a survey of the low achievers in mathematics who were selected as a sample. Survey has been made by collecting information regarding marks in mathematics as well as family information regarding parents' income, education. Survey has been made for

collecting information regarding causes of low achievement of students as well as from teachers and parents through questionnaire. This survey was made to find out the causes of low achievement in mathematics and on the basis of this cause of low achievement programme for enhancing achievement was planned.

(b) Experiment

After collecting information through survey the investigator conducted an experiment on seventy students of class X having fifty or less than fifty marks in mathematics of class IX, to enhance their achievement in mathematics. The experiment was carried out in the year June 2004 to March 2005 by the investigator by taking prerequisite tests and unit tests, analyzing their answer books and providing remedial measures, as well as providing counselling to enhance their achievement in mathematics. Details regarding prerequisite tests and unit tests administered are given in programme schedule. In the beginning seventy students were identified as low achievers based on result of mathematics for class IX but ten students could not complete the whole programme of one year for one or other reason, so finally sixty students were available completed the whole programme.

Remedial measures were taken after administering the prerequisite tests, unit tests and the pilot test. Details regarding remedial measures have been mentioned at the end of each chapter of mathematics of class X in the chapter four. Counselling was provided to the sample selected as and when needed in group or individual or for the whole sample. The details regarding counselling sessions and its content are presented in the chapter four.

(c) Single Group Pre Test – Post Test Design

In this study there was a single group of the low achievers in mathematics. The group consisted of seventy students whose marks in mathematics varying from twenty five to fifty in class IX annual examination. This test of class IX annual examination was considered as pre test and the final achievement test administered at the end of the programme was considered as a post test.

3.5 DESIGN OF THE STUDY

The whole programme for enhancing achievement of the students of class X was developed, implemented and evaluated by the investigator in four phases. The phases of the study have been briefly reported in lines to follow.

Phase I – Students Profile

In phase I the investigator has administered information schedule and collected information about students' marks in mathematics in class IX final examination and the investigator has also collected the information about their family and analyzed the same information to get some basic connective causes of low achievement in mathematics. The marks was recorded individually of all the seventy students so that the investigator can compare marks with the final achievement test after the implementation of the programme. To verify their marks, photocopy of the mark–sheet of class IX was collected by the investigator from the students.

Phase II – Situation Analysis

After identifying low achievers of class IX in mathematics, the next question raised in the mind of the investigator was what were the factors responsible for their low achievement in mathematics? To identify the factors responsible for low achievement in mathematics, the investigator has constructed and administered a questionnaire for the students, for the teachers of mathematics of class X and also for the parents of the students whose child was selected under the sample.

By analyzing the data the responses of all the three questionnaires the investigator identified the real factors responsible for this low achievement in mathematics. The investigator has identified some factors which were responsible for all the students for their low achievement in mathematics.

A review of related literature also focuses the factors responsible for low achievement in mathematics and weaknesses in mathematics.

Thus situation analysis was made by the investigator which helped the investigator to frame the programme for enhancing students' achievement in mathematics of class X.

Phase III – Teaching, Testing and Counselling

On the basis of the factors which were identified as responsible for low achievement in mathematics the investigator has developed and implemented the programme. It was an experiment on the students of Class X. The programme mainly consisted of teaching, testing and counselling.

The investigator has conducted four counselling sessions in general for all the students selected under sample the detail regarding counselling sessions is provided in programme schedule and many counselling sessions for particular student or group of students.

The investigator administered prerequisite tests and unit tests for the whole course of class X mathematics for the students, on the basis of their tests answer books, error analysis was carried out, based on error analysis further reasons for such errors were located and accordingly remedial teaching was provided throughout the year. In some cases remedial teaching was provided to individual or small group also. When needed additional reading materials and material for extra practice, was provided for all the chapters to the students selected under the sample. Students were exposed to the demonstration of study habits, utility of time, reading and revision method, method of writing answer book, making charts, etc.

The investigator has also administered the pilot test which covered entire syllabus of class X mathematics. On the basis of the result and error analysis further counselling and guidance sessions were organized as per the need of the students.

Special material for motivation and enrichment was provided related to concentration, mini–nap (short sleep), time management, examination tips, techniques for removing examination stress and related to positive thinking etc. Detail is provided in programme schedule in the same chapter. The investigator has given a special orientation to the parents of the students who were selected under the sample.

The investigator has continued this programme for enhancing achievement till the final achievement test.

Phase IV – Effectiveness of the Programme

In this phase the investigator has studied the effectiveness of the programme in terms of achievement of the students of class X in mathematics by administering the final achievement test.

Finally the investigator has designed and administered the final achievement test of hundred marks on 28th February 2005, which covered entire syllabus, based on scheme given by the Board. Comparing marks of pre–test and post–test effectiveness of the programme was proved.

3.6 PROGRAMME SCHEDULE

The data collection was done over a period of one full school academic year using the following tools through the underlined programme schedule.

Tools Used	Tools Administered in Month / Year
Information Schedule for Students	June 2004
Questionnaire for Students	June 2004
Questionnaire for Parents	June 2004
Questionnaire for Teachers	June 2004

Table – 12:

List of the Prerequisite / Unit / Pilot / Final Achievement Tests Administered for the Enhancing Achievement of the Students

Tools Used: Tests	Type of Test	Tools Administered in Month / Year
Functions	Prerequisite Test	June, 2004
	Unit Test	June, 2004
Rational Expressions	Prerequisite Test	June, 2004
	Unit Test	July, 2004
Cyclic Expressions	Prerequisite Test	July, 2004
	Unit Test	July, 2004
Ratio and Proportion	Prerequisite Test	July, 2004
	Unit Test	July, 2004
Variation	Prerequisite Test	September, 2004
	Unit Test	September, 2004
Quadratic Equations	Prerequisite Test	October, 2004
	Unit Test	October, 2004
Trigonometry	Prerequisite Test	October, 2004

	Unit Test	November, 2004
Height and Distances	Prerequisite Test	November, 2004
	Unit Test	November, 2004
Statistics	Prerequisite Test	November, 2004
	Unit Test	November, 2004
Computing	Prerequisite Test	July, 2004
	Unit Test	July, 2004
Similar Triangles	Prerequisite Test	August, 2004
	Unit Test	August, 2004
Conditions of Similarity	Prerequisite Test	August, 2004
	Unit Test	August, 2004
Similarity and Pythagoras Theorem	Prerequisite Test	August, 2004
	Unit Test	August, 2004
Circle and Chord	Prerequisite Test	December, 2004
	Unit Test	December, 2004
Arc of a Circle	Prerequisite Test	December, 2004
	Unit Test	December, 2004
Circle and its Tangent	Prerequisite Test	December, 2004
	Unit Test	December, 2004
Construction	Prerequisite Test	September, 2004 – January, 2005
	Unit Test	September, 2004 – January, 2005
Area	Prerequisite Test	January, 2005
	Unit Test	January, 2005
Volume	Prerequisite Test	January, 2005
	Unit Test	February, 2005
Pilot Test		20th February, 2005
Final Achievement Test		28th February, 2005

3.6.1 Counselling Sessions

Counselling sessions on correlates to achievement were organized as per requirement. Two type of counselling sessions were arranged and counselling was provided as under:

1) Individual counselling or group counselling and
2) Counselling to all the students selected under the sample.

Individual or group counselling was given to the students during the whole academic year as and when required.

Four counselling sessions were organized by the investigator for all the students selected under the sample. All counselling sessions were for two hours and thirty minutes. All counselling sessions were organized by the investigator. In the counselling sessions the investigator covered all the required aspects and topics which enhance the achievement of the students, and reducing factors affecting their low achievement in mathematics. The topics covered under counselling sessions are shown in table 13.

Table – 13:

Topics Covered under Counselling Sessions

Sr. No.	Particulars and Components	Day, Date and Time Duration
1)	Positive Goal Setting – (a) Setting goal for marks in mathematics. (b) How to achieve the goal? (c) Positive thinking (negative to positive attitude for mathematics).	Wednesday 30th June, 2004 7:00 pm to 9:30 pm
2)	Relevant Skill Development – (a) Enhance Concentration. (b) Recalling Skill. (c) Revision Planning. (d) Listening Skill. (e) Speedy Reading, Writing and Calculation. (f) How to improve handwriting. (g) Good habit formation regarding study (study habits).	Wednesday 28th July, 2004 7:00 pm to 9:30 pm
3)	Examination Skill Development – (a) How to study on the examination day. (b) Planning of three hours of examination and information related to it. (c) Importance of chart marking and notes of model sums. (d) Pattern of writing answer.	Wednesday 1st November, 2004 7:00 pm to 9:30 pm

4)	Stress Management – (a) Mini–nap (Short sleep). (b) Simple Relaxation technique. (c) Removing fear for mathematics. (d) Time management. (e) Deep Breathing. (f) Auto suggestions during breathing phases.	Saturday 4th December, 2004 7:00 pm to 9:30 pm

3.7 PROCEDURE OF DATA COLLECTION

- Information schedule was given personally by the investigator to seventy students at thirty schools selected under sample for collecting data regarding information about marks obtained in mathematics in the class IX final examination and some information regarding family and the same were collected back from the students in the month of June 2004.
- Questionnaire for the students was administered in the classroom itself in the month of June 2004. Enough time was given to fill it up. Needed instructions were given to the students. Data were collected by the investigator through questionnaire regarding factors contributing and affecting the low achievement in mathematics and its related twelve aspects.
- Parents were personally contacted and importance of the study was explained to them. After this questionnaire was given to them. Parents were given fifteen to twenty days for responding to the questionnaire and the same were collected back from the parents in the month of June 2004.
- The questionnaire for teachers of mathematics of class X and covering letter was distributed personally in each school whose student was selected under the sample and the teachers were given twenty days to respond to the questionnaire and the same were collected back from the teachers in the month of June 2004.

Data Collection Regarding Tests:

- All the prerequisite tests and unit tests were administered in the existing class–room before or after teaching time. For test students were arranged one on a bench, date and time of the test was declared in advance to the students. Each test administration took different time duration as per the marks of the tests. All prerequisite tests were administered before transaction of each chapter of class X and all the unit tests were administered after the transaction (teaching unit) of each chapter. The pilot test and the final achievement test were administered after completing the whole syllabus on the fixed date and time by giving time duration of three hours. Answer–books of all the tests were collected by the investigator. Data regarding marks obtained by the students in different tests and errors committed in the tests were collected from the answer books of the students. Using the data collected, required remedial plan and procedure was decided and taken to enhance the achievement in mathematics till the end of the programme.

3.8 DATA ANALYSIS

The study included both qualitative and quantitative data.

- Data regarding information schedule was analysed by frequency and percentages.
- Data regarding questionnaire for the students, teachers and parents were analysed using content analysis and close ended questions were analysed using frequency and percentage.
- Data regarding different tests.

The investigator calculated the marks for each item and also found whether the item attempted was correct or incorrect / false. The investigator also found whether the item was partly attempted or not at all attempted. Also the mean for each test was calculated. For each test error analysis was done and required remedial measures were taken by the investigator. Marks of all the tests were analysed. At last, analysis was carried out by comparing marks of class IX (pre–test) and class X (post–test) in mathematics. Finally 't' test was applied to study effectiveness of the programme.