

CHAPTER 3

RESEARCH METHODOLOGY

3.0 Introduction

This chapter explains the research methodology adopted by the researcher. Chapter enhances to realize the purpose and objectives with which this research is done. The researcher also highlighted the methodological approaches used in different phases of this study. The chapter includes the statement of the problem, objectives of the study, explanation of the context of the present study, research design, selection of sample, tools and techniques adopted, explanation of different phases of the study, procedures for data collection and data analysis of this study.

3.1 Research Methodology

By focusing the objectives of the research, the researcher adopted the most suitable research methodologies, the mixed methods and also the triangulation for the present study. Mixed methods is a research methodology that incorporates multiple methods to broaden the understanding of the research problem in an appropriate and principled manner (Bryman, 2012., Creswell, 2015., Creswell & Plano Clark, 2011). This is a methodology involving the collection, analysis, interpretation and reporting of both qualitative and quantitative data. Triangulation refers to the use of multiple methods or data sources in qualitative research to develop a comprehensive understanding of phenomena (Patton, 1999). The methodology adopted here proved as the most appropriate one to fulfill the demand of the different phases through which the study was carried out. The mixed methods helped the researcher to deal with the tools' preparation, techniques used for the data collection and analysis. The researcher focused on the following research questions while proceeding with the current study with a focus to develop a professional enrichment programme for the secondary school mathematics teachers.

3.1.1 Research Questions:

- 1) How mathematics as a subject is being taught in Secondary Schools?
- 2) What are the major challenges of Mathematics Teachers?
- 3) What are the Professional development needs of mathematics teachers at Secondary School level?

- 4) How do Mathematics Teachers upgrade their Professional Competencies?
- 5) How will the Professional Enrichment Programme (PEP) develop the teaching skills in teachers?
- 6) What impact does the PEP make on Mathematics learning outcomes of students?

3.2 Statement of the Problem

Development of Professional Enrichment Programme for the Secondary School Mathematics Teachers.

3.3 Objectives of the Study

1. To identify the Professional Development Needs of Secondary School Mathematics Teachers.
2. To develop Professional Enrichment Programme (PEP) for Mathematics Teachers of Secondary Schools.
3. To study the effectiveness of the developed programme.

3.4 Explanation of the Terms

3.4.1 Professional Development Needs:

Professional development needs of mathematics teachers include the content and methodological knowledge and skills required for effective mathematics teaching - learning at Secondary School Education.

3.4.2 Professional Enrichment Programme:

The term Professional Enrichment programme means a comprehensive, sustained and an intensive approach to improve teacher's effectiveness in raising students' learning outcomes. It is the enrichment training provided to teachers over a period of time to promote their development in all aspects of skill, content and pedagogy that enable them to be professionally competent.

3.5 Delimitation of the Study

The study was delimited to Class IX and X Mathematics Teachers of CBSE English medium schools of GUJARAT. Though there are 30373 affiliated schools following CBSE curriculum

across India and abroad according to **School Affiliation Re-Engineered Automation System (SARAS 5.0)** of CBSE, only the mathematics teachers of secondary section of CBSE English medium schools of Gujarat were considered for the sampling purposes, hence the study was delimited accordingly.

3.6 Context of the Present Study

The present study was carried out by focusing the mathematics teachers teaching at secondary schools. The researcher being in the field of education in the past 2 decades- as a mathematics teacher as well as the principal of a secondary school, has closely observed the lack of quality teaching, especially in secondary stage, resulting into the poor performance of students and hence majority of students losing interest in the subject mathematics. The researcher understood the vital role of the mathematics teachers in making the mathematics education a quality one in the secondary section, as the secondary section education is very crucial for the learners to make their career options and their life. Also, the review of many related literature revealed the fact through their findings that professional development programmes for the secondary mathematics teachers are required at regular intervals, in order to make them equipped to deliver in the classroom situations, the way the present generation learners are expected to be taught and nurtured to make them fit to live in the century.

In this context, the researcher was interested to develop and implement a Professional Enrichment Programme, by focusing both the generic and content aspects of teaching mathematics. This programme is aimed to enhance the professional competencies and skills of teachers. The researcher had a strong desire to make influence in mathematics education of secondary level which in turn might result into the improved learning outcomes of students. The researcher carried out the research with a wish to inculcate and develop the learners' interest in the subject mathematics.

Therefore the researcher put sincere efforts in conducting a survey to identify the professional development needs of the secondary school mathematics teachers with the support of “Gyan Sarovar”- the Central Gujarat CBSE Schools Sahodaya Complex. The researcher interacted with many Principals, mathematics teachers of secondary level, and with experts in the field of mathematics education at secondary level. Through the survey findings and the data collected through informal and unstructured interviews, interactions, discussions and classroom

observations, the researcher could identify the specific areas on which there was a need of programme development to enrich the practice and knowledge of secondary school mathematics teachers. The researcher, accordingly developed the content of the Professional Enrichment Programme, validated the same with the help of experts and then implemented the same through the sample mathematics teachers of various CBSE schools. After the implementation of the programme, the researcher studied the effectiveness of the programme.

3.7 Research Design

The main purpose of the present study was to develop and implement a Professional Enrichment Programme for mathematics teachers of secondary schools to enhance their professional competencies, content, pedagogical and methodological knowledge and also to improve their classroom management skills which in turn may improve the learning outcomes of students. To develop such a programme, by considering both generic and content-based needs identified by the researcher during the first phase of the study through the need identification questionnaire-NAQPEMT- and the other tools-informal interviews and classroom observations- the researcher felt the need of a strong design for the programme. Many reviews have been made by the researcher in order to have a strong base for the study. After reviewing several programmes designed by various researchers in the past, the current programme was designed and developed by focusing the objectives of the study. The reviewed literature, review of the other programmes, teaching modules and programme principles have given a direction to the researcher for the present programme designing and development.

Also, during the initial stage, the researcher set a strong base for this study by interacting with mathematics teachers of different secondary schools and also with the principals of various schools, through the support of “Gyan Sarovar”- the Central Gujarat CBSE Schools Sahodaya Complex.

The researcher conducted informal interviews and interactions to know about the difficulties, needs and the present status of mathematics teachers. These activities helped the researcher to gain some insights of the present mathematics education. After setting a strong base for the study, the researcher conducted the study in different phases.

The following table explains about the 5 different phases of the study.

Table- 3.1 Different Phases of the Study

PHASE	PURPOSE	DESCRIPTION OF THE ACTIVITIES
I	Identifying the Training Needs of Secondary School Mathematics Teachers.	<p>Review of various related literature.</p> <p>Interaction with teachers and principals.</p> <p>Development of the tool: Need Assessment Questionnaire for Professional Enrichment of Mathematics Teachers (NAQPEMT).</p> <p>Survey: Administering the NAQPEMT on a sample of 112 secondary school mathematics teachers.</p> <p>Classroom observations of few teachers.</p>
II	Development of the Programme	<p>Based on the outcome of the need assessment survey, informal interviews and classroom observations in Phase I, the content of the Professional Enrichment Programme (PEP) was developed.</p>
III	Programme Validation	<p>Validation of the programme by collecting the opinions of the experts -Professors, Principals, and experienced teachers of the relevant field.</p>
IV	Implementation of the Programme	<p>Physical training session of 62 mathematics teachers at secondary schools.</p> <p>Selected 12 teachers were asked to explore the programme.</p> <p>The programme was implemented by 12 teachers, conveniently selected by the researcher.</p> <p>Online sessions with 12 teachers who implemented the programme.</p>

V	Studying the Effectiveness of the Programme	<p>Opinions were collected through feedback form from 62 teachers who attended the training sessions.</p> <p>Feedback and opinions were collected from 12 teachers who implemented the programme.</p> <p>Feedback was collected from 221 students for whom the programme was carried out by the participating teachers.</p> <p>Informal interviews and classroom observations were conducted to study the effectiveness of the programme.</p>
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A description about the 5 phases of the study is given below.

- **Phase – I: Identifying the Professional Development Needs:**

The professional development needs of mathematics teachers of secondary schools were identified by the researcher, focusing on the generic and content-specific areas. In the generic area, the researcher tried to identify the needs on the following aspects practiced by teachers: Methodology of teaching, Pedagogical aspects, Classroom management skills, Use of technology, Assessment patterns, References & Resources they use, their Familiarity on various education policies and their recommendations.

A need assessment survey was conducted using a self-developed questionnaire- **Need Assessment Questionnaire for Professional Enrichment of Mathematics Teachers (NAQPENT)**, to identify both generic and content-specific areas to focus on the programme development. Researcher conducted informal interviews, interactions and classroom observations of teachers to identify the needs of programme development for secondary mathematics teachers.

- **Phase – II: Developing a Professional Enrichment Programme (PEP)**

Based on the needs identified through the survey, informal interviews, interactions, classroom observations and the analysis of the data so collected, the researcher developed a programme – which consisted of both the Standardized Teacher Professional Development

(Split Model) and Self-Directed Teacher Professional Development aspects which are briefed below.

Adopting the Split Model of the Standardized Teacher Professional Development helped the researcher to provide training by conducting offline and online sessions for teachers to have the proper understanding of the developed modules of the programme, then implementing the inputs in the actual classrooms, and then follow up on training through feedback and reflective and open discussions.

Self-Directed Teacher Professional Development incorporated was to provide self-learning modules to teachers through which they could do independent learning, using the provided content and by using resources like computers, the internet, and other digital devices.

Four modules on four identified topics were developed by the researcher.

- **Phase – III: Validation of the content of the developed programme.**

The developed programme was reviewed by the experts of mathematics education. Principals of few schools who were having mathematics background and few Professors of the Universities were contacted and requested by the researcher for their expert guidance on the content of the programme. Expert's guidance and suggestions were considered for the modification of the programme content, wherever felt necessary. Such relevant and useful suggestions from experts helped to improve the quality of the programme.

- **Phase – IV: Implementation of the programme:**

The developed programme was implemented in the following manner.

A physical training session was conducted by the researcher for 62 selected mathematics teachers of the secondary section of the schools of Central Gujarat. Principals of the schools who are members of GYAN SAROVAR-The Central Gujarat CBSE Schools Sahodaya Complex (an association of CBSE Schools Principals of Central Gujarat)- were approached by the researcher to ensure the participation of the teachers for the training sessions.

After explaining the developed modules through the physical training session, discussions were made on the implementation. Further, selected 12 teachers from Vadodara city were conveniently chosen and asked to implement the programme in their classrooms. The researcher was constantly guiding those 12 teachers through online training sessions and

informal interactions. Also, they were asked to explore the Self- Learning aspects of the Modules. Selected those 12 sample teachers were given 2 months' time duration to thoroughly explore and understand the programme. After exploring the programme, they were asked to implement the same in their classrooms.

- **Phase – V: Evaluating the effectiveness of the programme:**

The effectiveness of the PEP was studied through-

- a) The feedback collected from the participant teachers and students for whom the programme was implemented. Analysis was made on the collected feedback.
- b) Informal interviews and online interactive sessions were conducted to understand the effectiveness of the programme.
- c) Selected teachers' classroom observations were also made by the researcher.

3.8 Population of the Study

Mathematics teachers working in the secondary schools constituted the population for the present study. According to **School Affiliation Re-Engineered Automation System (SARAS 5.0)** of CBSE, there are 30373 affiliated schools following CBSE curriculum across India and abroad. Many state boards also now adopted curriculum and syllabus which matches with the syllabus developed by NCERT. Though the present study was conducted in Vadodara, Gujarat by selecting the sample mathematics teachers from Central Gujarat and then few teachers of Vadodara for the implementation of the programme , the study was focused on the entire mathematics teaching community of secondary section of the schools , who are following the curriculum developed by NCERT.

3.9 Sample and Sampling Techniques for the Study

As the study was conducted in different stages, multi stage sampling technique were used to select the sample for the study

For sampling, the researcher approached the President of GYAN SAROVAR Sahodaya and also various member school Principals to ensure the interest, regularity, and willingness on the part of the schools to depute Mathematics Teachers for the programme.

The following diagram shows the sampling techniques used for the different phases of the study.

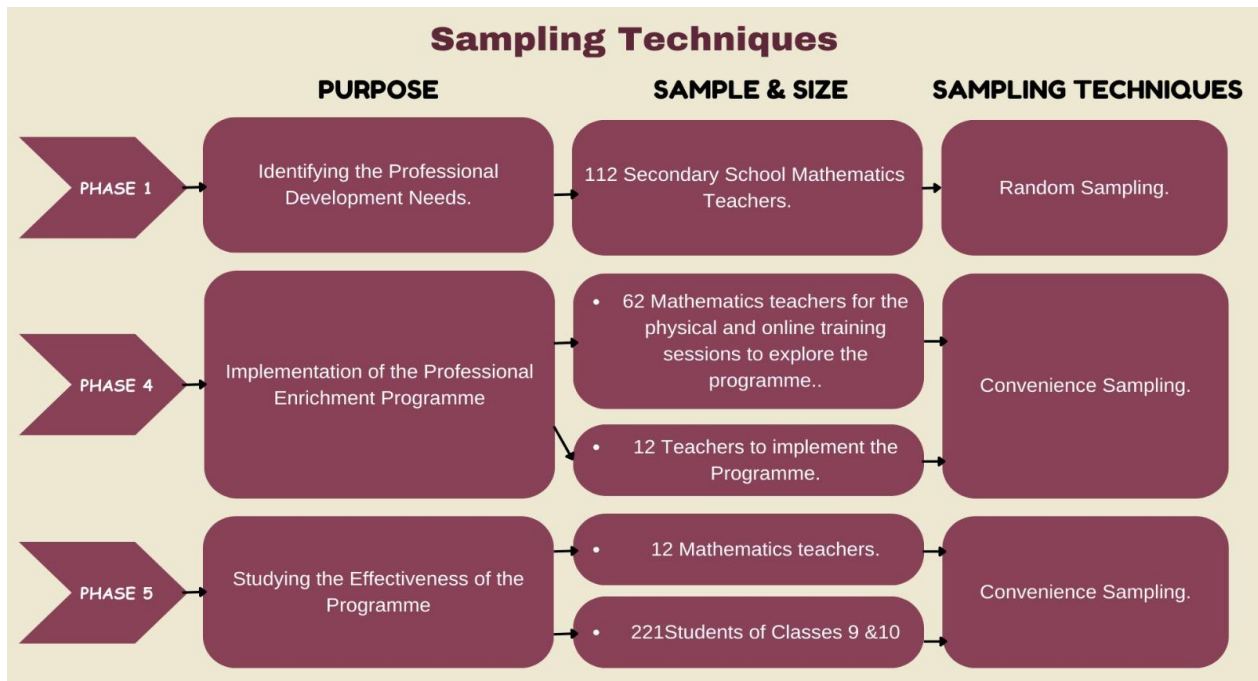


Figure- 3.1 Sampling Techniques

A description of the sampling techniques is given below.

Phase I: During the first phase of the study to identify the professional development needs of the mathematics teachers of secondary schools, the researcher adopted random sampling technique. 112 mathematics teachers of various secondary schools in Gujarat were approached randomly by the researcher with the help of GYAN SAROVAR SAHODAYA- an association of all CBSE schools of central Gujarat. Researcher approached the principals of these schools with a request to provide the secondary section mathematics teachers of their schools as sample for the study. These 112 mathematics teachers from various cities of Gujarat served as the sample for the first phase of the study.

Phase IV: During this phase of the Implementation of the Professional Enrichment Programme, the researcher adopted convenience sampling. 62 mathematics teachers of the secondary schools were conveniently selected from the member schools of GYAN SAROVAR SAHODAYA and researcher conducted offline and online training sessions to explain the developed programme.

Out of these 62 teachers, again 12 teachers were conveniently chosen to implement the developed programme in their classrooms.

Phase V: During the phase V of the study, to evaluate the effectiveness of the programme, the researcher employed convenience sampling technique and selected 12 mathematics teachers of secondary schools situated in Vadodara city of Gujarat by considering various parameters. The convenience to reach out to those mathematics teachers who were in the close proximity of researcher was the main parameter, along with other few aspects (which are mentioned in details in Chapter- 4), while selecting the teachers through the convenience sampling.

3.10 Research Tools and Techniques

Research tools play an important role in the research to collect essential data to address the research objectives. The researcher adopted different techniques and developed different tools for data collection, development of modules and to check the effectiveness of the developed programme.

The following diagram shows the research tools which were used at different phases of the study.

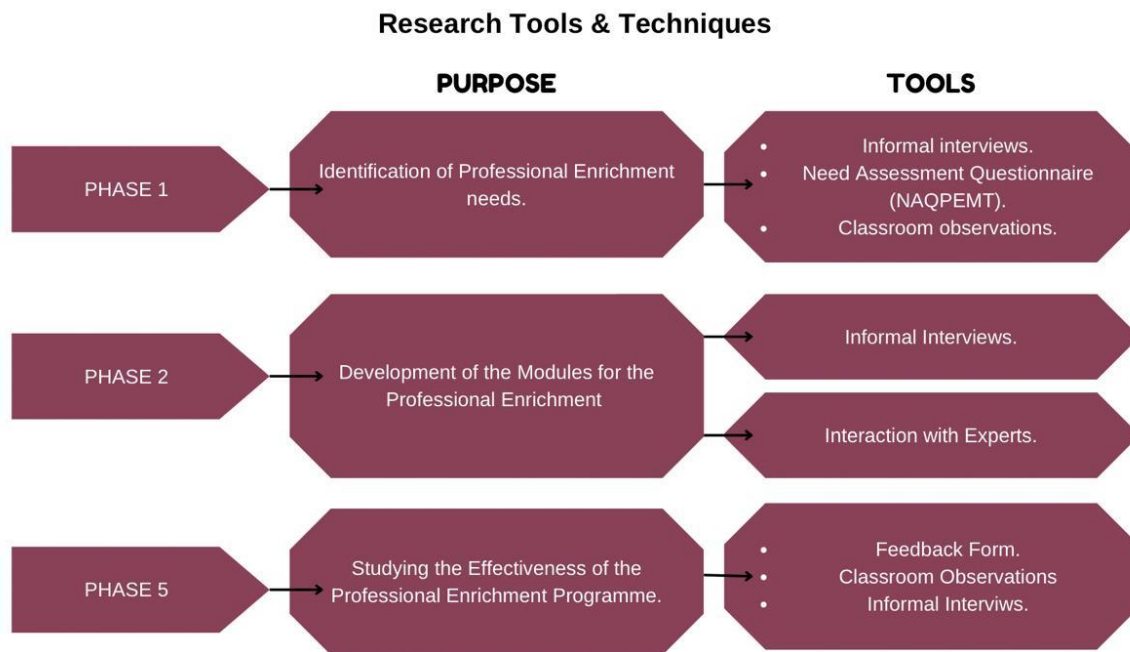


Figure- 3.2 Research Tools

A detailed description of tools developed and adopted for the various phases of the study is provided below.

1) Need Assessment Questionnaire for Professional Enrichment of Mathematics Teachers (NAQPENT):

In Phase I of the study, the researcher developed a questionnaire- Need Assessment Questionnaire for Professional Enrichment of Mathematics Teachers (NAQPENT) to identify their professional development needs. The questionnaire developed by the researcher contained items with respect to content, methodology, classroom management, ICT resources, assessment practices etc. in order to understand the specific training needs and Professional Enrichment Programme needs of Secondary Section Mathematics Teachers.

The questionnaire comprised 8 different dimensions to identify and understand the information regarding the academic and professional background, instructional practices and attitude towards teaching mathematics of secondary section mathematics teachers. The 8 dimensions covered in the questionnaire for which questions were framed are:

- 1) Background information (16 Questions)
- 2) **I.** Mathematics as a subject (14 Questions)
II. Pedagogy and Methodology Related (41 Questions)
III. Assessment Practices (12 Questions)
IV. Technology integrated Practices (8 Questions)
V. Other areas of Need for Professional Enrichment Program. (10 Questions)
VI. Teachers' familiarity with certain documents. (10 Questions)
VII. Content Related
 1. Area of Proficiency (15 Questions)
 2. Identifying the difficulty level of each topic of Class IX and X.

Apart from the questions to identify the 'Background Information' of the sample teachers, each question pertaining to all other 7 dimensions was given a 5-point rating scale. Few open ended questions were given in some of the dimensions.

Each item contained in the NAQPENT was validated by experts like Principals and Professors from mathematics background and education department of various universities. According to

their guidance and suggestions, required modifications were made and a pilot study was conducted with mathematics teachers of secondary section of 2 schools. This pilot study helped the researcher to understand the applicability, clarity, relevance etc., to validate the questionnaire. The NAQPMT was then administrated upon 112 sample mathematics teachers of secondary section of various schools in Gujarat.

A copy of this tool - NAQPMT- is given as **Appendix II**.

2) Informal Interviews:

During the initial phase of this study, the researcher conducted informal interviews and lots of interactions with different school Principals and secondary section mathematics teachers to understand the specific areas of problems while teaching Mathematics in class 9 and 10. These interactions and interviews helped the researcher to understand many methodological and pedagogical improvements required while teaching mathematics in secondary section. This enhanced the researcher's understanding about the findings which did emerge through the survey.

Inputs from such informal discussions gave the researcher a clear understanding of the areas to focus while developing the enrichment programme. Such understanding gained through the interactions led the researcher to derive an appropriate design for the enrichment programme in terms of its usability and execution.

Before the implementation of the developed programme, the researcher conducted 2 – 3 interactive sessions online on each module of the programme to discuss with the selected teachers for the implementation. This helped the researcher to give an understanding and clarity about the developed programme and also to understand the usability and adaptability of the programme.

Interactions and informal interviews were again held by the researcher during Phase –IV, during the implementation of the developed programme and also during Phase –V while studying the effectiveness of the programme.

2) Classroom Observations:

During Phase I (identification of needs), the researcher did the classroom observations of selected mathematics teachers to understand the methodology used in classrooms, the content clarity and the learning outcomes in students, the learning gaps, the assessment practices, technology integration in classrooms and the classroom management skills of mathematics teachers. The researcher interacted with a few mathematics teachers and their principals to understand the training needs.

Also, to study the effectiveness of the implemented PEP, during Phase V, the researcher conducted classroom observations of few teachers who implemented the developed programme. These observations helped the researcher to study the impact of the programme on Teachers' Professional Development.

3) Feedback Forms:

In Phase V, to study the effectiveness of the programme, the researcher used the Feedback Forms.

3 types of Feedback Forms were developed by the researcher.

- To collect feedback from the participant teachers who attended the physical and online training sessions.
- To collect feedback from the teachers who implemented the programme.
- To collect feedback from the students at schools where programme was implemented by the participating teachers.

Through the Feedback Form, the researcher collected their opinions and their experiences while implementing the programme which helped the researcher to understand the effectiveness of the programme. Apart from the feedback form, the researcher's continuous interaction with the participating teachers helped in the implementation in its desired manner and also it gave complete insights of the participating teachers' understanding of the programme.

Copies of all the 3 Feedback Forms are given as **Appendix III** attachment

3.11 Data Collection Procedure

Since the study was carried out in 5 different phases, the researcher adopted different tools and techniques for the data collection and analysis, which were appropriate for the requirement for the different phases.

A brief about the data collection procedure is given below.

Table-3.9 Data Collection Procedure.

Phases of Study	Data Collection Procedure
Phase I: Identification of Professional Development Needs	Primary Data: Response to NAQPMT by Mathematics teachers. Data through Informal Interviews, Interactions and Classroom observations of Mathematics teachers and Principals. Secondary Data: Data through review of Reports, Articles and Research Papers.
Phase II: Development of PEP	Inputs and opinions from secondary mathematics teachers and expert professors and principals who had mathematics background. Review of contents of other modules and other professional development programmes.
Phase III: Validation	Informal Interviews, Interactions and Discussion with teachers, experts and experienced professors and principals.
Phase IV: Implementation of PEP	Interaction with participating teachers by conducting offline and online sessions to give training clarity about the programme. Also, continuous discussions and observation of classes.
Phase V: Evaluating the effectiveness of PEP	Feedback and opinions of participating teachers who explored and implemented the programme, feedback from students whom the programme was implemented, data through Informal Interviews, Interactions and Classroom observations.

A detailed description of data collection procedure adopted at different phases of the study is given below.

PHASE - I: Identification of Professional Development Needs of Mathematics Teachers:

The data was collected by the researcher during this Phase of the study to identify the needs of the professional enrichment programme- from 112 mathematics teachers across Gujarat, by using the NAQPMT. The researcher being the executive committee member of GYAN SAROVAR SAHOD AYA, this very active Sahodaya of Central Gujarat played a major role in the data collection process. The researcher also collected information by reviewing related literature and meeting and interacting with mathematics teachers and various school Principals to understand the exact needs for the development of a Professional Enrichment Programme.

The quantitative data collected in this phase through NAQPMT was analyzed in terms of Percentage and Mean score calculations and the qualitative data collected through NAQPMT, interactions, informal interviews and classroom observations were analyzed descriptive data analysis method/ narrative analysis method.

PHASE - II: Development of Professional Enrichment Programme:

The development of the content of the programme was done in phase 2, which was based on the analysis of the data collected during the first phase. For this, the researcher gathered information through a review of the previous studies and the other teaching–learning modules developed earlier. The researcher visited mathematics professors, teachers and experts in the area several times to gather innovative approaches and other understanding from them and also to get their review as well, during the programme development which the researcher used to modify the content of the programme.

PHASE - III: Validation of Content of PEP:

The validation of the content was done by visiting the experts – the professors, senior mathematics teachers, few school Principals having mathematics subject mastery -, by providing them with the printed content and the soft copies to review and the suggested and required inputs were incorporated in the programme by the researcher.

PHASE - IV: Implementation of the PEP:

For the implementation of the developed programme, the researcher gathered 62 mathematics teachers of secondary schools of GUJARAT and had offline training session for them to have an exposure for the programme. Further, the researcher conducted online sessions, when and where

required to give clarity about the programme. Their opinions about the programme were collected through the Feedback Form.

Out of these 62 teachers, 12 teachers were chosen conveniently to implement the programme in their classrooms. The implementation of the programme was minutely monitored by the researcher by continuously interacting and guiding them telephonically and by interacting with them through the online platforms like WhatsApp – to provide them with guidance and support in making the clear understanding of the programme. Researcher collected the opinions from those 12 teachers through the Feedback Form.

Also, the researcher collected Feedback of 221 students of class IX & X, for whom the programme was implemented by the participating teachers, in order to understand the effectiveness of the programme.

PHASE- V: Evaluating the Effectiveness of the Programme.

For evaluating the effectiveness of the programme, Feedback forms were developed by the researcher for collecting the opinions of the participating mathematics teachers at various levels. 3 types of feedback were collected by the researcher:

- Feedback from 62 participant teachers who attended the physical and online training sessions.
- Feedback from 12 teachers who implemented the programme.
- Feedback from 221 students of class IX & X of the schools where programme was implemented by the participating teachers.

3.12 Data Analysis

Analysis and interpretation of the data gathered for the present study was carried out by the researcher, by keeping the research objectives in mind. Data collected during the various phases of the study by using the mixed methods were both qualitative and quantitative in nature. Researcher used Need Assessment Survey to collect quantitative data and Interviews and Classroom Observations to collect qualitative data on teachers' perceptions. Mixed methods helped the researcher to combine the qualitative and quantitative data collected, their analysis and interpretations. Triangulation helped the researcher to combine several qualitative data types like triangulation of the data collected through Informal Interviews and Classroom Observations. The

researcher followed the basic statistical analysis steps: collection of data, integration and presentation of data, analyzing the data, interpretation of data and the presentation of results- which were very essential for the research conclusion.

The following section presents a brief of the complete analysis procedures followed for both quantitative and qualitative data.

3.12.1 Quantitative Data Analysis Process:

The quantitative data collected for the first phase of the study using the NAQPMT and in the last phase of the study through Feedback Form were analyzed through the descriptive statistical analysis techniques – percentage and mean score calculations. First, the raw data was converted into table form by assigning numerical scores for each response. A 5- point rating scale was adopted in the questionnaire and in the feedback forms to convert the data in quantitative manner. Then the data was explored thoroughly by the researcher to organize the same and to keep the data ready for analysis and interpretation.

3.12.2 Qualitative Data Analysis Process:

The qualitative data obtained from NAQPMT during the first phase of the study, Feedback Forms used to study the effectiveness of the programme during the last phase of the study, Informal Interviews, Interactions with participating teachers and Classroom Observations made at various phases of the study were analyzed through both inferential and narrative analysis methods. Researcher adopted triangulation to combine the various sources of qualitative data collected to keep them ready for analysis and interpretation and result presentations.

3.13 Conclusion

This chapter provided the research methodology of the study and the other methodological approaches adopted during the programme development, its implementation and the evaluation of the programme. The methodological approach highlighted in each phase of the study was done by the researcher, in order to realize the objectives of the study.

The next chapter reveals the detailed description of the data collection process and statistical data analysis carried out, along with their interpretations and results presentations.