CHAPTER 4
DATA ANALYSIS AND INTERPRETATION

4.0 Introduction

The detailed analysis and interpretation of the data collected during different phases of the study are explained in this chapter. Data analysis and interpretation were carried out by focusing the objectives of the study. Data collected were both qualitative and quantitative in nature. Hence, the analysis was done by adopting both qualitative and quantitative analysis techniques.

The analysis and the interpretation of the data with respect to the objectives of the study are divided into 3 sections, as given below.

SECTION - I: IDENTIFICATION OF THE TRAINING NEEDS OF MATHMATICS TEACHERS OF SECONDARY SCHOOLS.

SECTION - II: DEVELOPMENT OF THE PROFESSIONAL ENRICHMENT PROGRAMME.

SECTION - III: IMPLEMNTATION AND EVALUATION OF THE EFFECTIVENESS OF THE PROGRAMME.

The detailed description of each section is presented in the next section.

SECTION - I

4.1 Identification of Professional Enrichment Needs of Secondary School Mathematics Teachers

During the first phase of the study, to identify the needs for the professional enrichment programme, the researcher administered the **Need Assessment Questionnaire for Professional Enrichment of Mathematics Teachers (NAQPEMT)** on 112 mathematics teachers of various secondary schools in Gujarat. The questionnaire contained 8 categories of questions or statements, in order to identify the specific needs for developing a professional enrichment programme for secondary section mathematics teachers.

The 8 dimensions considered to categorize the statements for NAQPEMT are:

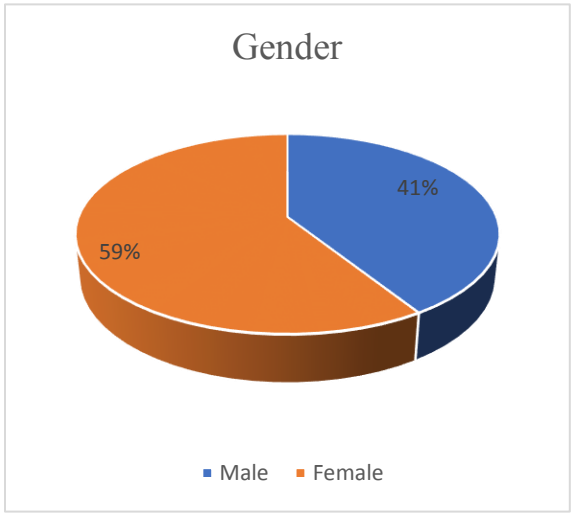
1. Profile and background information of the sample mathematics teachers.
2. Teachers' perception about Mathematics as a subject.
3. Pedagogy and methodology related practices.
4. Assessment practices.
5. Technology integration practices.
6. Other than content and pedagogy (if any to opine).
7. Teachers' familiarity with various policies and relevant resources.
8. Content related opinions as per the difficulty in teaching- learning.

All the above dimensions included are carefully framed by the researcher in order to identify the specific training needs if any, on each of the above dimension. The quantitative data collected against the above-mentioned dimensions were analyzed in terms of their descriptive statistics- percentage and mean scores calculations. The qualitative data collected in terms of the opinions captured of the participants were analyzed by using the qualitative data analysis method. Dimension wise analysis and interpretation are presented below.

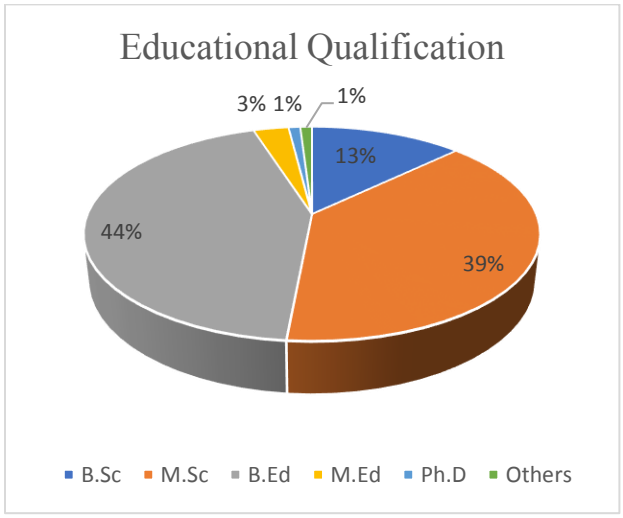
4.1.1 Profile of the Respondents

The below presented Pie- Charts (Graph-4.1 to Graph -4.7) & the Bar Graph- 4.8 show the profile and other background information of the 112 teachers who participated in the need identification survey. The data collected on various parameters of the participants included gender, educational qualification, medium of learning, types of schools, schools' affiliation, years of experience in teaching and classes taught. The demographic details of the participants collected were converted in quantitative form and were analyzed and the interpretation is presented below.

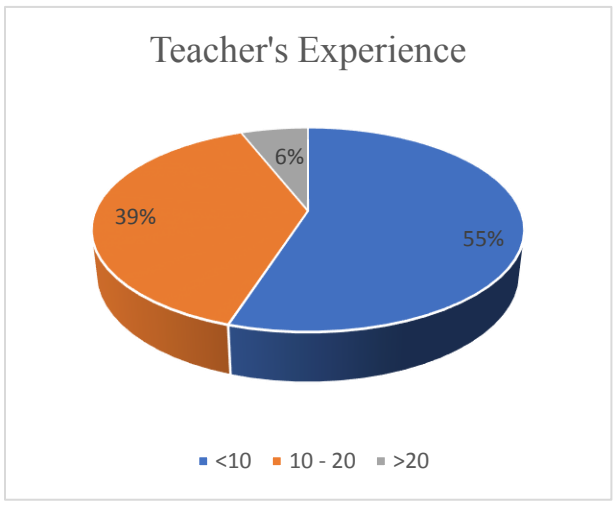
Graph - 4.1 Gender of Participants



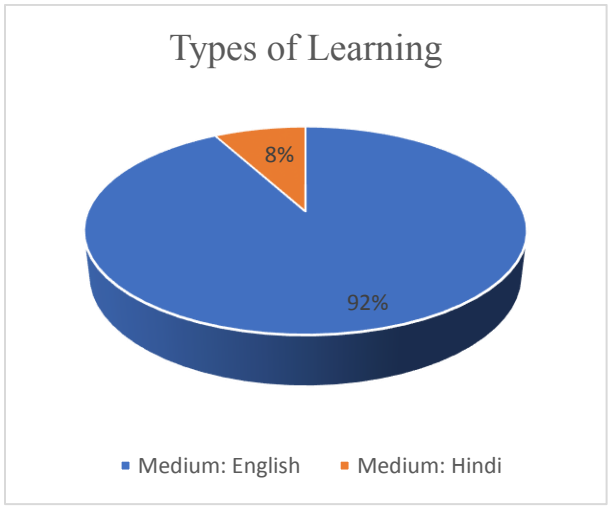
Graph - 4.2 Educational Qualification



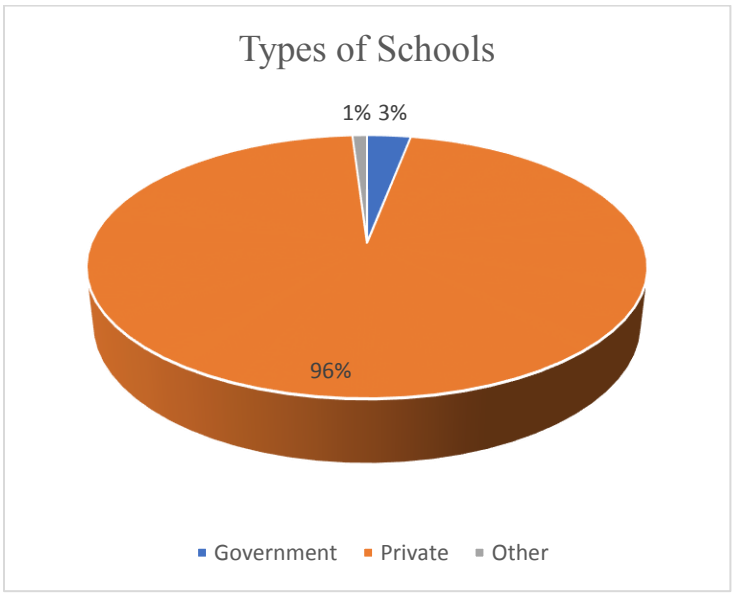
Graph - 4.3 Work Experience of the Participants



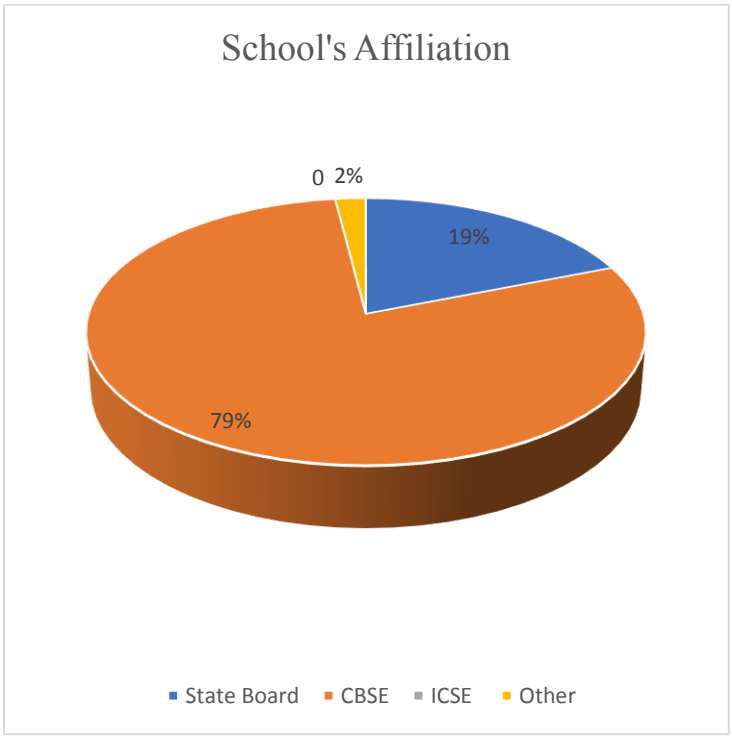
Graph - 4.4 Medium of learning of Participants



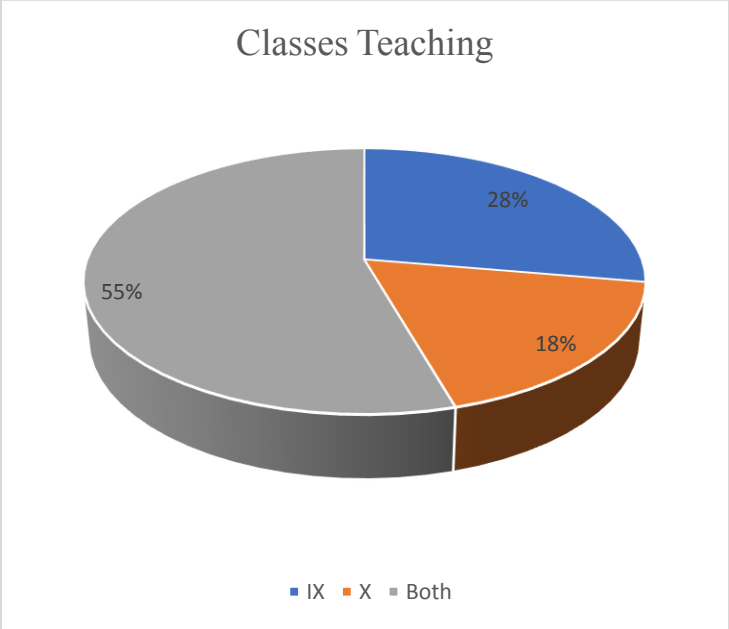
Graph - 4.5 Types of schools of Participants



Graph - 4.6: School's Affiliation



Graph - 4.7: Classes taught by the Participants



From the analysis of the above pie-charts, the following interpretations are being drawn by the researcher.

Graph 4.1 revealed, female respondents constituted 59% of the sample, compared to 41% male respondents.

Graph 4.2 revealed that the majority of respondents hold a B.Ed. degree (44%), followed by M.Sc. (39%) and B.Sc. (13%), with a small number holding M.Ed. (3%), Ph.D. (1%), and other qualifications (1%).

Graph 4.3 revealed that more than half of the respondents have less than 10 years of experience (55%), with 39% having 10-20 years of experience and 6% having over 20 years.

Graph 4.4 shows most teachers have learned in English medium schools (92%), while a minority in Hindi medium schools (8%).

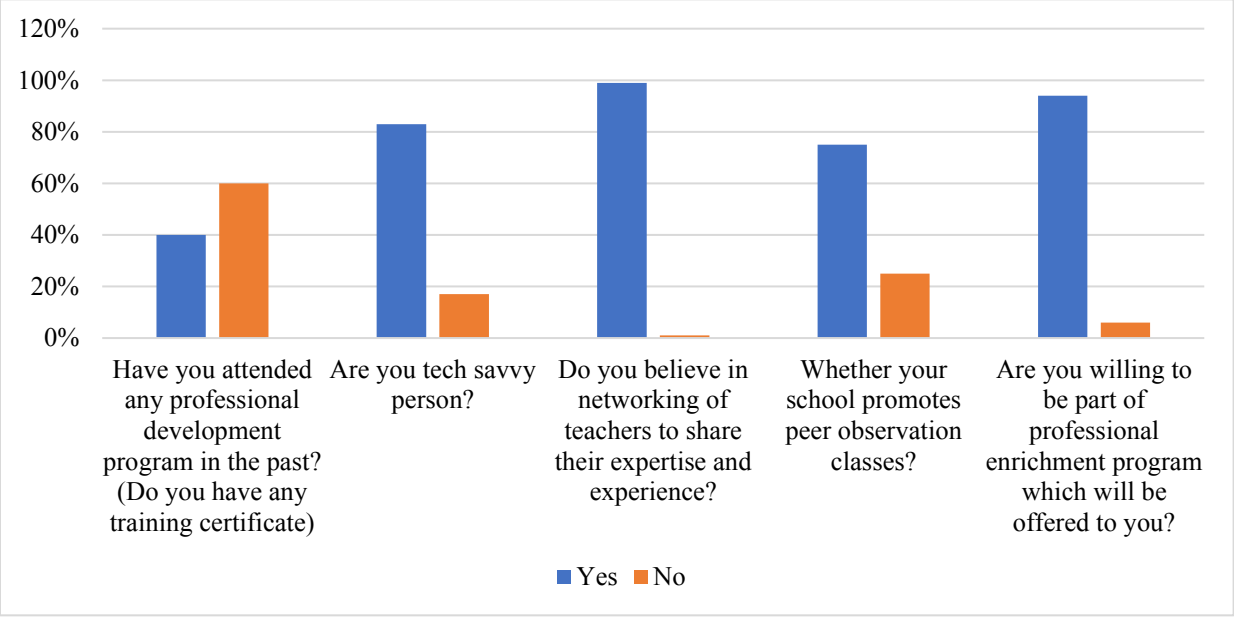
Graph 4.5 revealed that the majority of the participants are employed in private schools (96%), with a small proportion in government (3%) and others (1%).

Graph 4.6 shows a good number of participants (79%) is employed in CBSE affiliated schools, where as 19% of the respondents are teaching in state board schools and 2% in other boards and 0% in ICSE.

Graph 4.7 conveys that the significant number of teachers teach both classes IX & X (55%), while others teach either only class IX (28%) or class X (18%).

Graph 4.8 given below summarizes the data gathered other than the demographic details of the respondents which included 'the status of participation in professional development programmes', 'information on possessing teacher training certificate', 'digital proficiency', 'interest in networking and collaboration', 'information about schools initiatives in promoting peer observation classes' and 'interest of the participants in the professional enrichment programmes in future'.

Graph-4.8 Participant Teachers' Background Information



The analysis of the above data can be interpreted in the following way.

Professional development programme participation status was split with 40% having attended such programs and 60% not. Similarly, 40% hold a teacher training certificate, while 60% do not. A large majority (83%) considered themselves as tech-savvy, and nearly all (99%) believe in the networking of teachers for sharing expertise. Additionally, 75% reported that their schools

promote peer observation classes, and 94% were eager to participate in professional enrichment programme which will be offered to them in future.

In conclusion, the analysis of the entire data gathered under the dimension of - Profile and Background Information - provided a comprehensive status of secondary school mathematics teachers, shedding light on their educational qualifications, gender distribution, medium of instruction, type of school, school affiliation, years of experience, teaching classes, professional development status, and attitudes towards technology and networking. These demographic and other details of the respondents helped the researcher to have a better understanding of the sample mathematics teachers who are working at secondary schools, for whom the professional enrichment programme was supposed to be developed.

4.1.2 Mathematics as a Subject

This dimension is included as a component in the questionnaire by the researcher to know the respondents' perception pertaining the nature of mathematics as a subject.

Table - 4.1 shows the statements contained under this category, for which the responses recorded, along with the percentage and mean calculation against each statement. This category included 14 statements describing the nature of mathematics as a subject.

Table - 4.1 Percentage and Mean Scores of Responses for Mathematics as a Subject

Mathematics as a subject.								
To what extent do you agree or disagree with the following statements?		**Strongly Disagree**	**Disagree**	**Neither Agree nor Disagree**	**Agree**	**Strongly Agree**	**Total Response**	**Mean**
1)	Mathematics is primarily an abstract subject	21(19%)	23(2I%)	10(9%)	40(36%)	18(16%)	112	3.10
2)	Learning Mathematics helps students in facing the real-life situations and solving problems.	0(0%)	0(0%)	1(1%)	40(36%)	71(63%)	112	4.63
3)	Some students have a natural talent for Mathematics.	1(1%)	4(4%)	3(3%)	49(44%)	55(49%)	112	4.37
4)	Teachers should adopt the same approach to address the different learning difficulties of different students in Mathematics subject.	36(32%)	40(36%)	3(3%)	17(15%)	16(14%)	112	3.56
5)	Teachers are required to use appropriate teaching aids for teaching different Mathematics topics.	2(2%)	1(1%)	3(3%)	45(40%)	61(54%)	112	4.45

6)	**Mathematics teachers need to have skills in**							
	• Drawing	1(1%)	1(1%)	15(13%)	65(58%)	30(27%)	112	4.09
	• Logical thinking	0(0%)	0(0%)	1(1%)	34(30%)	77(69%)	112	4.68
	• Comprehension	0(0%	1(1%)	7(6%)	50(45%)	54(48%)	112	4.49
	• Basic computational skills	0(0%)	0(0%)	0(0%)	36(32%)	76(68%)	112	4.68
	• Articulation	1(1 %)	1(1 %)	8(7 %)	62(55 %)	40(36 %)	112	4.24
	• Analytical approach to problem solving	0(0.00%)	0(0.0%)	0(0.00%)	37(33%)	73(65.18%)	112	4.67
7)	A liking for and understanding of students are essential for teaching Mathematics.	1(0.89%)	2(1.8%)	6(5.36%)	54(48.2%)	46(41.07%)	112	4.29
8)	It is not necessary for students to communicate their Mathematics ideas.	33(29.46%)	54(48.21%)	7(6.25%)	12(10.7%)	5(4.46%)	112	3.88
9)	Technology distracts students from learning basic skills.	9(8%)	29(26%)	40(36 %)	20(18 %)	14(13 %)	112	3.01
10)	Understanding when, how and which a Mathematical technique to be used is important rather than just memorizing formulae and technique from memory.	0(0%)	1(1%)	0(0%)	46(41%)	65(58%)	112	4.56
11)	Teacher should often remind students that a law of Mathematics may not be fun or interesting but it's important to learn it anyway.	13(12%)	35(31%)	21(19 %)	31(28 %)	12(11 %)	112	1.84
12)	While communicating with parents and students about performance, I tend to focus on student weaknesses instead of strengths.	25(22%)	46(41%)	25(22%)	8(7%)	8(7%)	112	3.50
13)	The existing curriculum focuses more on learning procedures than increasing the students' understanding and reasoning capacity.	3(3%)	22(20%)	22(20%)	54(48%)	11(10 %)	112	1.61
14)	Mathematics is all about solving problems given in exercises of the text books.	54(48%)	44(39%)	3(3%)	4(4%)	7(6%)	112	4.13

The analysis of the above mean scores reveals the following:

Respondents exhibited varied views on whether ‘Mathematics is primarily abstract’ (Mean 3.10). A significant number strongly disagreed (21 respondents) on it and a substantial minority strongly agreed (18 respondents), indicating differing perceptions of the subject's nature. There was strong consensus (Mean 4.63) among participant teachers that ‘learning mathematics aids in real-life problem-solving’. The majority strongly agreed (71 respondents), highlighting the perceived practical value of mathematical education. Opinions varied on ‘whether some students have a natural talent for mathematics’ (Mean 4.37). Many agreed (55 respondents) and a notable number are neutral (49 respondents), suggesting a spectrum of beliefs regarding innate mathematical ability. Participant teachers expressed mixed views on ‘adopting the same approach for different learning difficulties in mathematics’ (Mean 3.56). A significant number disagreed (40 respondents), advocating for tailored approaches, while others agreed (17 respondents) on uniform teaching method. There is strong agreement (Mean 4.45) regarding ‘the necessity of appropriate teaching aids in mathematics instruction’. Most respondents agreed (61 respondents), underscoring the importance of visual and interactive tools in enhancing learning.

Teachers strongly endorsed the need for diverse skills among mathematics teachers , particularly in ‘logical thinking’ (Mean 4.68), ‘basic computational skills’ (Mean 4.68), and ‘an analytical approach to problem-solving’ (Mean 4.67). This highlights the multifaceted demands placed on teachers in fostering a comprehensive mathematical understanding through professional enrichment programmes. There was consensus among participant teachers that ‘empathy and communication skills are crucial for teaching mathematics effectively’ (Mean 4.29). The majority agreed (57 respondents), emphasizing the importance of relational skills in instructional practices. Participant teachers are divided on ‘the necessity of students communicating their mathematical ideas’ (Mean 3.88). A significant number disagreed (55 respondents) on it, indicating support for student expression, others agreed (12 respondents) on a more passive approach.

Opinions varied on ‘whether technology distracts from learning basic skills’ (Mean 3.01). Some participants agreed (40 respondents) and a significant number were neutral (38 respondents), suggesting ongoing debate over the role of technology in mathematical education.

Participant teachers strongly supported 'prioritizing understanding over memorization in mathematics' (Mean 4.56). Most agreed (65 respondents), reflecting a consensus on the importance of conceptual mastery in mathematical learning. Participant teachers expressed mixed views on 'emphasizing the importance of mathematical laws' (Mean 1.84). Many disagreed (35 respondents), advocating for contextual relevance and others agreed (12 respondents) on a more traditional emphasis.

Participant teachers had divided opinions on 'whether to focus on student weaknesses or strengths in communicating with parents about the performances' (Mean 3.50). Some participants were neutral (25 respondents) on 'addressing weaknesses', others disagreed (25 respondents), suggesting varying approaches in feedback delivery of participant mathematics teachers.

Opinions varied on 'whether the curriculum emphasizes procedures over understanding' (Mean 1.61). A majority disagreed (22 respondents), advocating for 'deeper understanding' and others agreed (11 respondents) for 'procedural focus'. Participant teachers expressed diverse perspectives on 'mathematics as exercise-bound problem-solving' (Mean 4.08). Many strongly agreed (54 respondents) with this view and others disagreed (4 respondents), highlighting differing views on the breadth of mathematical study.

The researcher delved into the varied perspectives of teachers regarding key aspects of mathematics education. The analysis of the data gathered under this dimension and its interpretation helped the researcher to understand the various training needs to focus on while developing the enrichment programme for teachers. The researcher could identify the need expressed by the teachers on curriculum reformation as the majority of the respondents opined that 'the existing curriculum focuses more on learning procedures than increasing the students' understanding and reasoning capacity'. It also revealed the need of support for mathematics teachers in terms of providing professional enrichment programme for them by involving technology and other instructional strategies. The need for continuous evaluation of curriculum on procedural learning versus conceptual understanding got emerged from the analysis of the dimension – mathematics as a subject. This indicates the need of a professional enrichment programme for the teachers.

4.1.3 Pedagogy and Methodology Related

This section of the questionnaire was to understand the training needs of teachers on pedagogical practices and methodological aspects in secondary schools.

Table - 4.2 shows the statements contained under this category for which the responses recorded along with the percentage and mean calculation against each statement. This category included 41 statements related to the Pedagogy and Methodology of teaching mathematics.

Table - 4.2 Percentage and Mean scores of Responses for Pedagogy and Methodology Related

In my Mathematics class, my students should: (Q. 1 – 14)								
Component of the Questionnaire		**Strongly Disagree**	**Disagree**	**Neither Agree nor Disagree**	**Agree**	**Strongly Agree**	**Total Response**	**Mean**
1)	Explain the reasoning behind an idea	0(0 %)	3(3 %)	2(2 %)	72(64 %)	35(31%)	112	4.24
2)	Represent and analyze relationships using tables, charts or graphs	0(0 %)	1(1 %)	3(3 %)	77 (68 %)	31(28 %)	112	4.23
3)	Work on problems for which there is no immediate and obvious solution	1(1 %)	12(11 %)	22(20 %)	59 (52 %)	18(16 %)	112	3.72
4)	Use computers to solve exercises or problems	19(17 %)	50 (44 %)	22(20 %)	14(13 %)	7(6 %)	112	3.54
5)	Write equations to represent relationships	1(1 %)	4(4 %)	2(2 %)	83 (73 %)	22(20 %)	112	4.08
6)	Practice computational skills	1(1 %)	1(1 %)	3(3 %)	69(61 %)	38(34 %)	112	4.27
7)	Use calculators to solve exercises or problems	40(36 %)	54(48 %)	10(9%)	6(5 %)	2(2 %)	112	4.11
8)	Link formal Mathematics with experimental learning.	1(1 %)	1(1 %)	7(6 %)	77(69 %)	26(23%)	112	4.13
9)	Work individually without assistance from the teacher	8(7 %)	28(25 %)	30(27 %)	37(27 %)	9(8 %)	112	3.88
10)	Work individually with assistance from the teacher	2(2 %)	12(11 %)	27(24 %)	56(50 %)	15(13 %)	112	3.63
11)	Work together as a class with the teacher teaching the whole class	2(2 %)	10(9 %)	12(11 %)	72(64 %)	16(14%)	112	3.80
12)	Work in pairs or small groups with assistance from the teacher.	1(1 %)	2(2 %)	14(13 %)	78 (69 %)	17(15 %)	112	3.96
13)	In my school we have the practices of making							
	• Daily lesson plan	4(4 %)	3(3 %)	4(4 %)	65 (57 %)	36(32 %)	112	4.13
	• Weekly lesson plan	1(1 %)	7(6 %)	4(4 %)	74 (66 %)	26(23 %)	112	4.04

	• Monthly lesson plan	1(1 %)	4(4 %)	0(0 %)	77 (68 %)	30(27 %)	112	4.17
	• Yearly lesson plan	4(4 %)	3(3 %)	2(2 %)	66 (58 %)	37(33 %)	112	4.15
14)	My daily lesson plan never helps in achieving my targets in terms of syllabus completion.	31(28 %)	50 (44 %)	14(13 %)	11(10 %)	6(5 %)	112	3.79
15)	I have the practice of using my own prepared teaching aids / models in classrooms.	4(4 %)	4(4 %)	24(21 %)	61 (54 %)	19(17 %)	112	3.78
16)	I am confident of my content. So, I do not prepare for my class.	15(14 %)	61 (54 %)	7(6 %)	18(16 %)	11(10 %)	112	3.46
17)	I do not link the new topic to be introduced in the class with the previous knowledge, the students have.	48(43 %)	54(47 %)	4(4 %)	2(2 %)	4(4 %)	112	4.25
18)	I introduce the topics by connecting the same with real life situation.	0(0 %)	0(0 %)	5(4 %)	52(46 %)	55 (50 %)	112	4.45
19)	I spend some time every day in my class to increase the basic computational skills of my learners.	1(1 %)	4(4 %)	19(17 %)	69 (61 %)	19(17 %)	112	3.90
20)	I am not able to reach every single learner of my class while delivering the concepts in terms of their understanding.	12(11 %)	39 (34 %)	28(25 %)	30(27 %)	3(3 %)	112	2.76
21)	Intelligent students of the class disturb me	30(27 %)	54 (48 %)	18(16 %)	8(7 %)	2(2 %)	112	3.91
22)	I emphasis on 'Visualization and Representation' of the facts and topics	1(1 %)	1(1 %)	5(4 %)	76 (68 %)	29(26 %)	112	4.17
23)	I do not get adequate time to implement innovative teaching strategies.	8(7 %)	43 (38%)	22(20 %)	37(33%)	2(2 %)	112	3.16
24)	My main concern in my class is to complete the syllabus.	17(15 %)	57 (51 %)	25(22 %)	9(8 %)	4(4 %)	112	3.66
25)	Towards the end of every class, I do recaptualization of the important concepts.	2(2 %)	5(4 %)	10(9 %)	68 (61 %)	27(24 %)	112	4.01
26)	One should not assign Mathematics problems that can be solved in different ways, as that may confuse the students.	28(25 %)	56(50 %)	17(15 %)	11(10 %)	0(0 %)	112	3.90
27)	It's not advisable for students to work together during Mathematics problem solving.	16(14 %)	61(54 %)	19(17 %)	13(12 %)	3(3 %)	112	3.66
28)	When students solve the same problem using different strategies, teacher should ask them to share the same in class.	1(1 %)	4(4 %)	5(4 %)	60 (53 %)	42(48 %)	112	4.23

29)	I often learn from my students during Mathematics class because they come up with indigenous ways of solving problems that I have never thought of.	3(3 %)	4(4 %)	22(20 %)	68 (60 %)	15(13 %)	112	3.79
30)	I do not assign real-life Mathematics problems that are of interest to students.	29(26 %)	68(61 %)	6(5 %)	9(8 %)	0(0 %)	112	4.04
31)	Teacher should make students feel that everybody can do Mathematics.	7(6%)	1(1%)	2(2%)	45(40 %)	57(51 %)	112	4.29
32)	I do not believe in communicating with my students' parents about student strength / weakness in learning Mathematics.	34(30 %)	66(59 %)	2(2 %)	8(7 %)	2(2 %)	112	1.91
33)	I always focus on 'Mathematization' of students thought process in my Mathematics class.	0(0%)	10(9 %)	17(15 %)	75 (67 %)	10(9 %)	112	3.76
34)	I practice 'activity – oriented' teaching in my class.	0(0 %)	3(3 %)	23(21 %)	68 (60 %)	18(16 %)	112	3.90
35)	When students are working on problems, I put more emphasis on getting the correct answer rather than on the process followed.	16(14 %)	64 (58 %)	12(11%)	15(13 %)	5(4 %)	112	3.63
36)	I ask my students to master basic operations before they enter into complex problems.	0(0 %)	1(1 %)	1(1 %)	65(58 %)	45(40 %)	112	4.38
37)	I refer various books (fax content)	0(0 %)	4(4 %)	9(8 %)	51 (45 %)	48(43 %)	112	4.28
38)	I make students to practice from other reference books apart from Text book exercises.	1(1 %)	7(6 %)	5(4 %)	62 (56 %)	37(33 %)	112	4.13
39)	**My classroom management skills are**							
	Excellent	0(0 %)	3(3 %)	8(7 %)	72 (64 %)	29(26 %)	112	4.13
	Good	3(3 %)	3(3 %)	7(6 %)	79 (70 %)	20(18 %)	112	3.98
	Average	5(4 %)	84(75%)	8(7 %)	13(12 %)	2(2 %)	112	3.69
	Need Improvement	8(7 %)	13(12 %)	11(10 %)	11(10 %)	1(1 %)	112	3.75
40)	I blame the students for not having adequate basic knowledge for understanding a new concept.	30(27 %)	66 (59 %)	11(10 %)	5(4 %)	0(0 %)	112	4.08

41)	**After teaching a concept,**							
	I solve every problem given in exercise for student.	7(6 %)	62 (56 %)	15(13 %)	17(15 %)	11(10 %)	112	2.67
	I ask students to solve the problems in the class	4(4 %)	7(6 %)	11(10 %)	75 (67 %)	15(13 %)	112	3.80
	I solve few questions and rest I assign students to do at home.	8 (7%)	15(13 %)	14(13 %)	60 (54 %)	15(13 %)	112	3.53

From the above analysis, the researcher could identify few such areas to focus on the pedagogy and methodology of teaching while developing the professional enrichment program. Out of 41 statements mentioned in this dimension, the identified areas are emphasized below.

Teachers widely endorsed the practice of explaining 'reasoning in mathematics' (Mean 4.24) which reflected a strong consensus on its pedagogical value. The practice of 'using visual aids to represent relationships' is highly regarded (Mean 4.23), with 77 respondents in agreement. This indicates a strong recognition of the importance of visual representations for conceptual clarity and analysis. 'Encouraging students to tackle complex problems' received moderate support (Mean 3.72), indicating varied comfort levels with ambiguous problem-solving scenarios.

The 'integration of computers in solving mathematical problem' showed moderate endorsement (Mean 3.54). 'Writing equations as a method to represent relationships' was highly supported (Mean 4.08) by the participant teachers, with 83 respondents in agreement. This highlighted the perceived value of 'algebraic representation' as a foundational skill.

The practice of honing computational skills is solidly endorsed (Mean 4.27), with 69 respondents 'recognizing the importance of fluency in basic arithmetic for problem-solving'.
Utilizing calculators in mathematical problem-solving was disagreed by 54 respondents. Integrating formal mathematics with experimental learning is well-supported (Mean 4.13), with 77 respondents agreeing.

'Working independently without teacher assistance' received moderate support (Mean 3.88), which indicates a balanced approach to fostering student autonomy while providing necessary support.' Working independently with teacher assistance' showed similar endorsement (Mean 3.63), with 56 respondents agreeing, suggesting a balanced approach to scaffolding learning and

promoting self-reliance. ‘Collaborative whole-class instruction’ received moderate support (Mean 3.80), recognizing the role of teacher-led instruction in facilitating collective learning experiences.

‘Collaborative small-group learning with teacher assistance’ is endorsed moderately (Mean 3.96) highlighting the benefits of ‘peer interaction and targeted teacher support Daily, Weekly, Monthly, and Yearly’.

‘Creating structured lesson plans across different timeframes received varied levels of support: daily plans (Mean 4.13), weekly plans (Mean 4.04), monthly plans (Mean 4.17), and yearly plans (Mean 4.15). Perceptions of the impact of daily lesson plans on syllabus completion are mixed (Mean 3.79). Some participant teachers agreed (11 respondents) on their efficacy, others expressed dissatisfaction (14 respondents), suggesting room for improvement.
The ‘use of personalized teaching aids and models’ is well-supported (Mean 3.78), with 61 respondents recognizing the value in customizing materials to enhance engagement and clarity. Participant teachers' confidence in content preparation shows moderate endorsement (Mean 3.46),

The practice of ‘linking new topics with prior knowledge of student’ is strongly supported (Mean 4.25), indicating widespread recognition of its benefits for comprehension and retention, showing a need of attention in this area while developing the professional enrichment programme. ‘Introducing topics through real-life situations’ is highly endorsed (Mean 4.45). The ‘commitment to enhancing basic computational skills, daily’ is well-supported (Mean 3.90), with 68 respondents reflecting consensus on the importance of foundational mathematical fluency.
‘Challenges in meeting the needs of every learner’ received mixed responses (Mean 2.76), indicating recognition of the difficulty in personalized instruction despite efforts.

‘Managing high-achieving students poses challenges’ (Mean 3.91), reflecting difficulties in meeting the needs of brilliant students within the classroom. Emphasis on visualization and representation in mathematics instruction is well-regarded (Mean 4.17), underscoring a commitment to enhancing conceptual understanding through visual strategies.’ Limited time for

innovative teaching strategies' is a concern (Mean 3.16), indicating challenges in implementing creative approaches within existing time constraints.

Emphasis on 'syllabus completion' is moderately supported (Mean 3.66), reflecting varying priorities between 'curriculum coverage and depth of understanding'. 'Recapping important concepts at the end of each class' received solid endorsement (Mean 4.01), suggesting a recognized value in reinforcing learning and enhancing retention. 'Assigning problems with multiple solution paths' is well-regarded (Mean 3.90), which indicates that participant teachers value the cognitive benefits of promoting diverse problem-solving approaches. 'Encouraging collaboration during problem-solving' received moderate support (Mean 3.66), recognizing the social and cognitive benefits of peer learning.

'Sharing varied problem-solving strategies' is highly endorsed (Mean 4.23), with 60 respondents strongly agreeing. Participant teachers value the opportunity for students to learn from each other's approach and deepen understanding.

'Assigning real-life mathematics problems of student interest' is well-supported (Mean 4.04), with 68 respondents agreeing, recognizing the value of fostering relevance and engagement in learning. 'Promoting inclusivity and confidence in mathematics' is highly endorsed (Mean 4.29) with 57 respondents strongly agreeing. Participant teachers emphasized 'creating a supportive environment for all students. Emphasis on 'the mathematization of thought processes' is well-regarded (Mean 3.76) with 75 respondents agreeing, reflecting a commitment to developing analytical and logical thinking skills which indicated the researcher for the need of focusing this area while developing the programme.

'Activity-oriented teaching practices' are moderately endorsed (Mean 3.90), with 68 respondents agreeing, indicating the importance of hands-on learning experiences. 'Mastering basic operations before tackling complex problems' is strongly supported (Mean 4.38), with 65 respondents agreeing, which indicates the importance of prioritizing and developing the foundational skills in learners.

'Referring to multiple sources for content' received solid endorsement (Mean 4.28), recognizing the importance of enriching instructional materials. 'The use of reference books apart from

textbooks' is supported (Mean 4.13) by the participants, indicating the benefit of supplementary resources. This indicates the need of suggesting various resources for references for mathematics teachers while developing the professional enrichment programme.

'Classroom management skills' received varied assessments, with ratings ranging from (Mean 3.98) to average (Mean 3.69) and needing improvement (Mean 3.75), reflecting the moderate efficiency on managing classroom dynamics which helped the researcher to focus on the teachers' need to work on their classroom management skills.

Overall, the analysis of the data gathered under the dimension- Pedagogy and Methodology related- helped the researcher to get a deeper insight on various methodological and pedagogical practices going on in the schools of secondary level. The researcher understood the need of incorporating the methodological and pedagogical aspects while designing and developing the professional enrichment programme for the teachers, in order to create a supportive learning environment where all students feel capable and valued. Researcher could identify many pedagogical aspects which are very relevant in the present classroom situations. This understanding helped the researcher to incorporate and highlight varied strategies to reinforce learning, in the professional enrichment programme which was focused to develop.

4.1.4 Assessment Practices

This component was included in the questionnaire by the researcher to understand the training needs and other perception of mathematics teachers pertaining to 'Assessment Practices'. The data related to the assessment practices from the sample mathematics teachers were captured through this section of the questionnaire. The analysis and interpretation are presented below.

Table - 4.3 shows the statements contained under the category 'Assessment Practices' for which the responses recorded, along with the percentage and mean calculation against each statement. This category included 12 statements related the assessment practices in schools

Table - 4.3 Percentage and Mean scores of Responses for Assessment Practices

Assessment Practices:								
Components of the Questionnaire		**Strongly Disagree**	**Disagree**	**Neither Agree nor Disagree**	**Agree**	**Strongly Agree**	**Total Response**	**Mean**
1)	I follow the Assessment patterns strictly as mentioned by CBSE.	0(0%)	3(3 %)	11(10 %)	62(55 %)	36(32%)	112	4.17
2)	Apart from the Periodic Tests mentioned by CBSE, I take class tests after each lesson.	0(0 %)	4(4 %)	13(12 %)	63(56 %)	32(29 %)	112	4.20
3)	I conduct diagnostic tests.	0(0 %)	7(6 %)	28(25 %)	61 (54 %)	16(14 %)	112	3.77
4)	I conduct remedial classes for the needy learners	0(0 %)	2(2 %)	6(5 %)	64(57 %)	40(36 %)	112	4.27
5)	I find improvement in learners after providing the remedial classes.	0(0 %)	2(2 %)	4(4 %)	75(67 %)	31(28 %)	112	4.21
6)	I change my teaching style after seeing the students' performance score to make it more impactful.	0(0 %)	4(4 %)	3(3 %)	67(60 %)	38(34 %)	112	4.24
7)	I think the multiple modes of assessment, rather than the unique test pattern need to be encouraged	0(0 %)	4(4 %)	8(7 %)	63(56 %)	37(33 %)	112	4.19
8)	**Through my assessment pattern, I focus more on**							
	• Evaluating conceptual understanding	0(0 %)	0(0 %)	2(2 %)	60(54 %)	50(45 %)	112	4.43
	• Evaluating the fast computational ability	1(1 %)	13(12 %)	8(7 %)	75 (67 %)	15(13%)	112	3.80
9)	I follow the blue print, when I prepare Question Paper.	1(1 %)	3(3 %)	1(1 %)	42(38 %)	65 (58 %)	112	4.49
10)	I select items in Question Papers only from Text Books.	21(19 %)	53(47 %)	25(22 %)	10(9 %)	3(3 %)	112	3.71
11)	The existing assessment practices really measure students' learning.	3(3 %)	21(19 %)	39(35 %)	43(38 %)	6(5 %)	112	2.75

The analysis from the above reveals the following:

Participant teachers demonstrated good response to following CBSE assessment patterns, with a mean score of 4.17 indicating overall agreement. The ‘practice of conducting class tests beyond CBSE requirements’ received moderate support (Mean 4.20) highlighting varying opinions on the frequency of assessments. Participant teachers show moderate support for ‘diagnostic tests (Mean 3.77), indicating the scope for improvement in implementing diagnostic assessment. The ‘provision of remedial classes’ garnered strong support (Mean 4.27) with high agreement (64 respondents) indicating widespread belief in the practice. Participant teachers exhibited ‘proactive behavior in adapting teaching styles based on assessment data’ (Mean 4.24). Strong agreement (67 respondents) signified a consensus on the importance of personalized instructional approaches tailored to student performance.

There is clear support for ‘diversifying assessment modes’ (Mean 4.19) which is reflected in high agreement (63 respondents). This underscores a shared belief in the benefits of varied assessment methods for capturing comprehensive student learning. Assessment practices strongly prioritized ‘evaluating conceptual understanding’ (Mean 4.43), with high agreement (60 respondents) of the participants. This indicates a collective emphasis on assessing deeper learning outcomes over superficial knowledge. Assessing fast computational ability received moderate support (Mean 3.80). These responses reveal varied opinions with significant agreement (75 respondents). This suggests the differing views on the importance of this skill related to other educational objectives.

The ‘use of blueprints in question paper preparation’ is highly endorsed (Mean 4.49) by the participant teachers. This indicates the perceived importance of structured assessment frameworks for maintaining fairness and consistency. There is moderate agreement (Mean 3.71) regarding ‘the exclusive use of textbook items in question papers. Perceptions on ‘the effectiveness of current assessment practices’ are mixed (Mean 2.75), with responses reflecting variability in agreement levels.

The interpretation of these data points out that, there is a strong need for prioritizing conceptual understanding in assessments, indicating a consensus on evaluating deeper learning outcomes. This is closely followed by widespread agreement on the use of blueprints in question paper preparation, highlighting participant teachers' endorsement of structured assessment framework.

Further insights highlighted mixed opinions on the effectiveness of current assessment practices, suggesting opportunities for refinement and improvement in aligning assessment strategies with educational objectives. With this understanding, the researcher focused to incorporate few assessment practices in the professional enrichment programme with an expectation of, teachers implementing the same in the classrooms.

4.1.5 Technology Integration Practices

The 'Technology Integrated Practices' is included as a strong component in the questionnaire by the researcher with an aim to identify the training needs of teachers on this component. The data captured under this dimension were quantitative in nature and the analysis was done using the percentage and mean score calculations.

Table-4.4 shows the statements contained under the category 'Technology Integrated Practices', for which the responses are integrated and the percentage and mean calculation are shown against each statement. The category included 8 statements describing the technology integrated practices.

Table - 4.4 Percentage and Mean scores of Responses for Technology Integration Practices

Technology Integration Practices:								
Component of the Questionnaire		**Strongly Disagree**	**Disagree**	**Neither Agree nor Disagree**	**Agree**	**Strongly Agree**	**Total Response**	**Mean**
1)	**I use the following technology integrated teaching – learning facilities in class rooms.**							
	Computers with internet connection	2(2 %)	14(13 %)	11(10 %)	69(62 %)	16(14 %)	112	3.74
	Digital classrooms	2(2 %)	10(9 %)	9(8 %)	61(54 %)	30(27 %)	112	3.96
	E-learning facility	3(3 %)	16(14 %)	13(12 %)	71 (63 %)	9(8 %)	112	3.60
2)	**I use the technology for Mathematics teaching – learning.**							
	Every period	6(5 %)	78 (70 %)	9(8 %)	14(13 %)	5(4 %)	112	2.41
	Once or Twice in a week	2(2 %)	20(18 %)	4(4 %)	70 (71 %)	7(6 %)	112	3.62
	Once in a month	4(4 %)	74 (66 %)	16(14 %)	14(13 %)	4(4 %)	112	2.46
	As per the demand of lessons / topics.	1(1 %)	3(3 %)	5(4 %)	69 (62 %)	34(30 %)	112	4.18

3)	My school has technology aided Mathematics laboratory.	4(4 %)	23(21%)	15(13 %)	47 (42%)	23(21 %)	112	3.55
4)	**I use technology integrated Mathematics lab:**							
	Every period	10(9 %)	87(78 %)	10(9 %)	5(4 %)	0(0 %)	112	2.09
	Once or Twice in a week	5(5 %)	15(13 %)	8(7 %)	80 (71 %)	4(4 %)	112	3.56
	Once in a month	5(5 %)	11(10 %)	10(9 %)	80(71 %)	6(5 %)	112	3.63
	As per the demand of lessons / topics.	4(4 %)	6(5 %)	2(2 %)	69 (61 %)	31(28 %)	112	4.04
5)	I prepare my lecture notes using power point presentation and supplement it with detailed explanation on the board.	1(1 %)	35(31 %)	30(27 %)	33 (29 %)	13(12 %)	112	3.20
6)	I use Mathematical software like Mathematica, MATLAB, etc., specially developed for better understanding / visualization of the Mathematical concepts.	1(1 %)	28(25 %)	16(14 %)	53 (47 %)	14(13 %)	112	3.46
7)	I make students aware about the available teaching aids on the web and use such aids some time in my class.	1(1 %)	16(14 %)	13(12 %)	73 (65 %)	9(8 %)	112	3.65
8)	I find technology integrated learning more effective than normal teaching – learning practice	1(1 %)	9(8 %)	28(25 %)	56 (50 %)	18(16 %)	112	3.72

While examining the ‘integration of technology’ in educational practices, several key findings emerged.

The mean score for using computers with internet connection in classrooms is 3.74. This indicates a moderate level of integration of technology. Digital classrooms have a mean score of 3.96, reflecting a relatively higher integration level. E-learning facilities scored a mean of 3.60, showing moderate use. The analysis of Frequency of Technology use for mathematics teachers revealed that the teachers’ preference to it, is as per the ‘Demand of Lessons/Topics’. This has a higher mean score of 4.18, indicating flexibility and situational approach in technology use

according to lesson requirements. The mean score for 'Technology aided Mathematics Laboratory' is 3.55, suggesting a moderate presence of technology in mathematics laboratories. Use of 'Power Point Presentations for Lecture Notes' has a mean score is 3.20, indicating its moderate use.

The analysis of technology integration practices as a whole, revealed the following areas of focus while developing the professional enrichment programme:

- Increased Utilization of Digital Classrooms and E-Learning Facilities: With mean scores of 3.96 and 3.60 respectively, there is a clear preference and need for expanding the use of digital classrooms and e-learning
- Promotion of Specialized Mathematical Software: With a mean score of 3.46, increasing the use of software like 'Mathematica' and 'MATLAB' can enhance understanding and visualization of mathematical concepts.
- Enhancing Awareness and Use of Web-Based Teaching Aids: The mean score of 3.65 suggests promoting and training on various online teaching aids to supplement classroom teaching.
- Perception and Effectiveness of Technology-Integrated Learning: A high mean score of 3.72 shows a moderate perception, underscoring the need for further integration and training on technology-enhanced learning methods.
- Addressing Infrequent Use of Technology in Daily Teaching: The low mean scores for daily and weekly use of technology (2.41 and 3.62) indicate the need for strategies to incorporate technology more regularly in teaching practices.

Overall, respondents exhibited a strong positive perception of technology-integrated learning, highlighting its perceived effectiveness in enhancing teaching and learning experiences. Digital classrooms are widely embraced, indicating a significant preference for interactive and digitally enriched learning environments. Awareness and occasional use of web-based teaching aids are also notably high among Participant teachers, underscoring their recognized value in supplementing traditional teaching methods. Additionally, there is a clear emphasis on adapting technology use based on lesson demands, reflecting a flexible approach to leveraging technological tools for instructional purposes. However, challenges persist in achieving

consistent utilization, as seen in lower scores for daily and weekly technology use in mathematics teaching. Addressing these discrepancies is crucial for optimizing technology's potential in fostering comprehensive and engaging educational practices.

The analysis and its findings in this dimension helped the researcher to identify the strong need for the technology integration in the teaching- learning process of mathematics and hence it was taken into consideration while developing the professional enrichment programme.

4.1.6 Familiarity with Various Policies and Relevant Resources

This dimension was included in the questionnaire by the researcher with an aim to understand whether there is a need to incorporate any policy matter or recommendations in the programme which was to be developed for the mathematics teachers. The data captured with this purpose was analyzed and interpretation of the same is presented below.

Table - 4.5 shows the statements contained under the category 'Familiarity with Various Policies and Relevant Documents' for which the responses are recorded along with the percentage and mean calculation against each statement. This category included 10 statements related to the teachers' familiarity with various education policies.

Table - 4.5 Percentage and Mean scores of Responses for Familiarity with Various Policies and Relevant Resources

Indicate your familiarity with each of the following:		No such Document	Not Familiar at all	Not much Familiar	Somewhat Familiar	Very Familiar	Total Response	Mean
1)	State Education Department Curriculum Guide / Manual.	3(3 %)	22(20 %)	26(23 %)	48 (42%)	13(12 %)	112	2.59
2)	State Education Department Assessment Specifications.	3(3 %)	19(17 %)	24(21 %)	50(45 %)	16(14 %)	112	2.49
3)	Central Board of Secondary Education (CBSE) Curriculum Guide / Manual.	1(1 %)	1(1 %)	6(5 %)	37(33 %)	67(60 %)	112	1.50
4)	CBSE Assessment pattern.	1(1 %)	1(1 %)	4(4 %)	26(23 %)	80 (71 %)	112	1.37
5)	CBSE Manual on Expected Learning outcomes of teaching Mathematics at Secondary level.	1(1 %)	3(3 %)	9(8 %)	42(37 %)	57 (51 %)	112	1.65
6)	'Position Paper' on Teaching of Mathematics by National Focus Group, NCERT.	1(1 %)	22(20 %)	41 (36 %)	25(22 %)	23(21 %)	112	2.58

7)	NCF (National Curriculum Framework), 2005-Recommendations on Teaching Mathematics.	1(1%)	11(10 %)	27(24 %)	44 (39 %)	29(26 %)	112	2.21
8)	Different modules / guidelines on effective teaching of Mathematics.	0(0%)	6(5 %)	15(13 %)	70 (63 %)	21(19 %)	112	2.05
9)	National Council of Teachers of Mathematics (NCTM) Professional Standards for Teaching Mathematics.	0(0 %)	14(13 %)	37(33%)	51(45 %)	10(9 %)	112	2.49
10)	The National Assessment for Educational Progress (NAEP) Assessment Frameworks / Specifications.	0(0 %)	25(22 %)	47(42%)	34(31 %)	6(5 %)	112	2.81

From the above analysis the researcher could identify the following:

The mean score of the familiarity for the 'State Education Department Curriculum Guide / Manual' is 2.59, indicating a moderate level of familiarity among respondents. With a mean score of 2.49, the 'State Education Department Assessment Specifications' exhibit a similar trend of moderate familiarity.

The 'CBSE Curriculum Guide / Manual' has a lower mean score of 1.50, reflecting a lack of familiarity of the same with majority of the respondents. The familiarity with the 'CBSE Assessment Pattern' is notably low, with a mean score of 1.37. CBSE Manual on 'Expected Learning Outcomes' has a mean score of 1.65, indicating relatively low familiarity.

The 'Position Paper' by NCERT shows a mean score of 2.58, reflecting moderate familiarity. The 'NCF Recommendations on Teaching Mathematics' have a mean score of 2.21, suggesting the need for enhanced exposure and understanding of these recommendations. The familiarity with 'various modules and guidelines on effective teaching of mathematics' and 'NCTM Professional Standards' also are relatively low, with mean scores of 2.05 and 2.49 respectively.

The 'NAEP Assessment Frameworks' has the highest mean score of 2.81 indicating the highest familiarity among respondents.

The analysis revealed varying levels of familiarity with key educational documents among respondents. To improve overall familiarity and usage, the researcher understood the need of efforts to be put on:

- Enhancing the dissemination and integration of CBSE Curriculum Guide/Manual and Assessment Pattern into teaching practices.
- Increasing awareness and understanding of the CBSE Manual on Expected Learning Outcomes and the 'Position Paper' by NCERT.
- Promoting the utilization of various modules/guidelines on effective teaching of mathematics.

Analysis of the data under this dimension helped the researcher to understand the areas where further education and outreach efforts could enhance understanding and implementation of the relevant documents in the process of teaching- learning of mathematics. Overall, these findings underscore the importance of targeted strategies to enhance awareness and integration of educational frameworks and standards into teaching practices, ensuring the required awareness among mathematics teachers, in order to enhance the quality mathematics teaching. Analysis and the interpretation of the data gathered under this dimension lead the researcher with an understanding of the policy matters and recommendations mainly of NEP-2020 and other relevant documents to be familiarized for mathematics teachers by incorporating them in the enrichment programme while developing the same for the teachers of secondary mathematics.

4.1.7 Content Related

The researcher divided this dimension of the questionnaire- Content Related- into two parts. In Part-1, the researcher wanted to understand the overall proficiency of various topics of mathematics included in the CBSE curriculum developed by NCERT where as in Part-2, the researcher aimed to find out the difficulties of secondary mathematics teachers while teaching in Class IX and Class X and the training needs of the teachers in secondary section.

Part-1 of the 'Content Related' dimension included 15 statements describing the proficiency of teaching mathematics on various important concepts. The second part of this dimension – Content Related- included statements to understand the difficulty level of teaching various topics of Class IX and X, covering all the chapters of NCERT syllabus of these two secondary classes.

Table - 4.6 Percentage and Mean scores of Responses for Content Related (Part-1)

Content Related:								
1. How much proficiency you have to teach the below topics for any class up to 10 ?:								
Component of the Questionnaire		**I do not teach these topics**	**Needs Preparation**	**Not well confident**	**Somewhat confident**	**Very well confident**	**Total Responses**	**Mean**
1)	Fractions, Decimals and Percentages	5(4 %)	0(0 %)	3(3 %)	40 (36 %)	64 (57 %)	112	1.59
2)	Ratios and Proportions	5(4 %)	0(0 %)	1(1 %)	6(5 %)	100 (90 %)	112	1.25
3)	Number Systems	1(1 %)	1(1 %)	1(1 %)	5(4 %)	104 (93 %)	112	1.13
4)	Measurement – Units, Instruments and Accuracy	4(4 %)	1(1 %)	2(2 %)	10(9 %)	95 (85 %)	112	1.29
5)	Perimeter, Area and Volume	0(0 %)	1(1 %)	0(0 %)	5(4 %)	106 (95 %)	112	1.07
6)	Geometric Figures – Definitions and Properties	0(0 %)	1(1 %)	1(1 %)	13(12 %)	97 (87 %)	112	1.16
7)	Geometric Figures – Symmetry, Motions and Transformations, Congruence and Similarity	0(0 %)	2(2 %)	2(2 %)	25(22 %)	83 (74 %)	112	1.31
8)	Coordinate Geometry	0(0 %)	0(0 %)	1(1 %)	5(4 %)	106 (95 %)	112	1.06
9)	Algebraic Representation	0(0 %)	0(0 %)	0(0 %)	11(10 %)	101 (90 %)	112	1.10
10)	Evaluate and Perform Operations on Algebraic Expressions	0(0 %)	0(0 %)	1(1 %)	9(8 %)	102 (91 %)	112	1.10
11)	Solving Linear Equations, Inequalities and Quadratic Equations	0(0 %)	1(1 %)	0(0 %)	12(11 %)	99 (88 %)	112	1.13
12)	Representation and Interpretation of Data in Graphs, Charts and Tables	0(0 %)	0(0 %)	1(1 %)	6(5 %)	105(94 %)	112	1.07
13)	Simple Probabilities – Understanding and Calculations	0(0 %)	0(0 %)	0(0 %)	8(7 %)	104 (93 %)	112	1.07
14)	Introduction to Trigonometry	0(0 %)	2(2 %)	1(1 %)	13(12 %)	96 (86 %)	112	1.19
15)	Theorems and Proofs	0(0 %)	4(4 %)	3(3 %)	25(22 %)	80 (71%)	112	1.38

The analysis of the above quantitative data and its interpretations in terms of percentage and mean scores highlight varying levels of understanding and confidence among teachers in teaching different mathematics concepts across the curriculum. Key areas which the researcher could identify to focus on are:

- Enhancing Coverage- Ensuring comprehensive coverage across all Mathematics topics to minimize gaps in instructional delivery.
- Support for Preparation- Providing resources and support for Participant teachers to enhance readiness in teaching diverse Mathematics concepts.
- Continuous Professional Development and Enrichment Programmes- Offering ongoing training and professional development opportunities to strengthen the instructional practices and confidence.

This interpretation helped the researcher to identify the above focus areas while developing the enrichment programme for the teachers.

Table - 4.7 Percentage and Mean Scores of Responses for the Difficulty Level of Class-IX Content (Part-2)

(VD- Very Difficult, D-Difficult, ND/NE- Not Difficult Not Easy, E-Easy & VE-Very Easy

Sr. No.	Area of Teaching / Topics		VD (5) No.of resp.(%)	D (4) No.of resp.(%)	ND/NE (3) No.of resp.(%)	E (2) No.of resp.(%)	VE (1) No.of resp.(%)	Blank No.of resp.(%)	Total Resp.	Mean
CLASS: IX										
01.	**NUMBER SYSTEMS**									
	1.	Irrational Numbers	27(24.11%)	23(20.54%)	17(15.18%)	17(15.18%)	19(16.96%)	9(8.04%)	112	2.96
	2.	Real Numbers and their Decimal Expansions	23(20.54%)	17(15.18%)	21(18.75%)	19(16.96%)	29(25.89%)	3(2.68%)	112	2.79
	3.	Representing Real Numbers on the Number Line	25(22.32%)	20(17.86%)	19(16.96%)	29(25.89%)	17(15.18%)	2(1.79%)	112	3.01
	4.	Operations on Real Numbers	21(18.75%)	27(24.11%)	19(16.96%)	18(16.07%)	21(18.75%)	6(5.36%)	112	2.92
	5.	Laws of Exponents for Real Numbers	22(19.64%)	26(23.21%)	16(14.29)	20(17.86%)	20(17.86%)	8(7.14%)	112	2.88
02.	**POLYNOMIALS**									
	1.	Polynomials in One Variable	0(0%)	0(0%)	12(10.71%)	36(32.14%)	58(51.79%)	6(5.36%)	112	1.48
	2.	Zeroes of a Polynomial	0(0%)	1(0.89%)	17(15.18%)	43(38.39%)	45(40.18%)	6(5.36%)	112	1.66
	3.	Remainder Theorem	0(0%)	2(1.79%)	27(24.11%)	38(33.93%)	38(33.93%)	7(6.25%)	112	1.81
	4.	Factorization of Polynomials	1(0.89%)	14(12.5%)	25(22.32%)	29(25.89%)	37(33.04%)	6(5.36%)	112	2.06
	5.	Algebraic Identities	1(0.89%)	9(8.04%)	19(16.96%)	39(34.82%)	38(33.93%)	6(5.36%)	112	1.91

03.	**COORDINATE GEOMETRY**									
	1.	Cartesian System	0(0%)	1(0.89%)	9(8.04%)	34(30.36%)	62(55.36%)	6(5.36%)	112	1.44
	2.	Plotting a Point in the Plane if its Coordinates are given.	0(0%)	0(0%)	10(8.93%)	29(25.89%)	67(59.82%)	6(5.36%)	112	1.38
04.	**LINEAR EQUATIONS IN TWO VARIABLES**									
	1.	Linear Equations	0(0%)	0(0%)	13(11.61%)	41(36.61%)	53(47.32%)	5(4.46%)	112	1.55
	2.	Solution of a Linear Equation	0(0%)	1(0.89%)	10(8.93%)	43(38.39%)	53(47.32%)	5(4.46%)	112	1.54
	3.	Graph of a Linear Equation in Two Variables	0(0%)	2(1.79%)	19(16.96%)	38(33.93%)	48(42.86%)	5(4.46%)	112	1.69
	4.	Equations of Lines Parallel to x-axis and y-axis	1(0.89%)	0(0%)	17(15.18%)	44(39.29%)	45(40.18%)	5(4.46%)	112	1.69
05.	**INTRODUCTION TO EUCLID'S GEOMETRY**									
	1.	Euclid's Definitions, Axioms and Postulates	1(0.89%)	10(8.93%)	28(25%)	42(37.5%)	26(23.21%)	5(4.46%)	112	2.13
	2.	Equivalent Versions of Euclid's Fifth Postulate	3(2.68%)	10(8.93%)	31(27.68%)	39(34.82%)	24(21.43%)	5(4.46%)	112	2.23
06.	**LINES AND ANGLES**									
	1.	Basic Terms and Definitions	0(0%)	6(5.36%)	8(7.14%)	39(34.82%)	53(47.32%)	6(5.36%)	112	1.60
	2.	Intersecting Lines and Non-intersecting Lines	0(0%)	6(5.36%)	7(6.25%)	42(37.5%)	51(45.54%)	6(5.36%)	112	1.61
	3.	Pairs of Angles	0(0%)	6(5.36%)	19(16.96%)	31(27.68%)	48(42.86%)	8(7.14%)	112	1.71
	4.	Parallel Lines and a Transversal	0(0%)	7(6.25%)	11(9.82%)	40(35.71%)	48(42.86%)	6(5.36%)	112	1.69
	5.	Lines Parallel to the same Line	0(0%)	7(6.25%)	11(9.82%)	41(36.61%)	47(41.96%)	6(5.36%)	112	1.70
	6.	Angle Sum Property of a Triangle	0(0%)	7(6.25%)	5(4.46%)	43(38.39%)	51(45.54%)	6(5.36%)	112	1.61
07.	**TRIANGLES**									
	1.	Congruence of Triangles	22(19.64%)	20(17.86%)	21(18.75%)	25(22.32%)	18(16.07%)	6(5.36)	112	2.87
	2.	Criteria for Congruence of Triangles	23(20.54%)	22(19.64%)	21(18.75%)	25(22.32%)	15(13.39%)	6(5.36)	112	2.96
	3.	Some Properties of a Triangle	24(21.43%)	23(20.54%)	23(20.54%)	25(22.32%)	15(13.39%)	2(1.79)	112	3.09
	4.	Some More Criteria for Congruence of Triangles	21(18.75%)	21(18.75%)	21(18.75%)	25(22.32%)	18(16.07%)	6(5.36)	112	2.86
	5.	Inequalities in a Triangle	20(17.86%)	25(22.32%)	20(17.86%)	25(22.32%)	16(14.29%)	6(5.36)	112	2.91

08.	**QUADRILATERALS**									
	1.	Angle Sum Property of a Quadrilateral	0(0%)	5(4.46%)	15(13.39%)	42(37.5%)	44(39.29%)	6(5.36%)	112	1.72
	2.	Types of Quadrilaterals	0(0%)	7(6.25%)	13(11.61%)	44(39.29%)	42(37.5%)	6(5.36%)	112	1.76
	3.	Properties of a Parallelogram	0(0%)	10(8.93%)	13(11.61%)	45(40.18%)	38(33.93%)	6(5.36%)	112	1.85
	4.	Another Condition for a Quadrilateral to be a Parallelogram	0(0%)	11(9.82%)	18(16.07%)	46(41.07%)	31(27.68%)	6(5.36%)	112	1.97
	5.	The Mid-Point Theorem	0(0%)	8(7.14%)	24(21.43%)	45(40.18%)	28(25%)	7(6.25%)	112	1.98
09.	**AREAS OF PARALLELOGRAMS AND TRIANGLES**									
	1.	Figures on the same Base and between the same Parallels	0(0%)	6(5.36%)	21(18.75%)	52(46.43%)	27(24.11%)	6(5.36%)	112	1.95
	2.	Parallelograms on the same Base and between the same Parallels.	1(0.89%)	5(4.46%)	22(19.64%)	52(46.43%)	26(23.21%)	6(5.36%)	112	1.97
	3.	Triangles on the same Base and between the same Parallels.	1(0.89%)	6(5.36%)	21(18.75%)	49(43.75%)	29(25.89%)	6(5.36%)	112	1.96
10.	**CIRCLES**									
	1.	Circles and its Related Terms: A Review	0(0%)	9(8.04%)	15(13.39%)	43(38.39%)	39(34.82%)	6(5.36%)	112	1.84
	2.	Angle Subtended by a Chord at a Point	0(0%)	13(11.61%)	17(15.18%)	45(40.18%)	31(27.68%)	6(5.36%)	112	2.00
	3.	Perpendicular from the Centre to a Chord	0(0%)	12(10.71%)	17(15.18%)	40(35.71%)	35(31.25%)	8(7.14%)	112	1.91
	4.	Circle through Three Points	0(0%)	17(15.18%)	25(22.32%)	36(32.14%)	28(25%)	6(5.36%)	112	2.17
	5.	Equal Chords and their Distances from the Centre	1(0.89%)	14(12.5%)	22(19.64%)	39(34.82%)	30(26.79%)	6(5.36%)	112	2.10
	6.	Angle Subtended by an Arc of a Circle	1(0.89%)	15(13.39%)	25(22.32%)	38(33.93%)	27(24.11%)	6(5.36%)	112	2.17
	7.	Cyclic Quadrilaterals	0(0%)	12(10.71%)	15(13.39%)	48(42.86%)	31(27.68%)	6(5.36%)	112	1.96
11.	**CONSTRUCTIONS**									
	1.	Basic Constructions	0(0%)	0(0%)	23(20.54%)	39(34.82%)	44(39.29%)	6(5.36%)	112	1.71
	2.	Some Constructions of Triangles	0(0%)	3(2.68%)	28(25%)	37(33.04%)	38(33.93%)	6(5.36%)	112	1.86
12.	**HERON'S FORMULA**									
	1.	Area of a Triangle – by Heron's Formula	0(0%)	1(0.89%)	13(11.61%)	42(37.5%)	51(45.54%)	5(4.46%)	112	1.59

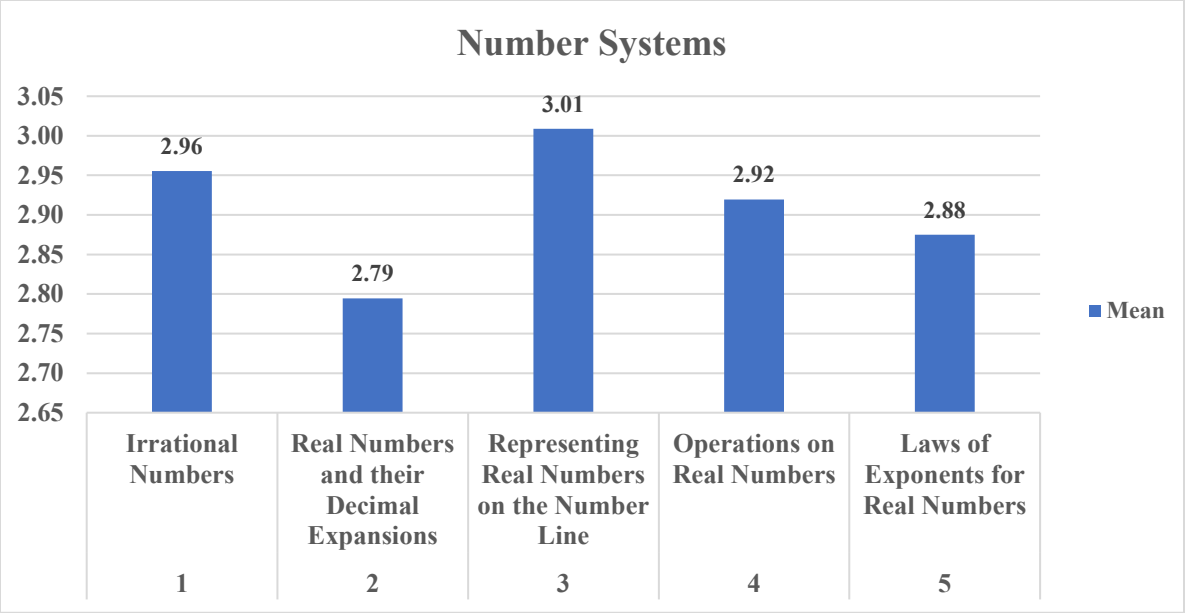
	2.	Application of Heron's Formula in finding Areas of Quadrilaterals	0(0%)	2(1.79%)	13(11.61%)	48(42.86%)	44(39.29%)	5(4.46%)	112	1.67
13.	**SURFACE AREAS AND VOLUMES**									
	1.	Surface Area of a Cuboid and a Cude	2(1.79%)	3(2.68%)	12(10.71%)	43(38.39%)	46(41.07%)	6(5.36%)	112	1.70
	2.	Surface Area of a Right Circular Cylinder	2(1.79%)	4(3.57%)	13(11.61%)	43(38.39%)	44(39.29%)	6(5.36%)	112	1.74
	3.	Surface Area of a Right Circular Cone	2(1.79%)	4(3.57%)	13(11.61%)	46(41.07%)	40(35.71%)	7(6.25%)	112	1.76
	4.	Surface Area of a Sphere	2(1.79%)	6(5.36%)	13(11.61%)	47(41.96%)	38(33.93%)	6(5.36%)	112	1.83
	5.	Volume of a Cuboid	2(1.79)	4(3.57%)	20(17.86%)	38(33.93%)	42(37.5%)	6(5.36%)	112	1.82
	6.	Volume of a Cylinder	2(1.79%)	4(3.57%)	20(17.86%)	38(33.93%)	42(37.50%)	6(5.36%)	112	1.82
	7.	Volume of a Right Circular Cone	2(1.79%)	11(9.82%)	15(13.39%)	41(36.61%)	37(33.04%)	6(5.36%)	112	1.95
	8.	Volume of a Sphere	2(1.79%)	10(8.93%)	14(12.50%)	41(36.61%)	39(34.82%)	6(5.36%)	112	1.90
14.	**STATISTICS**									
	1.	Collection of Data	0(0.00%)	0(0.00%)	10(8.93%)	49(43.75%)	47(41.96%)	6(5.36%)	112	1.56
	2.	Presentation of Data	0(0.00%)	1(0.89%)	10(8.93%)	45(40.18%)	50(44.64%)	6(5.36%)	112	1.55
	3.	Geographical Representation of Data	1(0.89%)	0(0.00%)	15(13.39%)	46(41.07%)	44(39.29%)	6(5.36%)	112	1.66
	4.	Measures of Central Tendency	1(0.89%)	1(0.89%)	18(16.07%)	43(38.39%)	43(38.39%)	6(5.36%)	112	1.71
15.	**PROBABILITY**									
	1.	Probability – an Experimental Approach	0(0.00%)	2(1.79%)	14(12.50%)	44(39.29%)	45(40.18%)	7(6.25%)	112	1.63

The graphical representations of the data integrated and presented above, on the content related dimension of NCERT syllabus of class -IX in the questionnaire and the analysis and interpretation of the same are presented below.

4.1.7.1 NUMBER SYSTEMS

The following graph shows the graphical representation of the mean scores of responses against each statement under the content: **Number Systems** of NCERT syllabus of class -IX

Graph - 4.9 Mean Scores of Responses to the Statements of the Chapter-Number Systems, under the Category of Content Related to Class –IX



The topic of 'Irrational Numbers' of the chapter NUMBER SYSTM has a mean difficulty score of 2.96, indicating that respondents generally find it as difficult. A significant portion of respondents (24.11%) rated it as Very Difficult, but Overall, while the topic is perceived as somewhat challenging by majority, a notable number of respondents find it relatively easy also.

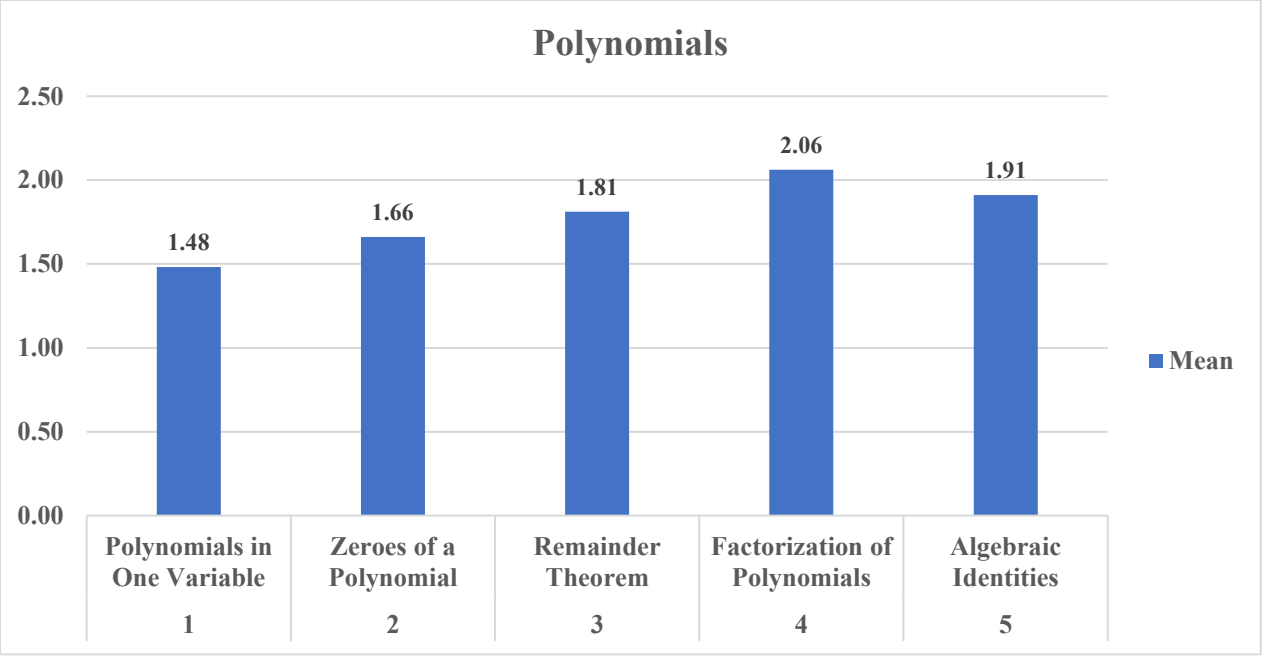
With a mean score of 2.79, the topic of 'Real Numbers and their Decimal Expansions' is perceived as slightly easier compared to Irrational Numbers. 'Representing Real Numbers on the Number Line' has the highest mean score of 3.01, indicating it is perceived as the most challenging among the topics.

The topic 'Operations on Real Numbers' has a mean difficulty score of 2.92, reflecting a moderate level of difficulty. 'Laws of Exponents for Real Numbers' has a mean score of 2.88, showing that respondents perceive it as moderately difficult.

4.1.7.2 POLYNOMIALS

The following graph shows the graphical representation of the mean scores of responses against each statement under the content: **Polynomials** of NCERT syllabus of class -IX

Graph - 4.10 Mean Scores of Responses to the Statements of the Chapter-Polynomials, under the Category of Content Related to Class –IX

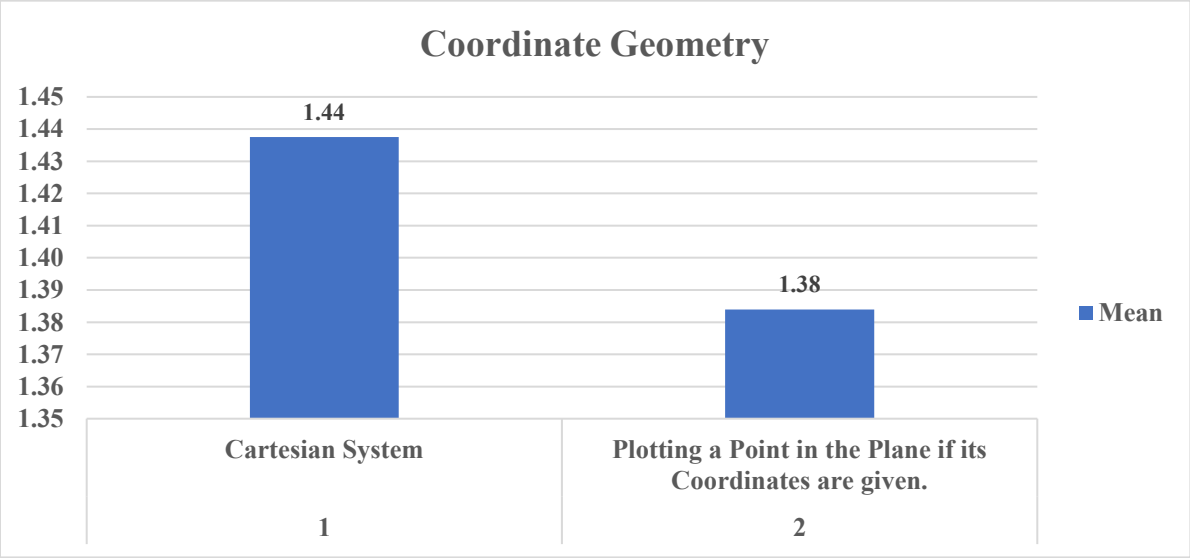


The topic of 'Polynomials in One Variable' has a mean difficulty score of 1.48, indicating that respondents generally find it to be very easy. 'Zeroes of a Polynomial' has a mean score of 1.66, reflecting that it is perceived as slightly more challenging than 'Polynomials in One Variable', yet still relatively easy. The topic of 'Remainder Theorem' has a mean score of 1.81, suggesting it is viewed as moderately easy. No respondents rated it as Very Difficult. The topic of 'Factorization of Polynomials' has a mean score of 2.06, reflecting a moderate level of difficulty compared to the other topics. The topic of 'Algebraic Identities' has a mean difficulty score of 1.91, indicating a moderate level of difficulty. Only 0.89% of respondents rated it as Very Difficult, and a large number of respondents still find the topic easy.

4.1.7.3 COORDINATE GEOMETRY

The following graph shows the graphical representation of the mean scores of responses against each statement under the content: **Polynomials** of NCERT syllabus of class -IX

Graph - 4.11 Mean Scores of Responses to the Statements of the Chapter-Coordinate Geometry, under the Category of Content Related to Class –IX

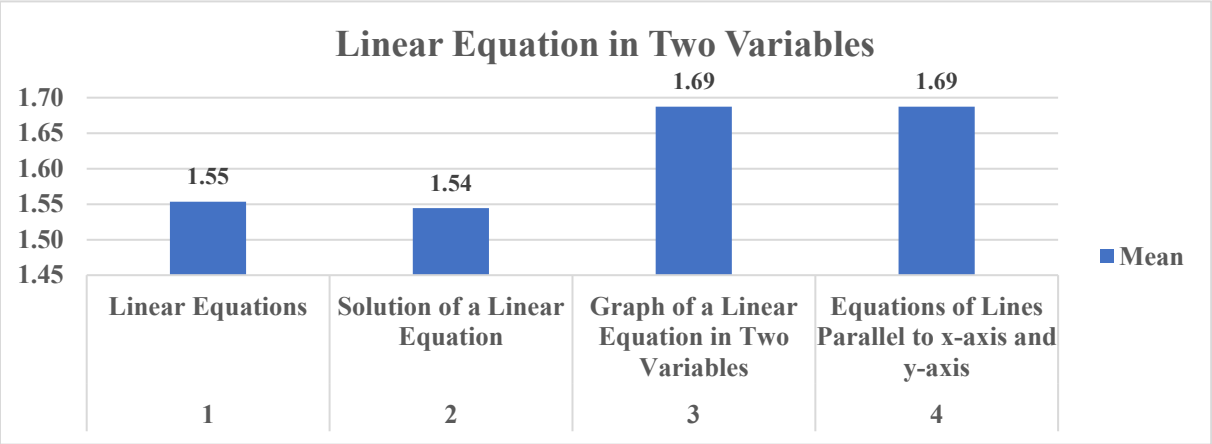


The topic of Cartesian System has a mean difficulty score of 1.44, indicating that it is perceived as very easy by the respondents. Notably, none of the respondents rated this topic as Very Difficult. Plotting a Point in the Plane if its Coordinates are given has a mean score of 1.38, reflecting that it is perceived as the easiest topic among the ones listed.

4.1.7.4 LINEAR EQUATIONS IN TWO VARIABLES

The following graph shows the graphical representation of the mean scores of responses against each statement under the content: **Linear Equations in Two Variables** of NCERT syllabus of class -IX

Graph -4.12 Mean Scores of Responses to the Statements of the Chapter-Linear Equations in Two Variables, under the Category of Content Related to Class –IX

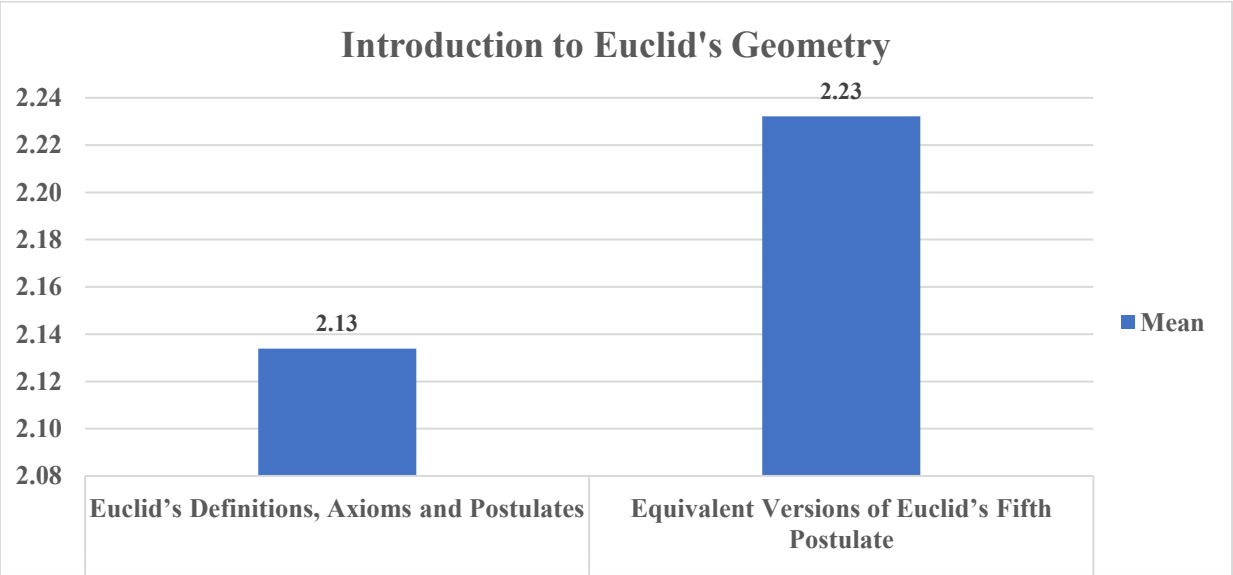


The topic of Linear Equations has a mean difficulty score of 1.55, indicating that it is perceived as very easy by the respondents. None of the respondents rated this topic as Very Difficult or Difficult. Solution of a Linear Equation has a mean score of 1.54, reflecting that it is perceived as very easy, similar to Linear Equations. This indicates that solving a linear equation is seen as a very manageable task by most respondents. The topic of Graph of a Linear Equation in Two Variables has a mean difficulty score of 1.69, suggesting it is still perceived as easy but slightly more challenging compared to the previous topics. Equations of Lines Parallel to X-axis and Y-axis has a mean score of 1.69, similar to the Graph of a Linear Equation in Two Variables. Only 0.89% of respondents rated it as Very Difficult.

4.1.7.5 INTRODUCTION TO EUCLID'S GEOMETRY

The following graph shows the graphical representation of the mean scores of responses against each statement under the content: **Introduction to Euclid's Geometry** of NCERT syllabus of class -IX

Graph - 4.13 Mean Scores of Responses to the Statements of the Chapter-Introduction to Euclid's Geometry, under the Category of Content Related to Class –IX

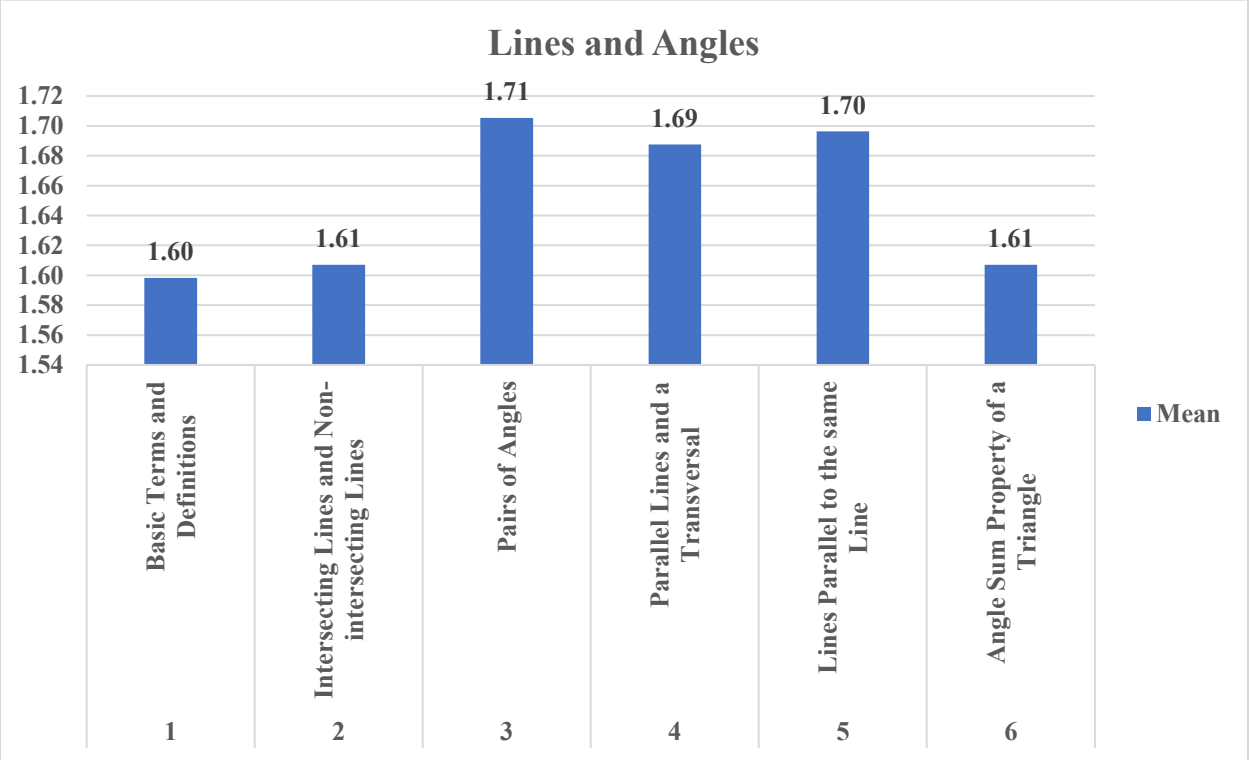


The topic of 'Euclid's Definitions, Axioms, and Postulates' has a mean difficulty score of 2.13, indicating that it is perceived as moderately difficult by the respondents. A very small percentage, 0.89%, rated it as Very Difficult, and 8.93% found it Difficult. This distribution suggests that while many respondents find the topic accessible, there is a notable group that perceives it as moderately challenging'. Equivalent Versions of Euclid's Fifth Postulate' has a mean score of 2.23, reflecting that it is perceived as slightly more challenging than the previous topic.

4.1.7.6 LINES AND ANGLES

The following graph shows the graphical representation of the mean scores of responses against each statement under the content: **Lines and Angles** of NCERT syllabus of class - IX

Graph - 4.14 Mean Scores of Responses to the Statements of the Chapter-Lines and Angles, under the Category of Content Related to Class -IX

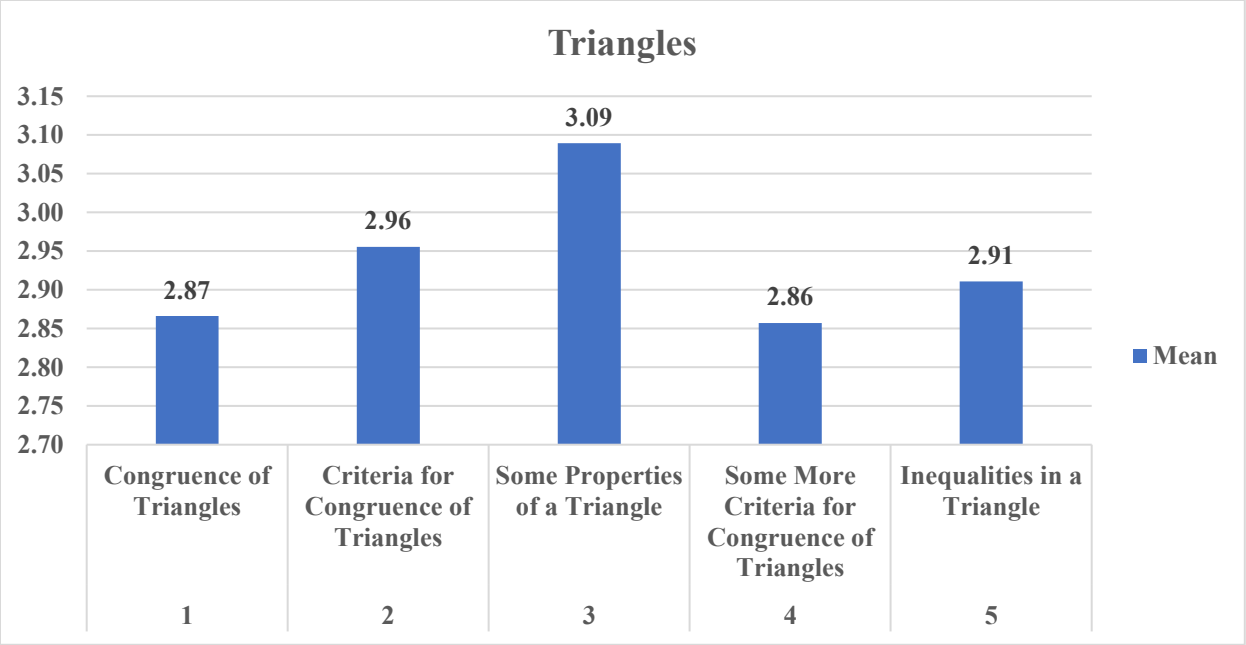


The topic of Basic Terms and Definitions has a mean difficulty score of 1.60, indicating that respondents generally find it to be very easy. Intersecting Lines and Non-intersecting Lines has a mean score of 1.61, reflecting that it is perceived as very easy, similar to Basic Terms and Definitions. None of the respondents rated this topic as Very Difficult. The topic of Pairs of Angles has a mean difficulty score of 1.71, suggesting it is still perceived as easy but slightly more challenging compared to the previous topics Parallel Lines and a Transversal has a mean score of 1.69, indicating it is still perceived as easy but with a minor increase in difficulty. This balanced distribution suggests that while the topic is generally perceived as easy, a small segment of respondents finds it moderately challenging. The topic of Lines Parallel to the Same Line has a mean difficulty score of 1.70, indicating it is perceived as easy. Angle Sum Property of a Triangle has a mean score of 1.61, reflecting that it is perceived as very easy.

4.1.7.7 TRIANGLES

The following graph shows the graphical representation of the mean scores of responses against each statement under the content: **Triangles** of NCERT syllabus of class -IX

Graph - 4.15 Mean Scores of Responses to the Statements of the Chapter-Triangles, under the Category of Content Related to Class –IX



The topic of Congruence of Triangles has a mean difficulty score of 2.87, indicating that respondents find it moderately challenging. A notable portion, 19.64%, rated this topic as Very Difficult, and 17.86% found it Difficult. This distribution suggests that while many respondents find the topic accessible, a significant group perceives it as challenging.

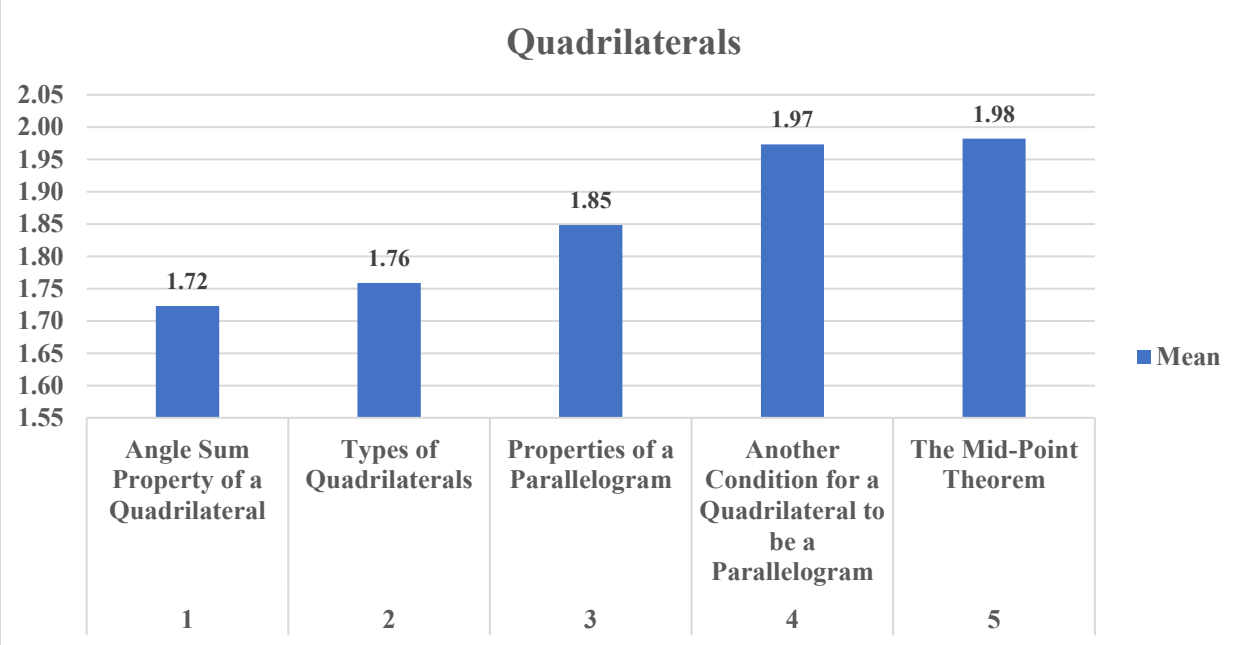
Criteria for Congruence of Triangles has a mean score of 2.96, reflecting that it is perceived as slightly more challenging than Congruence of Triangles. A notable percentage, 20.54%, rated this topic as Very Difficult, and 19.64% found it Difficult. This indicates that the criteria for congruence are seen as more challenging compared to other topics, with a significant portion finding it difficult. The topic of Some Properties of a Triangle has a mean difficulty score of 3.09, suggesting it is perceived as the most challenging among the listed topics. Some More

Criteria for Congruence of Triangles has a mean score of 2.86, indicating it is moderately challenging. 18.75% of respondents rated it as Very Difficult, and the same percentage found it Difficult. Inequalities in a Triangle has a mean difficulty score of 2.91, indicating a moderate level of difficulty. 17.86% of respondents rated it as Very Difficult, and 22.32% found it Difficult. This distribution suggests that inequalities in a triangle are seen as moderately challenging by a significant portion of respondents, with mixed perceptions about its difficulty.

4.1.7.8 QUADRILATERALS

The following graph shows the graphical representation of the mean scores of responses against each statement under the content: **Quadrilaterals** of NCERT syllabus of class -IX

Graph - 4.16 Mean Scores of Responses to the Statements of the Chapter-Quadrilaterals, under the Category of Content Related to Class –IX



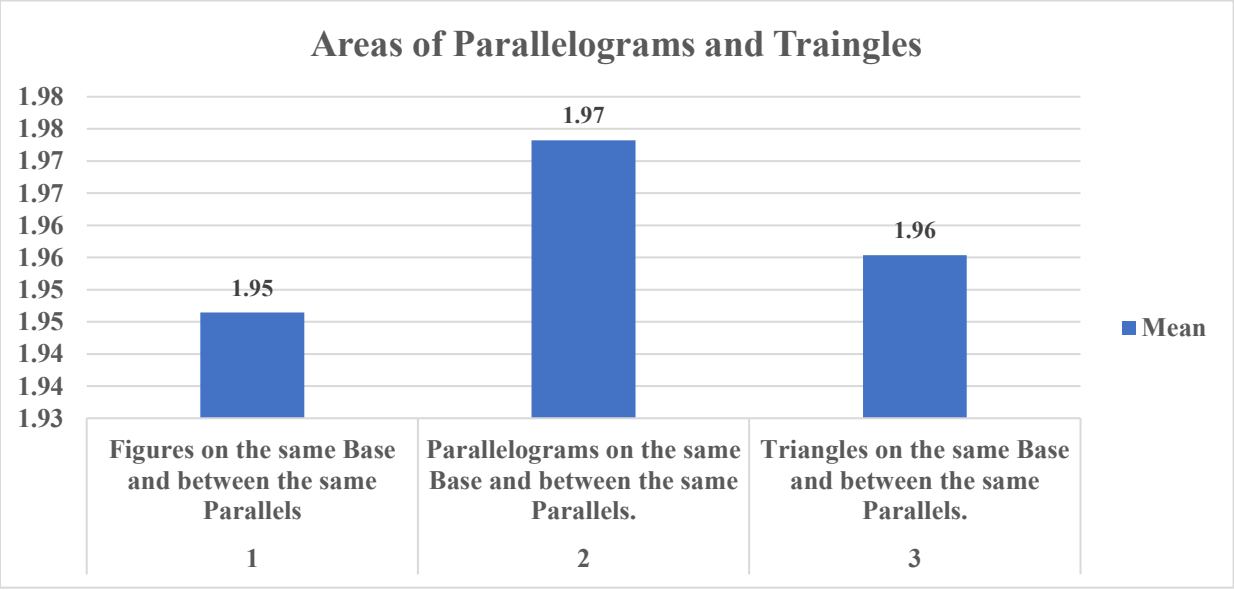
The topic of Angle Sum Property of a Quadrilateral has a mean difficulty score of 1.72, indicating that respondents generally find it to be easy. None of the respondents rated this topic as Very Difficult, and only 4.46% found it Difficult. Types of Quadrilaterals has a mean score of 1.76, reflecting that it is perceived as very easy.

The topic of Properties of a Parallelogram has a mean difficulty score of 1.85, suggesting it is perceived as easy but with a slightly higher level of difficulty compared to the previous topics. Another Condition for a Quadrilateral to be a Parallelogram has a mean score of 1.97, indicating it is perceived as moderately easy. The Mid-Point Theorem has a mean difficulty score of 1.98, suggesting it is perceived as moderately easy.

4.1.7.9 AREAS OF PARALLELOGRAMS AND TRIANGLES

The following graph shows the graphical representation of the mean scores of responses against each statement under the content: **Areas of Parallelograms and Triangles** of NCERT syllabus of class -IX

Graph - 4.17 Mean Scores of Responses to the Statements of the Chapter-Areas of Parallelograms and Triangles, under the Category of Content Related to Class –IX



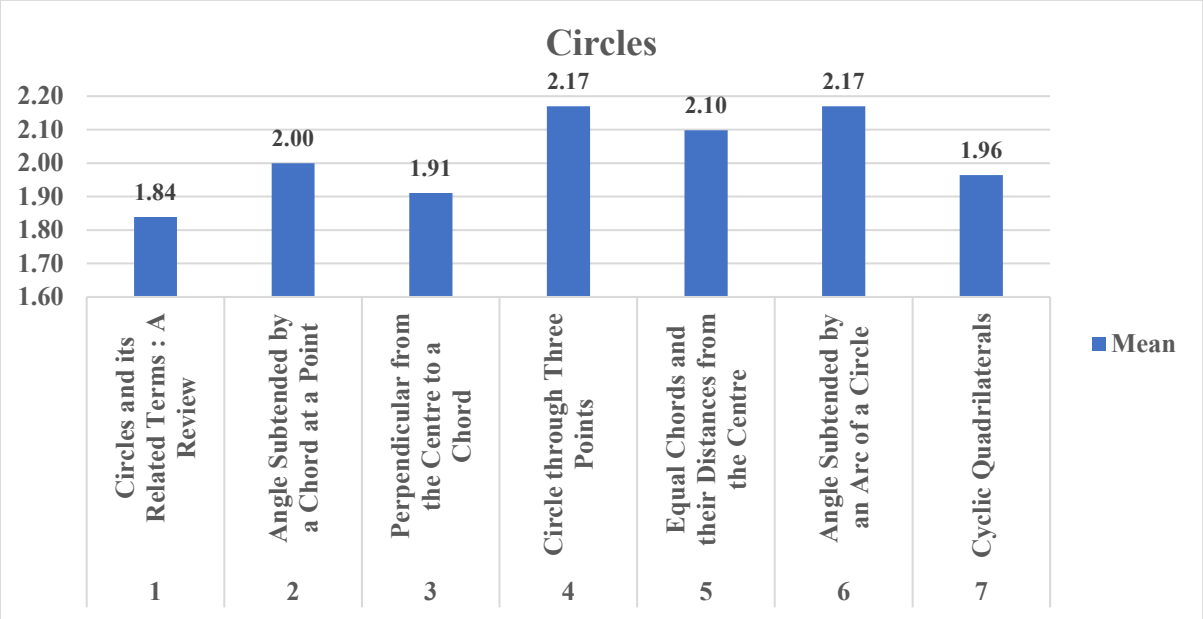
The topic of Figures on the same Base and between the same Parallels has a mean difficulty score of 1.95, indicating that respondents find it moderately easy. This distribution suggests that understanding figures on the same base and between the same parallels is generally manageable, with a majority finding it straightforward.

Parallelograms on the same Base and between the same Parallels has a mean score of 1.97 and Triangles on the same Base and between the same Parallels has a mean difficulty score of 1.96, reflecting that they are perceived as moderately easy.

4.1.7.10 CIRCLES

The following graph shows the graphical representation of the mean scores of responses against each statement under the content: **Circles** of NCERT syllabus of class -IX

Graph - 4.18 Mean Scores of Responses to the Statements of the Chapter-Circles, under the Category of Content Related to Class –IX



The topic of Circles and its Related Terms: The Review has a mean difficulty score of 1.84, indicating that respondents generally find it to be easy. Angle Subtended by a Chord at a Point has a mean score of 2.00, reflecting that it is perceived as moderately easy. Perpendicular from the Centre to a Chord has a mean difficulty score of 1.91, which indicates that understanding the perpendicular from the center to a chord is generally accessible, with a moderate level of difficulty perceived by some respondents.

Circle through Three Points has a mean difficulty score of 2.17, indicating it is perceived as moderately easy. None of the respondents rated this topic as Very Difficult, although a notable

segment of respondents finds it moderately challenging. Equal Chords and their Distances from the Centre has a mean score of 2.10, reflecting that it is perceived with a moderate level of difficulty. Angle Subtended by an Arc of a Circle has a mean difficulty score of 2.17, indicating it is perceived as moderately challenging. Cyclic Quadrilaterals has a mean difficulty score of 1.96, reflecting that it is perceived as easy. None of the respondents rated this topic as Very Difficult.

4.1.7.11 CONSTRUCTIONS

The following graph shows the graphical representation of the mean scores of responses against each statement under the content: **Constructions** of NCERT syllabus of class -IX

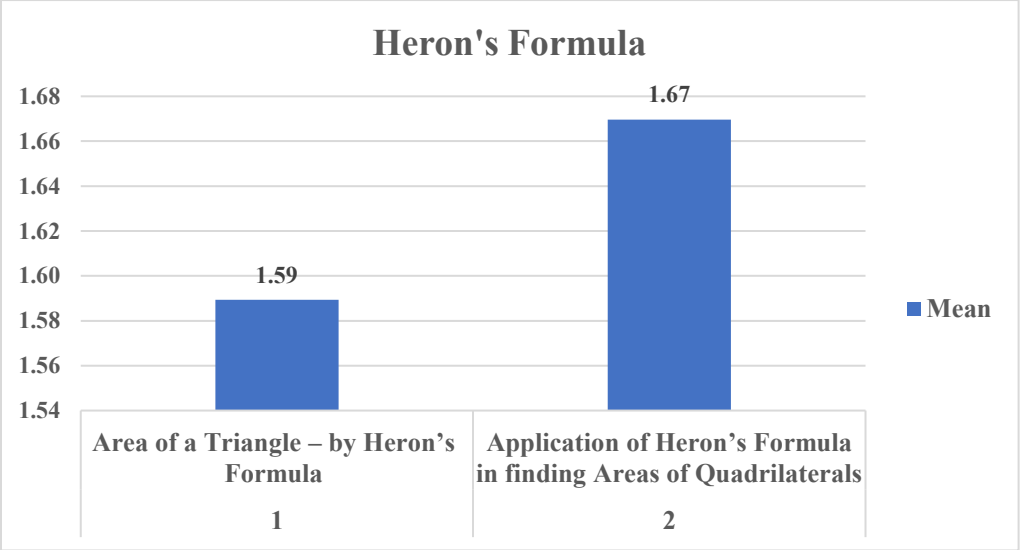
Graph - 4.19 Mean Scores of Responses to the Statements of the Chapter-Constructions, under the category of Content Related to Class –IX

Basic Constructions have a mean difficulty score of 1.71, indicating that respondents generally find them to be moderately easy. Some Constructions of Triangles have a mean score of 1.86, reflecting that they are perceived as easy. None of the respondents rated this topic as Very Difficult.

4.1.7.12 HERON'S FORMULA

The following graph shows the graphical representation of the mean scores of responses against each statement under the content: **Heron's Formula** of NCERT syllabus of class -IX

Graph - 4.20 Mean Scores of Responses to the Statements of the Chapter-Heron's Formula, under the category of Content Related to Class –IX



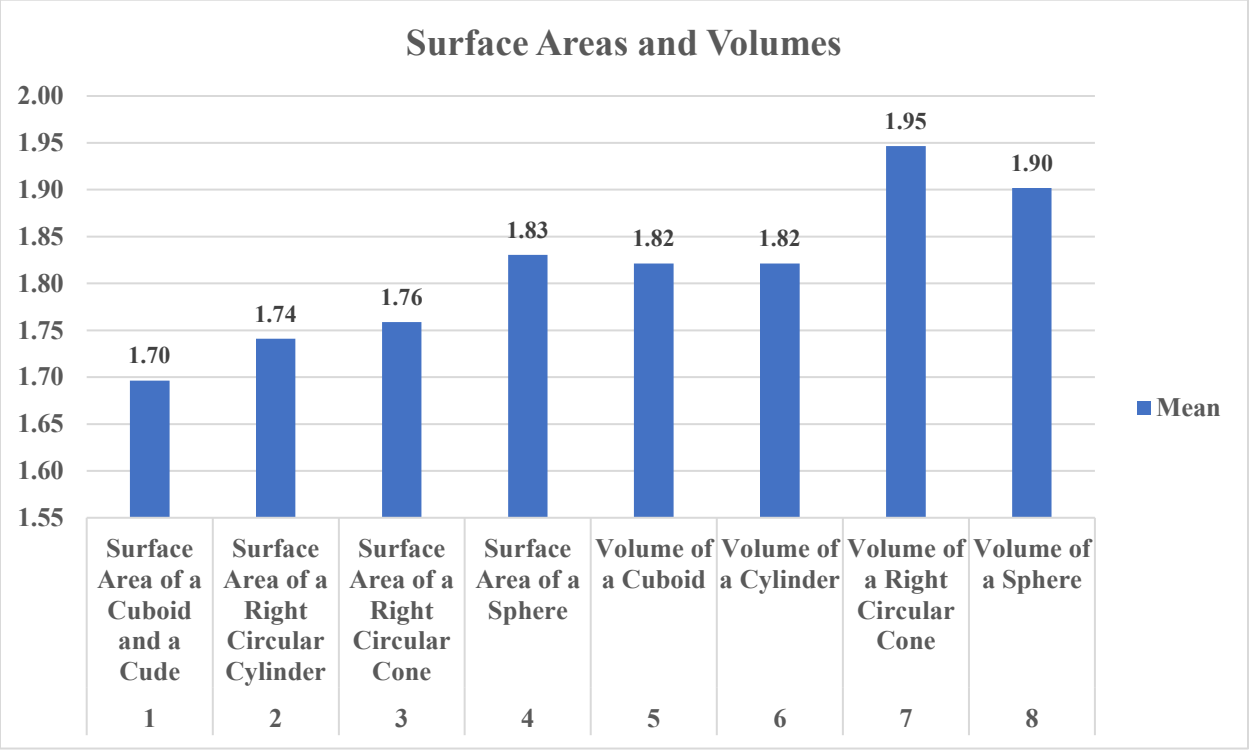
The topic 'Area of a Triangle – by Heron's Formula' has a mean difficulty score of 1.59, indicating that respondents generally find it moderately easy. This distribution suggests that calculating the area of a triangle using Heron's Formula is widely perceived as accessible and straightforward.

The application of Heron's Formula in finding areas of quadrilaterals has a mean score of 1.67, indicating that it is also perceived as moderately easy. None of the respondents rated this topic as Very Difficult, and 1.79% found it Difficult. 11.61% rated it as Not Difficult/Not Easy. A significant portion of respondents, 42.86%, considered it Easy, and 39.29% found it Very Easy. This indicates that applying Heron's Formula to find the areas of quadrilaterals is generally considered accessible, with a few respondents noting a moderate level of difficulty.

4.1.7.13 SURFASE AREAS AND VOLUMES

The following graph shows the graphical representation of the mean scores of responses against each statement under the content: **Surface Areas and Volumes,** of NCERT syllabus of class -IX

Graph - 4.21 Mean Scores of Responses to the Statements of the Chapter-Surface Areas and Volumes, under the category of Content Related to Class –IX



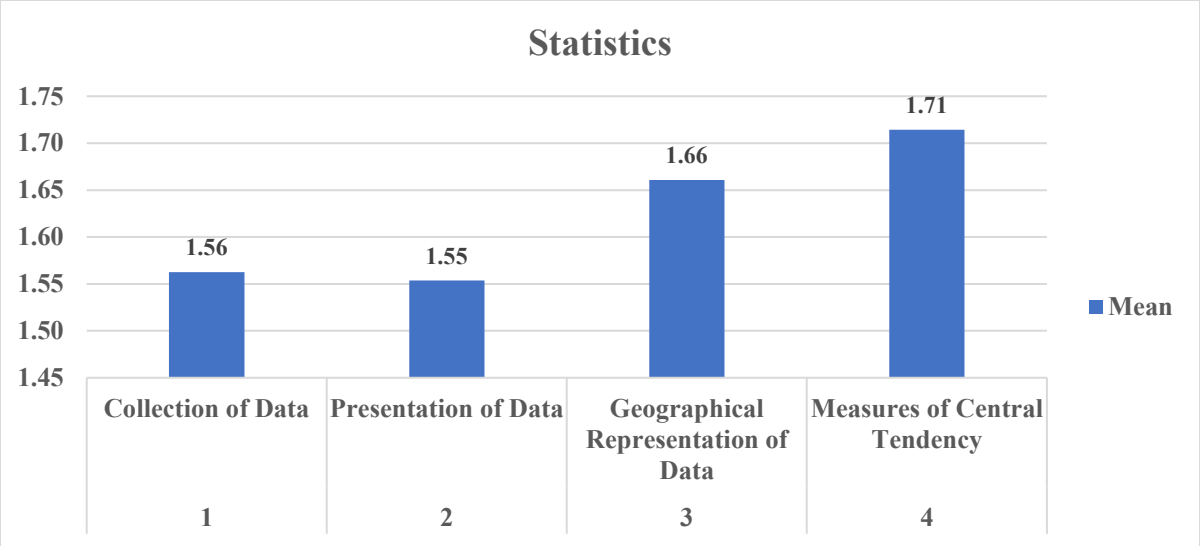
The 'surface area of a cuboid and a cube' has a mean difficulty score of 1.70, the' surface area of a right circular cone' has a mean score of 1.76 and the 'surface area of a sphere has a mean score of 1.83, indicating that respondents generally find them moderately easy

The 'volume of a cuboid' has a mean score of 1.82, indicating that respondents find it moderately easy. Only 1.79% of respondents rated this topic as Very Difficult, and 3.57% found it Difficult. The 'volume of a cylinder' also has a mean score of 1.82, indicating that it is moderately easy. The 'volume of a right circular cone' has a mean score of 1.95, indicating that it is perceived as easy. This indicates that calculating the volume of a 3-dimensional figure is generally manageable, with a few respondents noting a moderate level of difficulty. The 'volume of a sphere' has a mean score of 1.90, indicating that respondents find it also moderately easy.

4.1.7.14 STATISTICS

The following graph shows the graphical representation of the mean scores of responses against each statement under the content: **Statistics** of NCERT syllabus of class -IX

Graph - 4.22 Mean Scores of Responses to the Statements of the Chapter-Statistics, under the category of Content Related to Class –IX

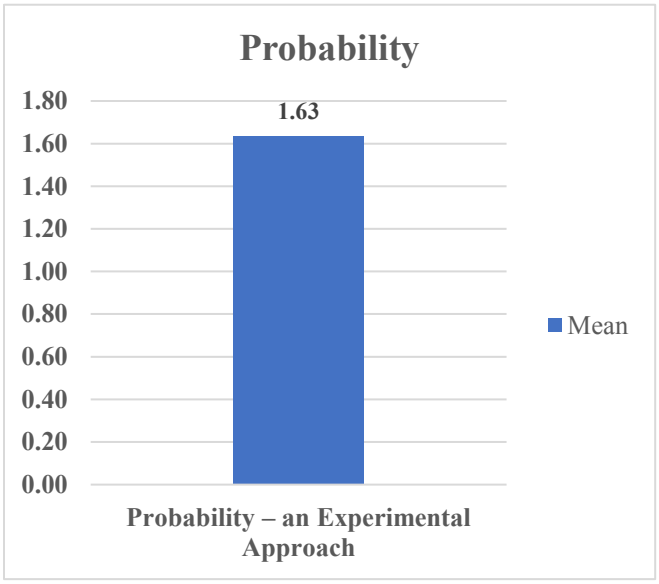


'The collection of data' has a mean difficulty score of 1.56, indicating that respondents generally find it relatively easy. No respondents rated this topic as Very Difficult or Difficult. 'The presentation of data' has a mean score of 1.55, indicating that it is also perceived as relatively easy. 'Geographical representation of data' has a mean score of 1.66, indicating that it is moderately easy. This suggests that representing data geographically is generally accessible, with a balanced perception of its difficulty. 'Measures of central tendency' have a mean score of 1.71, indicating that respondents find it moderately easy. A significant portion, 38.39%, considered it Easy, and 38.39% found it Very Easy.

4.1.7.15 PROBABILITY

The following graph shows the graphical representation of the mean scores of responses against each statement under the content: **Probability** of NCERT syllabus of class -IX

Graph - 4.23 Mean Scores of Responses to the Statements of the Chapter-Probability, under the category of Content Related to Class –IX



This topic 'Probability - an Experimental Approach' has a mean difficulty score of 1.63, indicating that it is perceived as relatively easy by respondents. No respondents rated it as Very Difficult.

From the analysis of the responses gathered, with respect to the content of class IX, based on their difficulty level of teaching as well as by considering the learning difficulties of the learners, the researcher could identify the following contents to focus on for the development of the professional enrichment programme. This content identification was based on the percentage and mean score obtained against each statement. Based on the analysis of difficulty perceptions among various mathematical topics, the findings indicate that the various topics of the chapter NUMBER SYSTEMS and TRIANGLES were perceived as the most challenging compared to other chapters. These topics received higher mean difficulty scores with significant percentages of respondents rating them as Very Difficult or Difficult. This suggests that these topics may require more focus and efforts in teaching and learning contexts.

The next section presents the data gathered and integrated on the content related dimension of NCERT syllabus of class - X in the questionnaire and also the analysis and interpretation of the same.

Table - 4.8 Percentage and Mean Scores of Responses for the Difficulty Level of Class X Content (Part-2)

(VD- Very Difficult, D-Difficult, ND/NE- Not Difficult Not Easy, E-Easy & VE-Very Easy)

Sr. No.		Area of Teaching / Topics	VD(5) No.of resp.(%)	D(4) No.of resp.(%)	ND/NE (3) No.of resp.(%)	E (2) No.of resp.(%)	VE (1) No.of resp.(%)	Blank No.of resp.(%)	Total Resp.	Mean
CLASS: X										
01.		**REAL NUMBERS**								
	1.	Euclid's Division Lemma	24(21.43%)	25(22.32%)	20(17.86%)	22(19.64%)	11(9.82%)	10(8.93%)	112	2.99
	2.	The Fundamental Theorem of Arithmetic	24(21.43%)	27(24.1%)	12(10.71%)	25(22.32%)	14(12.5%)	10(8.93%)	112	2.93
	3.	Revisiting Irrational Numbers	21(18.75%)	24(21.43%)	13(11.61%)	27(24.11%)	17(15.18%)	10(8.93%)	112	2.78
	4.	Revisiting Rational Numbers and their Decimal Expansions	20(17.86%)	23(20.54%)	21(18.75%)	15(13.39%)	21(18.75%)	12(10.71%)	112	2.73
02.		**POLYNOMIALS**								
	1.	Geometrical Meaning of the Zeroes of a Polynomial	0	8(7.14%)	18(16.07%)	40(35.71%)	31(27.68%)	15(13.39%)	112	1.76
	2.	Relationship between Zeroes and Coefficients of a Polynomial	0	5(4.46%)	19(16.96%)	40(35.71%)	33(29.46%)	15(13.39%)	112	1.70
	3.	Division Algorithm for Polynomials	0	8(7.14%)	19(16.96%)	41(36.61%)	29(25.89%)	15(13.39%)	112	1.79
03.		**PAIR OF LINEAR EQUATIONS IN TWO VARIABLES**								
	1.	Pair of Linear Equations in Two Variables	0	2(1.79%)	21(18.75%)	37(33.04%)	37(33.04%)	15(13.39%)	112	1.63
	2.	Graphical Method of Solution of a Pair of Linear Equations	0	4(3.57%)	21(18.75%)	39(34.82%)	33(29.46%)	15(13.39%)	112	1.70
	3.	Algebraic Methods of Solving a Pair of Linear Equations	0	3(2.68%)	20(17.86%)	39(34.82%)	33(29.46%)	17(15.18%)	112	1.63
		Substitution Method	0	3(2.68%)	15(13.39%)	44(39.29%)	33(29.46%)	17(15.18%)	112	1.59
		Elimination Method	0	2(1.79%)	17(15.18%)	44(39.29%	33(29.46%)	16(14.29%)	112	1.61
		Cross-Multiplication Method	0	8(7.14%)	19(16.96%)	38(33.93%)	31(27.68%)	16(14.29%)	112	1.75
	4.	Equations Reducible to a Pair of Linear Equations in Two Variables	0	8(7.14%)	26(23.21%)	35(31.25%)	26(23.21%)	17(15.18%)	112	1.84
04.		**QUADRATIC EQUATIONS**								
	1.	Quadratic Equations	0	2(1.79%)	21(18.75%)	41(36.61%)	33(29.46%)	15(13.39%)	112	1.66
	2.	Solution of a Quadratic Equation by Completing the Square	3(2.68%)	13(11.61%)	27(24.11%)	25(22.32%)	28(25%)	16(14.29%)	112	2.02
	3.	Nature of Roots	0	3(2.68%)	26(23.21%)	31(27.68%)	36(32.14%)	16(14.29%)	112	1.68

05.	**ARITHMETIC PROGRESSIONS**									
	1.	Arithmetic Progressions	0	4(3.57%)	19(16.96%)	39(34.82%)	34(30.36%)	16(14.29%	112	1.65
	2.	nth Term of an AP	0	7(6.25)	19(16.96)	37(33.04)	33(29.46)	16(14.29)	112	1.71
	3.	Sum of First n Terms of an AP	1(0.89%)	7(6.25%)	23(20.54%)	34(30.36%)	31(27.68%)	16(14.29%)	112	1.79
06.	**TRIANGLES**									
	1.	Similar Figures	21(18.75%)	27(24.11%)	15(13.39%)	25(22.32%)	16(14.29%)	8(7.14%)	112	2.89
	2.	Similarity of Triangles	17(15.18%)	25(22.32%)	23(20.54%)	21(18.75%)	13(11.61%)	13(11.61%)	112	2.76
	3.	Criteria for Similarity of Triangles	23(20.54%)	22(19.64%)	20(17.86%)	21(18.75%)	12(10.71%)	14(12.5%)	112	2.83
	4.	Areas of Similar Triangles	25(22.32%)	20(17.86%)	30(26.79%)	22(19.64%)	12(10.71%)	3(2.68%)	112	3.13
	5.	Pythagoras Theorem	20(17.86%)	30(26.79%)	22(19.64%)	20(17.86%)	17(15.18%)	3(2.68%)	112	3.06
07.	**COORDINATE GEOMETRY**									
	1.	Distance Formula	0	2(1.79%)	15(13.39%)	39(34.82%)	40(35.71%)	16(14.29%)	112	1.53
	2.	Section Formula	0	5(4.46%)	21(18.75%)	36(32.14%)	34(30.36%)	16(14.29%)	112	1.69
	3.	Area of a Triangle	0	7(6.25%)	16(14.29%)	36(32.14%)	37(33.04%)	16(14.29%)	112	1.65
	4.	Some More Criteria for Congruence of Triangles	3(2.68%)	5(4.46%)	21(18.75%)	32(28.57%)	33(29.46%)	18(16.07%)	112	1.74
08.	**INTRODUCTION TO TRIGONOMETRY**									
	1.	Trigonometric Ratios	0	5(4.46%)	23(20.54%)	36(32.14%)	32(28.57%)	16(14.29%)	112	1.72
	2.	Trigonometric Ratios of Some Specific Angles	0	6(5.36%)	25(22.32%)	35(31.25%)	30(26.79%)	16(14.29%)	112	1.78
	3.	Trigonometric Ratios of Complementary Angles	0	6(5.36%)	27(24.11%)	35(31.25%)	28(25%)	16(14.29%)	112	1.81
	4.	Trigonometric Identities	2(1.79%)	13(11.61%)	33(29.46%)	24(21.43%)	24(21.43%)	16(14.29%)	112	2.08
09.	**SOME APPLICATIONS OF TRIGONOMETRY**									
	1.	Heights and Distances	2(1.79%)	10(8.93%)	31(27.68%)	28(25%)	25(22.32%)	16(14.29%)	112	2.00
10.	**CIRCLES**									
	1.	Tangent to a Circle	0	9(8.04%)	25(22.32%)	41(36.61%)	21(18.75%)	16(14.29%)	112	1.91
	2.	Number of Tangents from a Point on a Circle	0	11(9.82%)	21(18.75%)	38(33.93%)	26(23.21%)	16(14.29%)	112	1.87
11.	**CONSTRUCTIONS**									
	1.	Division of a Line Segment	0	4(3.57%)	17(15.18%)	46(41.07%)	29(25.89%)	16(14.29%)	112	1.68
	2.	Construction of Tangents to a Circle	1(0.89%)	4(3.57%)	26(23.21%)	36(32.14%)	29(25.89%)	16(14.29%)	112	1.79
12.	**AREAS RELATED TO CIRCLES**									
	1.	Areas of Sector and Segment of a Circle	0	11(9.82%)	31(27.68%)	30(26.79%)	24(21.43%)	16(14.29%)	112	1.97

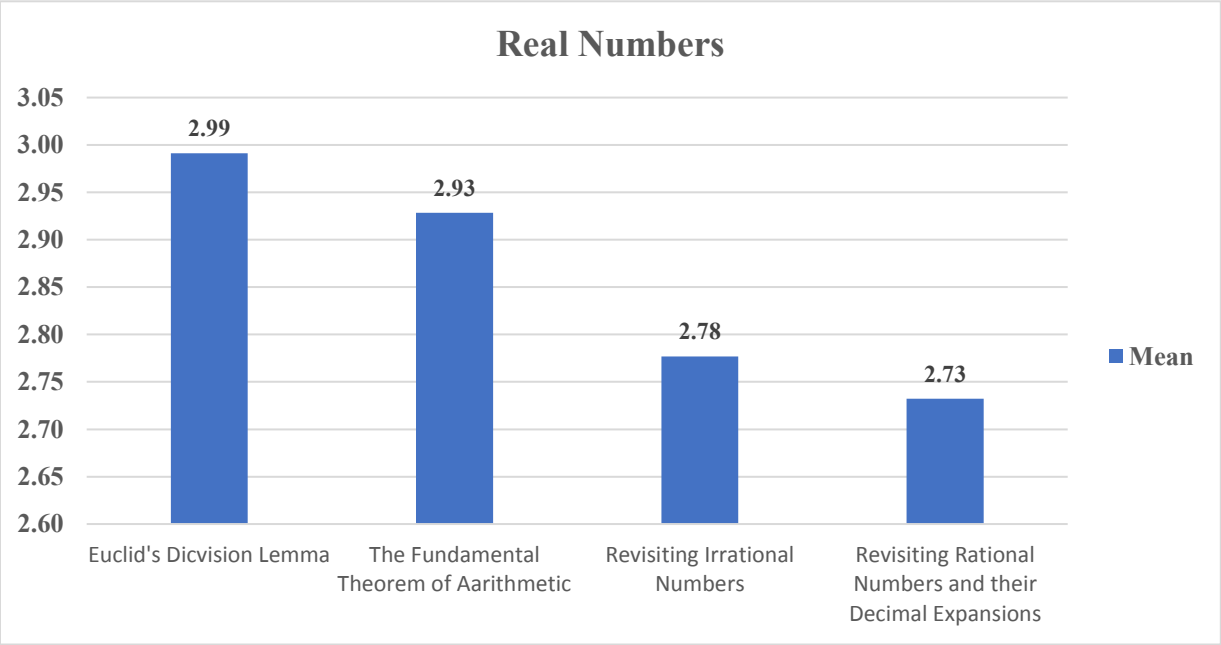
	2.	Areas of Combinations of Plane Figures	0	15(13.39%)	33(29.46%)	29(25.89%)	19(16.96%)	16(14.29%)	112	2.11
13.	**SURFACE AREAS AND VOLUMES**									
	1.	Surface Area of a Combination of Solids	1(0.88%)	15(13.27%)	19(16.81%)	44(38.94%)	18(15.93%)	16(14.16%)	112	2.02
	2.	Volume of a Combination of Solids	1(0.88%)	13(11.5%)	23(20.35%)	39(34.51%)	21(18.58%)	16(14.16%)	112	1.99
	3.	Conversion of Solid from One Shape to Another	1(0.88%)	17(15.04%)	19(16.81%)	41(36.28%)	19(16.81%)	16(14.16%)	112	2.04
	4.	Frustum of a Cone	2(1.77%)	21(18.58%)	26(23.01%)	29(25.66%)	19(16.81%)	16(14.16%)	112	2.20
14.	**STATISTICS**									
	1.	Mean of Grouped Data	0	3(2.68%)	15(13.39%)	49(43.75%)	30(26.79%)	15(13.39%)	112	1.65
	2.	Mode of Grouped Data	0	4(3.57%)	13(11.61%)	51(45.54%)	29(25.89%)	15(13.39%)	112	1.66
	3.	Median of Grouped Data	0	4(3.57%)	16(14.29%)	48(42.86%)	29(25.89%)	15(13.39%)	112	1.69
	4.	Graphical Representation of Cumulative Frequency Distribution	1(0.89%)	8(7.14%)	20(17.86%)	39(34.82%)	28(25%)	16(14.29%)	112	1.81
15.	**PROBABILITY**									
	1.	Probability – A Theoretical Approach	0	6(5.36%)	13(11.61%)	37(33.04%)	41(36.61%)	15(13.39%)	112	1.59

The graphical representations of the data integrated and presented above, on the content related dimension of NCERT syllabus of class - X in the questionnaire and the analysis and interpretation of the same are presented below.

4.1.7.16 REAL NUMBERS

The following graph shows the graphical representation of the mean scores of responses against each statement under the content: **Real Numbers** of NCERT syllabus of class -X

Graph - 4.24 Mean Scores of Responses to the Statements of the Chapter-Real Numbers, under the Category of Content Related to Class –X

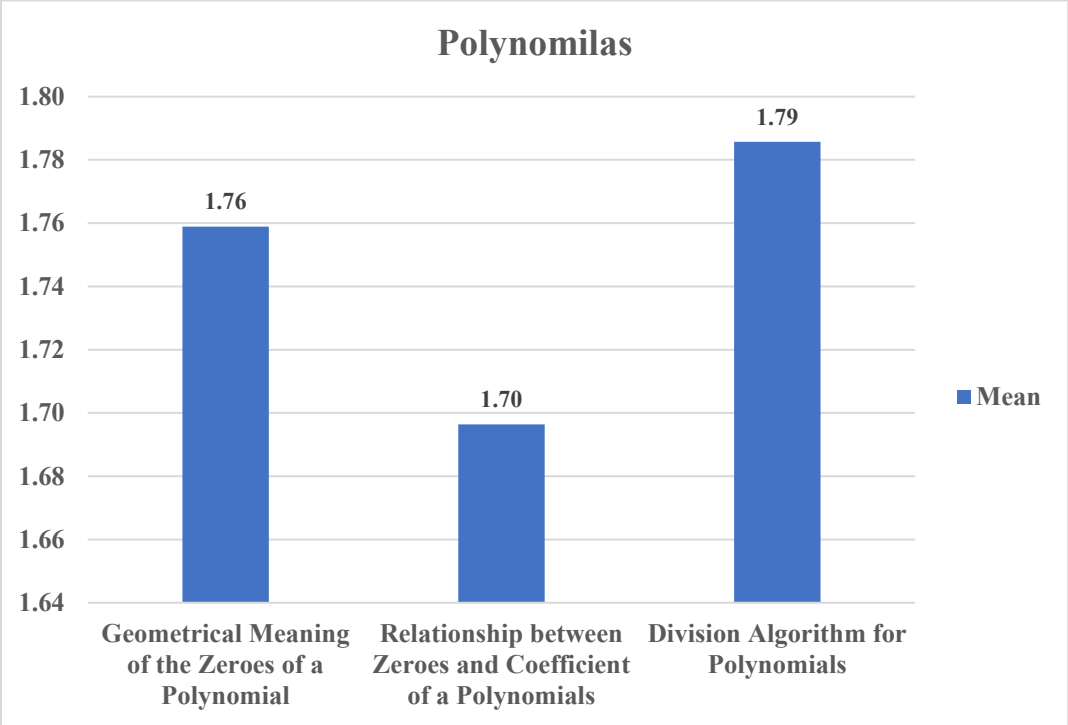


For 'Euclid's Division Lemma,' a substantial portion of respondents found it challenging, this topic had a mean difficulty rating of 2.99, indicating it is perceived as the most difficult among the listed topics. Similarly, 'The Fundamental Theorem of Arithmetic' has a mean difficulty rating of 2.93, suggesting it is also considered quite difficult. 'Revisiting Irrational Numbers' has the mean difficulty rating of 2.78, indicating a moderate level of perceived difficulty. 'Revisiting Rational Numbers and their Decimal Expansions' appeared to be the least difficult topic and this topic has a mean difficulty rating of 2.73, reflecting its relatively lower perceived difficulty compared to the other topics.

4.1.7.17 POLYNOMIALS

The following graph shows the graphical representation of the mean scores of responses against each statement under the content: **Polynomials** of NCERT syllabus of class -X

Graph - 4.25 Mean Scores of Responses to the Statements of the Chapter-Polynomials, under the Category of Content Related to Class –X

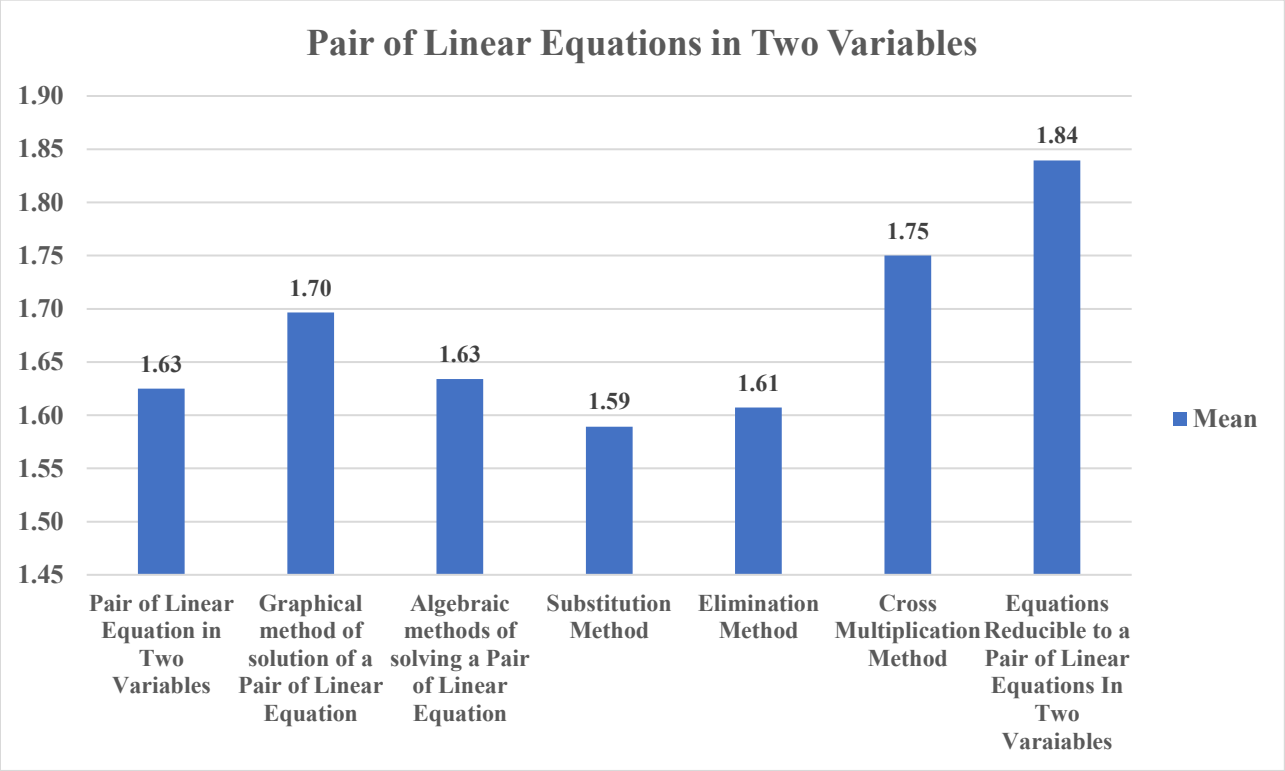


For 'Geometrical Meaning of the Zeroes of a Polynomial,' has a mean difficulty rating of 1.76, indicating it is perceived as relatively easy among the listed topics. Similarly, 'Relationship between Zeroes and Coefficients of Polynomials' has a mean difficulty rating of 1.70, suggesting it is the easiest among the listed polynomial topics. For 'Division Algorithm for Polynomials, the mean difficulty rating for this topic is 1.79, indicating it is perceived as slightly more difficult than the other two polynomial topics but still generally easy.

4.1.7.18 PAIR OF LINEAR EQUATIONS IN TWO VARIABLES

The following graph shows the graphical representation of the mean scores of responses against each statement under the content: **Pair of Linear Equations in Two Variables** of NCERT syllabus of class -X

Graph - 4.26 Mean Scores of Responses to the Statements of the Chapter-Pair of Linear Equations in Two Variables, under the Category of Content Related to Class –X

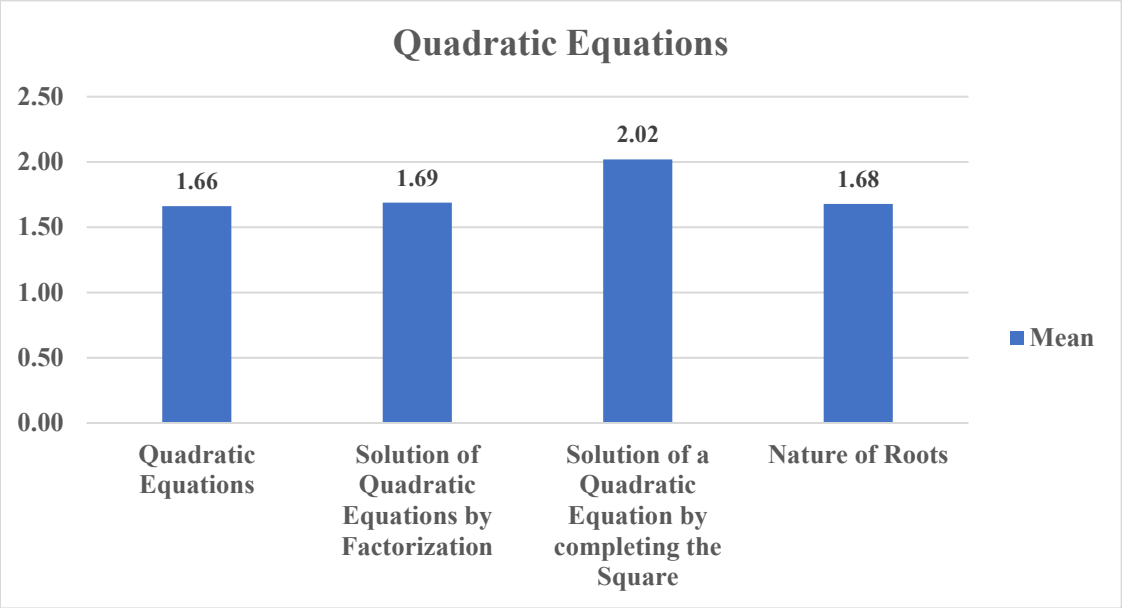


For the topic 'Pair of Linear Equations in Two Variables' has a mean difficulty rating of 1.63, indicating it is perceived as relatively easy among the listed topics. The 'Graphical Method of Solution of a Pair of Linear Equations' has a mean difficulty rating of 1.70, suggesting it is also considered easy. For the 'Algebraic Methods of Solving a Pair of Linear Equations, has a mean difficulty rating of 1.63, indicating it is perceived as relatively easy.

4.1.7.19 QUADRATIC EQUATIONS

The following graph shows the graphical representation of the mean scores of responses against each statement under the content: **Quadratic Equations** of NCERT syllabus of class -X

Graph - 4.27 Mean Scores of Responses to the Statements of the Chapter-Quadratic Equations, under the Category of Content Related to Class –X

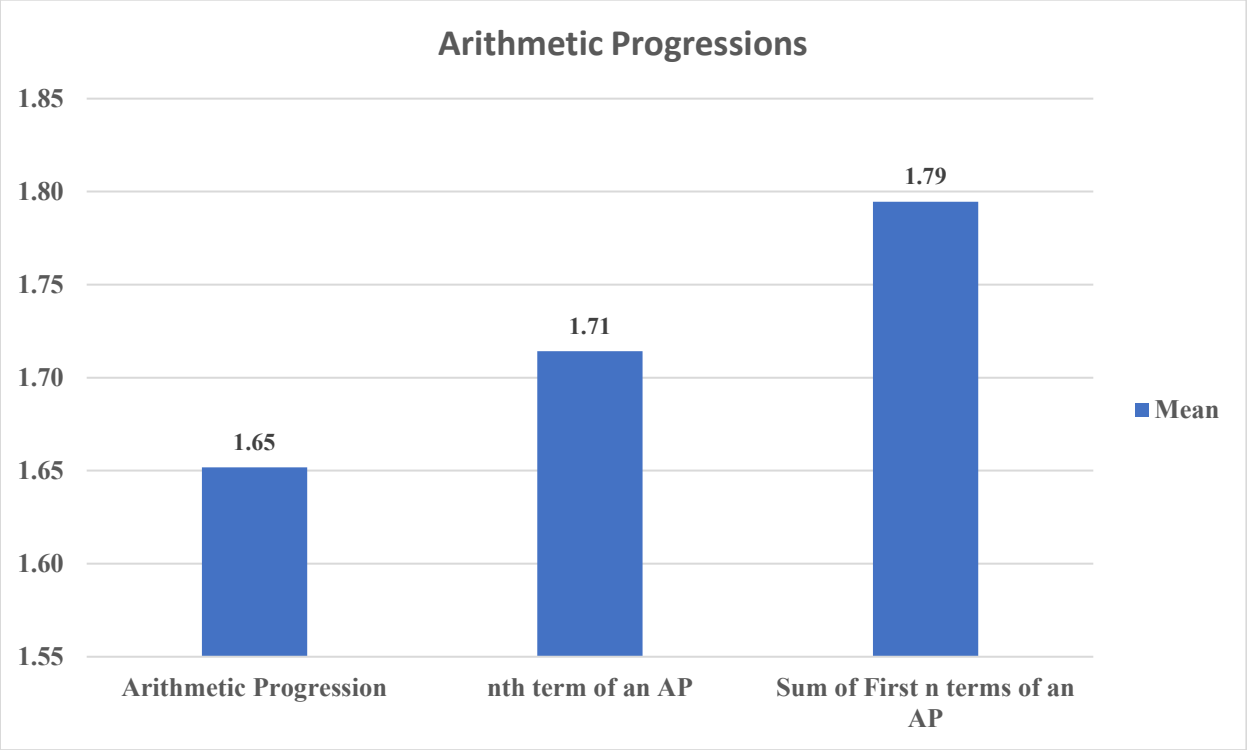


For the topic 'Quadratic Equation**s'** has a mean difficulty rating of 1.66, indicating it is perceived as relatively easy among the listed topics. The 'Solution of Quadratic Equations by Factorization' also had no respondents rating it as 'Very Difficult' and this topic has a mean difficulty rating of 1.69, suggesting it is also considered easy. For the 'Solution of a Quadratic Equation by Completing the Square' the mean difficulty rating for this topic is 2.02, indicating it is perceived as the most challenging within the quadratic equations section. The 'Nature of Roots' has a mean difficulty rating of 1.68, suggesting it is perceived as relatively easy.

4.1.7.20 ARITHMETIC PROGRESSIONS

The following graph shows the graphical representation of the mean scores of responses against each statement under the content: **Arithmetic Progressions** of NCERT syllabus of class -X

Graph - 4.28 Mean Scores of Responses to the Statements of the Chapter-Arithmetic Progressions, under the Category of Content Related to Class –X

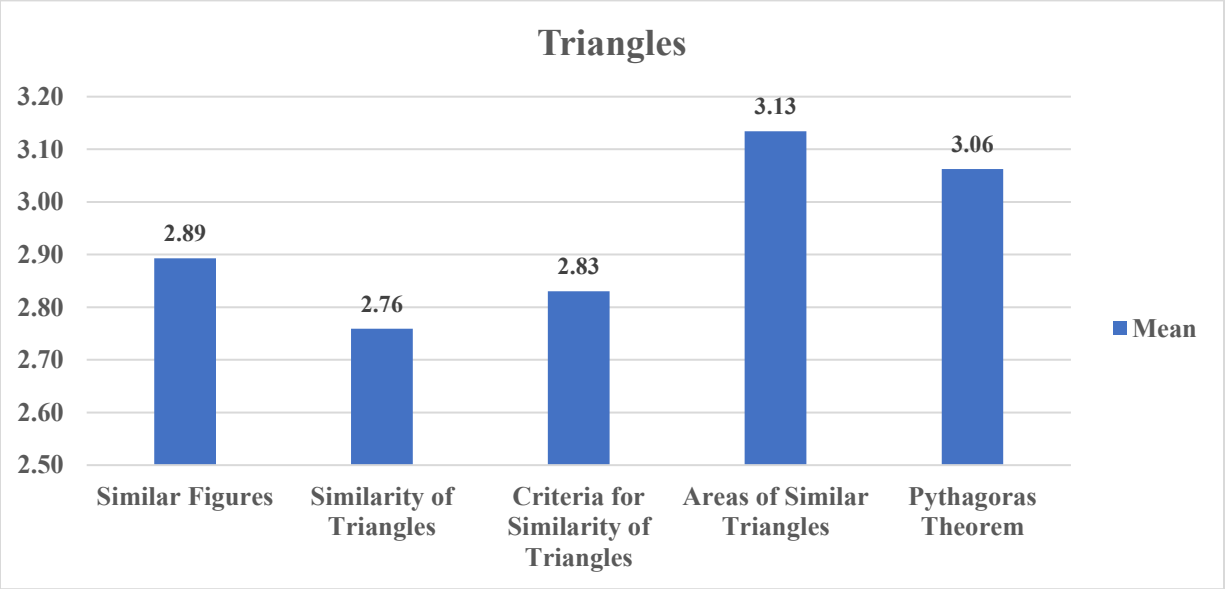


For the topic 'Arithmetic Progression' has a mean difficulty rating of 1.65, indicating it is perceived as relatively easy among the listed topics. The 'nth Term of an AP' has a mean difficulty rating of 1.71, suggesting it is slightly more challenging than 'Arithmetic Progression' but still considered easy. For the 'Sum of the First n Terms of an AP', mean difficulty rating is 1.79, indicating it is perceived as the most challenging within the arithmetic progression section.

4.1.7.21 TRIANGLES

The following graph shows the graphical representation of the mean scores of responses against each statement under the content: **Triangles** of NCERT syllabus of class -X

Graph - 4.29 Mean Scores of Responses to the Statements of the Chapter-Triangles, under the Category of Content Related to Class -X



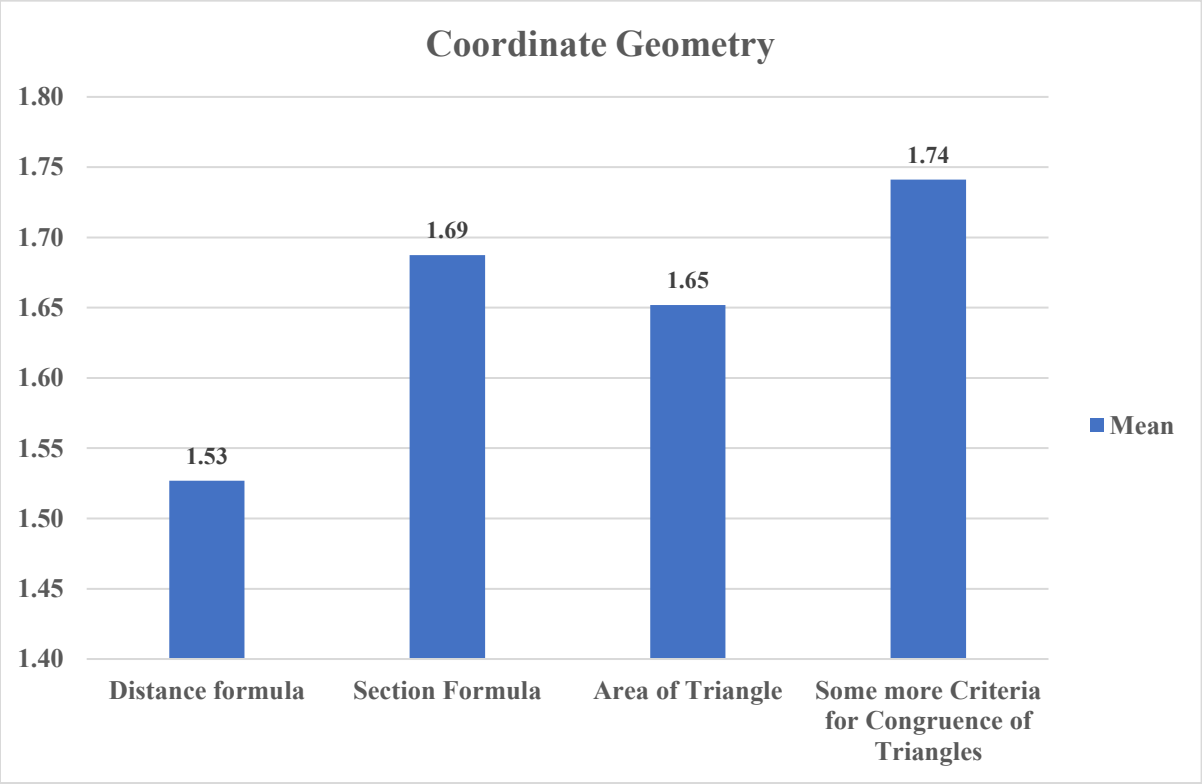
Respondents varied in their perception of 'Similar Figures', with a mean score of the responses 2.89 indicating its moderately high difficulty level. 'Similarity of Triangles' elicited diverse perceptions among respondents, with 15.18% finding it very difficult and 22.32% rating it as difficult. It has the mean difficulty score of 2.76, indicating it as comparatively easy amongst the other topics of the chapter TRIANGLES.

The perception of 'Criteria for Similarity of Triangles' was balanced, with mean score 2.83. This balanced response suggests that while some found it challenging, many respondents also found aspects of the criteria accessible or straightforward. 'Areas of Similar Triangles' emerged as the most challenging topic among respondents, with the highest mean value 3.13. This indicates a widespread perception of difficulty, reflecting complexities in understanding and applying concepts related to the areas of similar triangles. 'Pythagoras Theorem' was perceived as moderately difficult by respondents, with 17.86% finding it very difficult and 26.79% rating it difficult. It has the mean score 3.06. This perception suggests that though a significant number of respondents found aspects of the theorem accessible or straightforward (17.86% found it as easy and 15.8%, very easy) but many respondents found it challenging.

4.1.7.22 COORDINATE GEOMETRY

The following graph shows the graphical representation of the mean scores of responses against each statement under the content: **Coordinate Geometry** of NCERT syllabus of class -X

Graph - 4.30 Mean Scores of Responses to the Statements of the Chapter-Coordinate Geometry, under the Category of Content Related to Class –X

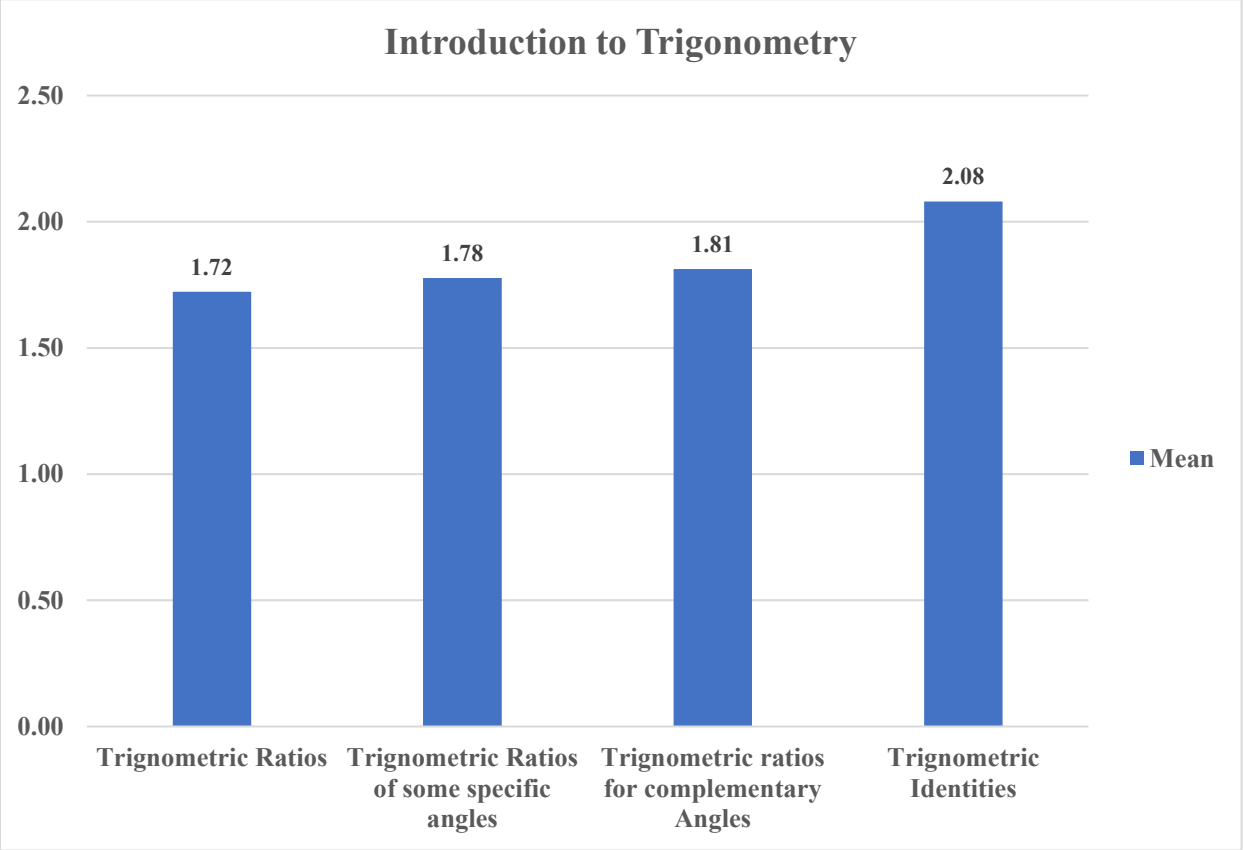


The 'Distance formula' yielded a diverse perception among respondents. With no respondents finding it very difficult, the topic averaged a low mean value of 1.53, suggesting a generally manageable difficulty level overall. In the 'Section formula' the topic averaged a moderate mean value of 1.69, suggesting a balanced yet moderately challenging perception overall.

'Area of Triangle' elicited a response where 42.86% found it neither difficult nor easy, showcasing a mixed perception among respondents. With no respondents rating it very difficult, the topic averaged a moderate mean value of 1.65, indicating a generally manageable yet varied perception of difficulty.

4.1.7.23 INTRODUCTION TO TRIGONOMETRY

The following graph shows the graphical representation of the mean scores of responses against each statement under the content: **Introduction to Trigonometry** of NCERT syllabus of class - X **Graph - 4.31 Mean Scores of Responses to the Statements of the Chapter-Introduction to Trigonometry, under the Category of Content Related to Class -X**

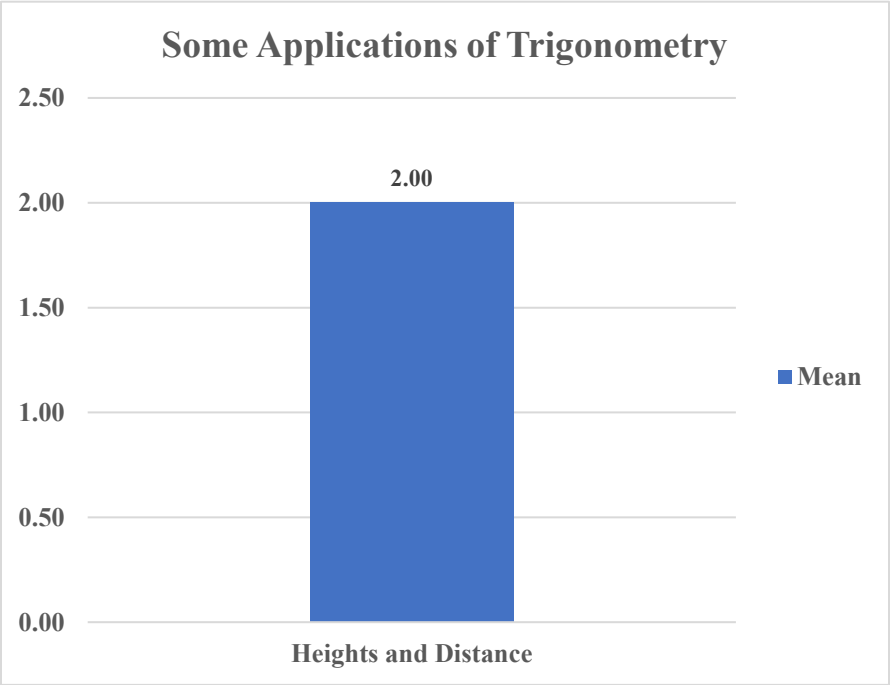


The topic on 'Trigonometric Ratios' revealed a diverse perception among respondents. With no respondents finding it very difficult, the chapter averaged a mean value of 1.72, indicating a generally manageable difficulty level overall. 'Trigonometric Ratios of Some Specific Angles', a similar trend emerged among respondents. With a mean value of 1.78, the topic's difficulty was moderate. The topic on 'Trigonometric Ratios for Complementary Angles' demonstrated a balanced perception among respondents. With a mean value of 1.81, the topic's difficulty was reflected moderately manageable. The topic covering, 'Trigonometric Identities' elicited varied perceptions among respondents. With a mean value of 2.08, the topic's difficulty was reflected moderately high.

4.1.7.24 SOME APPLICATIONS OF TRIGONOMETRY

The following graph shows the graphical representation of the mean scores of responses against each statement under the content: **Some Applications of Trigonometry** of NCERT syllabus of class -X

Graph - 4.32 Mean Scores of Responses to the Statements of the Chapter-Some Applications of Trigonometry, under the Category of Content Related to Class –X

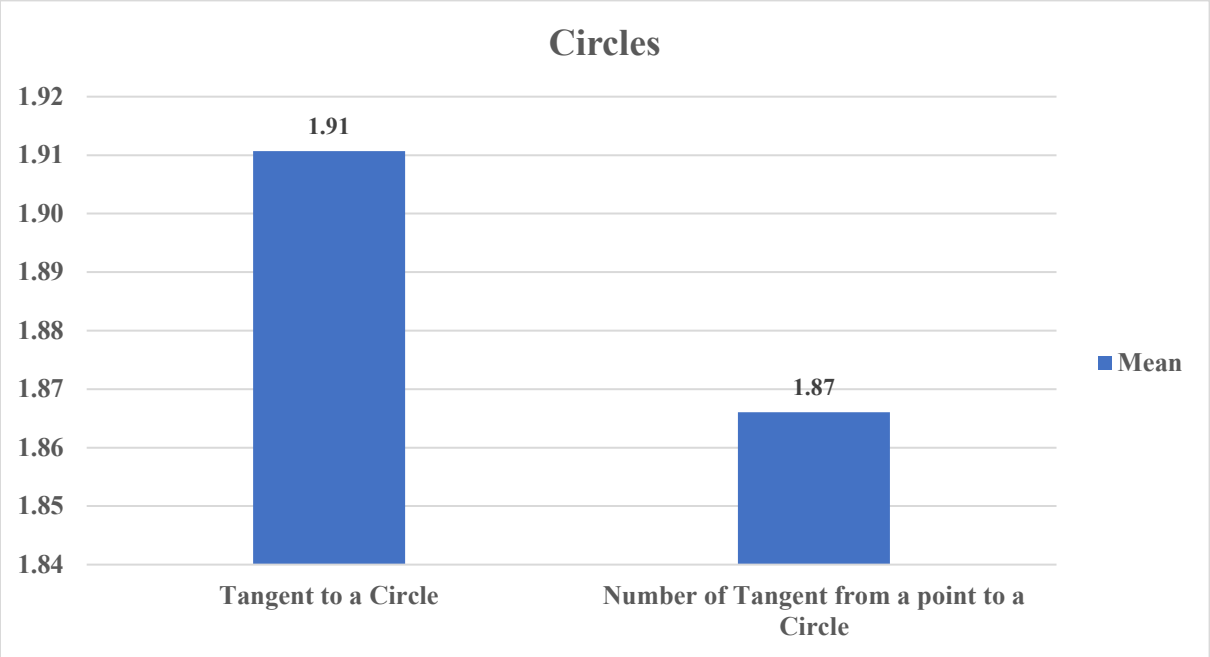


The topic on 'Heights and Distance' in trigonometry showcased varied perceptions among respondents. With a mean value of 2.00, the topic's difficulty level was reflected moderate.

4.1.7.25 CIRCLES

The following graph shows the graphical representation of the mean scores of responses against each statement under the content: **Circles** of NCERT syllabus of class -X

Graph - 4.33 Mean Scores of Responses to the Statements of the Chapter-Circles, under the Category of Content Related to Class -X

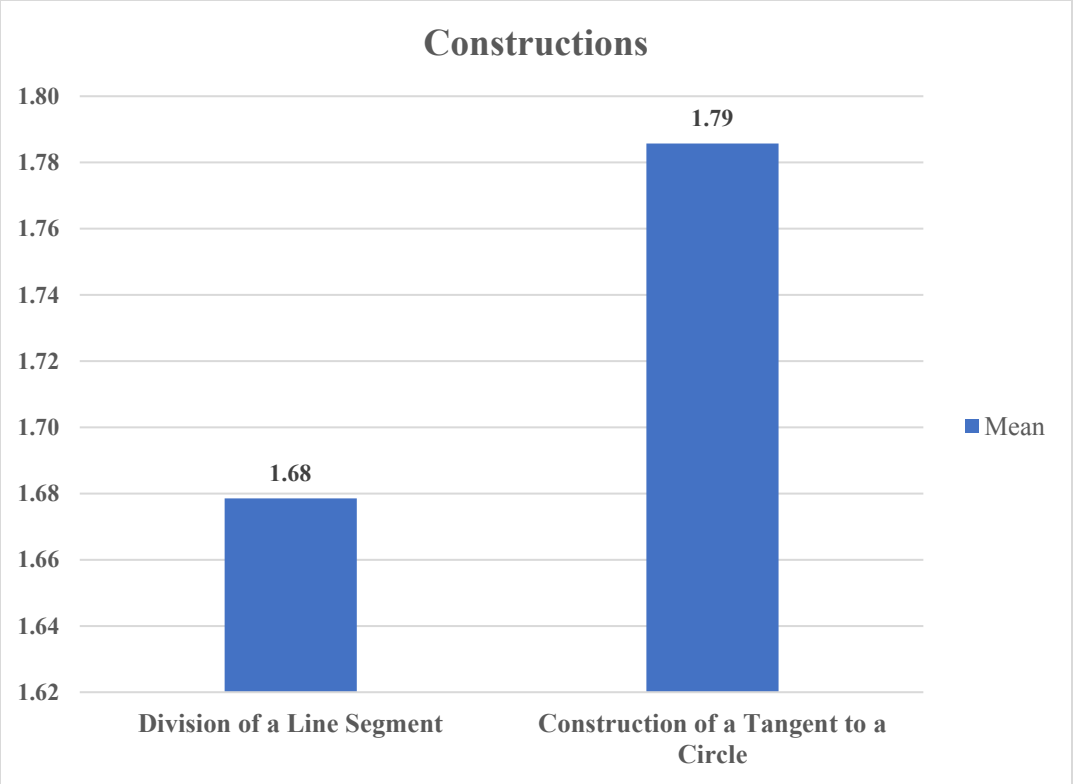


'Tangent to a Circle' in Geometry demonstrated a diverse perception among respondents. With a mean value of 1.91, its difficulty level was found moderate. For 'Number of tangents from a point to a circle', the respondents exhibited a diverse perception. With a mean value of 1.87, its difficulty level was reflected moderately manageable.

4.1.7.26 CONSTRUCTIONS

The following graph shows the graphical representation of the mean scores of responses against each statement under the content: **Constructions** of NCERT syllabus of class -X

Graph - 4.34 Mean Scores of Responses to the Statements of the Chapter-Constructions, under the Category of Content Related to Class –X

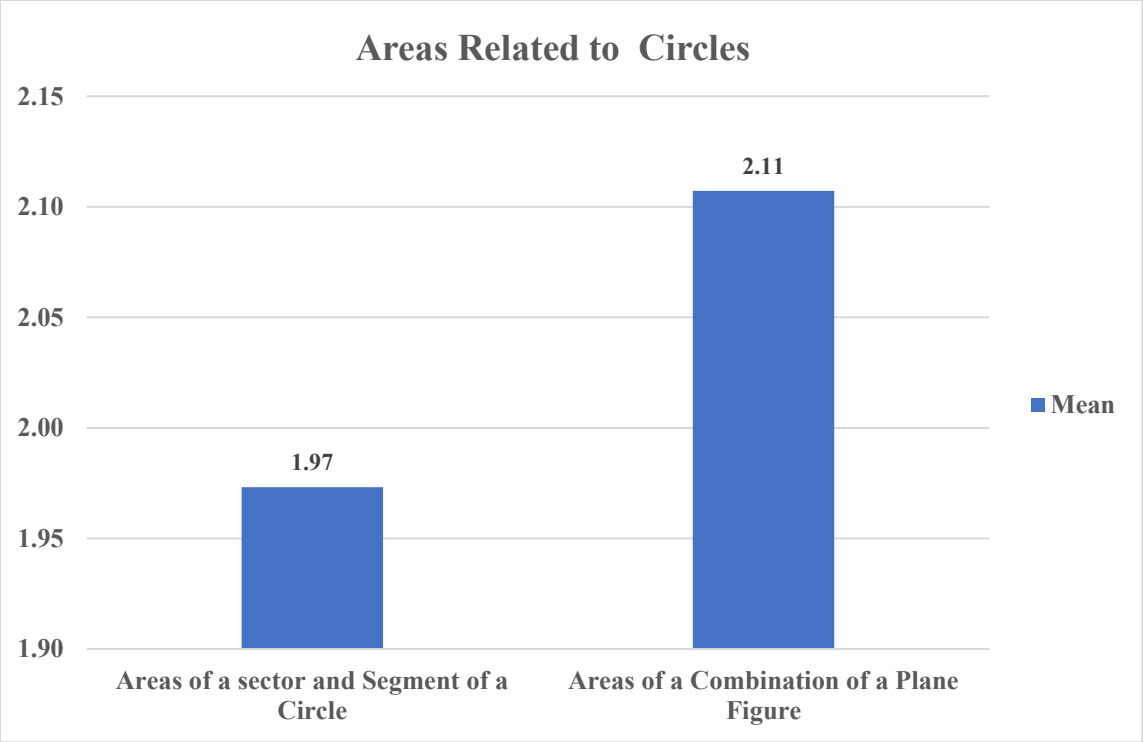


The topic on 'Division of a line segment' in geometric constructions showed a balanced perception among respondents. With a mean value of 1.68, the chapter's difficulty level was reflected as moderate. 'Construction of a tangent to a circle,' respondents exhibited a similar perception. With a mean value of 1.79, the difficulty level of the topic was reflected as moderately manageable.

4.1.7.27 AREAS RELATED TO CIRCLES

The following graph shows the graphical representation of the mean scores of responses against each statement under the content: **Areas Related to Circles** of NCERT syllabus of class -X

Graph - 4.35 Mean Scores of Responses to the Statements of the Chapter-Areas Related to Circles, under the Category of Content Related to Class –X

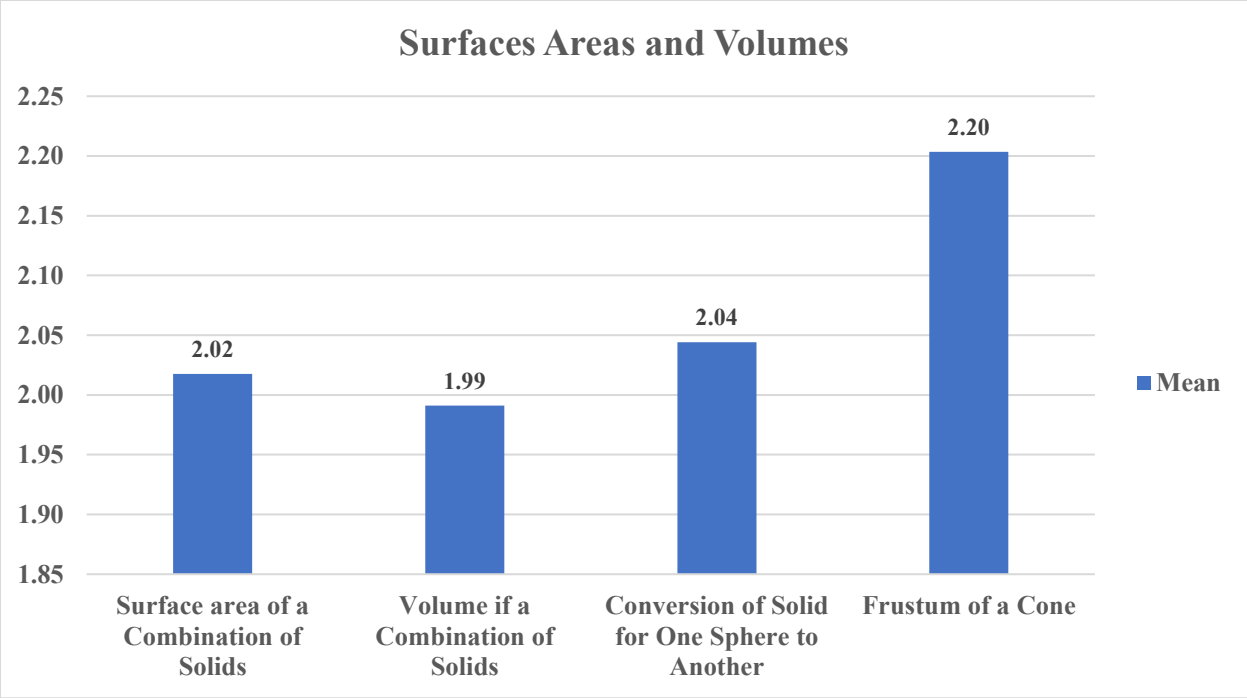


'Areas of a sector and segment of a circle' revealed varied perceptions among respondents. With a mean value of 1.97, the topic's difficulty level was moderate. The topic covering, 'Areas of a combination of plane figures' respondents exhibited a diverse perception. With a mean value of 2.11, the difficulty level of this topic was reflected moderately higher.

4.1.7.28 SURFACE AREAS AND VOLUMES

The following graph shows the graphical representation of the mean scores of responses against each statement under the content: **Surface Areas and Volumes** of NCERT syllabus of class -X

Graph - 4.36 Mean Scores of Responses to the Statements of the Chapter-Surface Areas and Volumes, under the category of Content Related to Class –X

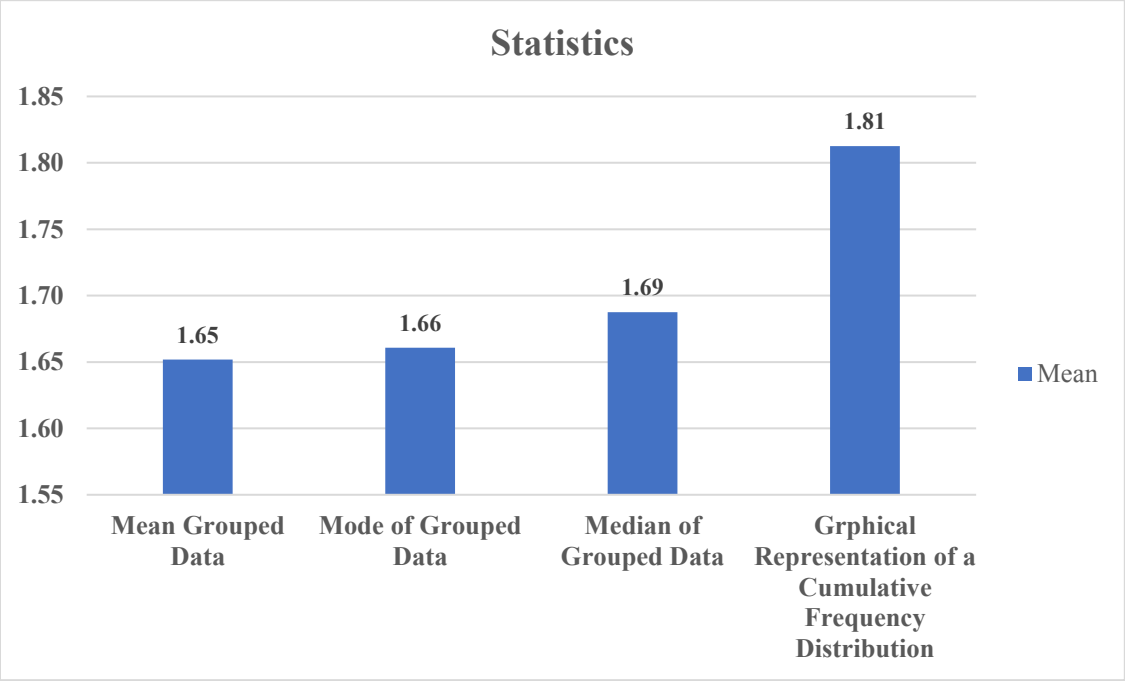


The topic 'Surface area of a combination of solids' showed a balanced perception among respondents. With a mean value of 2.02, the chapter's difficulty level was moderate overall, reflecting differing levels of comprehension and ease among respondents. The topic 'Volume of a combination of solids,' respondents exhibited a similar perception. With a mean value of 1.99, the chapter's difficulty level was reflected as moderately manageable. The topic covering the 'Conversion of solid from one sphere to another' revealed with a mean value of 2.04, the chapter's difficulty level as moderate. On the 'Frustum of a cone,' respondents exhibited a diverse perception. With a mean value of 2.20, the chapter's difficulty level was moderately higher.

4.1.7.29 STATISTICS

The following graph shows the graphical representation of the mean scores of responses against each statement under the content: **Statistics** of NCERT syllabus of class -X

Graph - 4.37 Mean Scores of Responses to the Statements of the Chapter-Statistics, under the Category of Content Related to Class –X

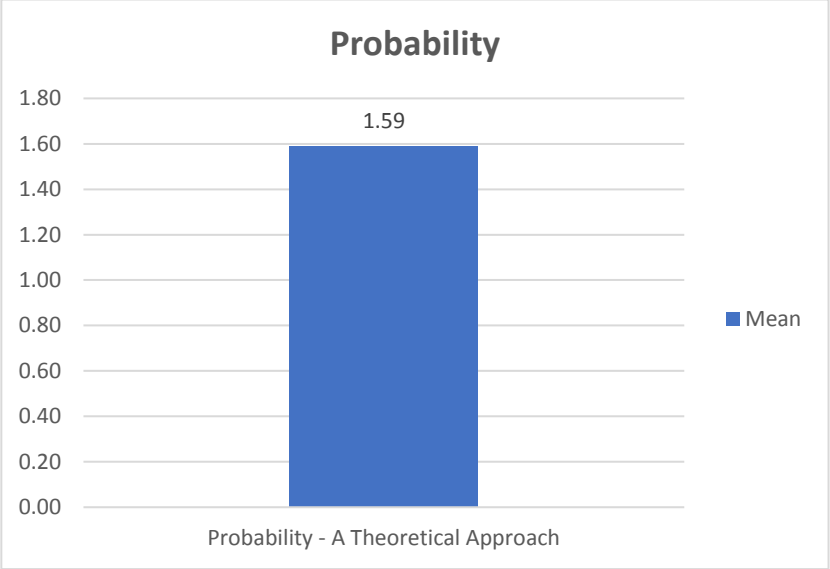


The topic 'Mean of grouped data' in statistics showed a balanced perception among respondents. With a mean value of 1.65, the chapter's difficulty level was moderate. The topic focusing on the 'Mode of grouped data,' respondents exhibited a similar perception. With a mean value of 1.66, the chapter's difficulty level was reflected moderately manageable. The topic covering the 'Median of grouped data' revealed varied perceptions among respondents. With a mean value of 1.69, the chapter's difficulty level was moderate. The 'Graphical representation of a cumulative frequency distribution,' respondents exhibited a diverse perception. With a mean value of 1.81, the chapter's difficulty level was moderately manageable.

4.1.7.30 PROBABILITY

The following graph shows the graphical representation of the mean scores of responses against each statement under the content: **Probability** of NCERT syllabus of class -X

Graph - 4.38 Mean Scores of Responses to the Statements of the Chapter-Probability, under the Category of Content Related to Class –X



The chapter on 'Probability - A Theoretical Approach' in statistics revealed a positive perception among respondents. With a mean value of 1.59, the chapter's difficulty level was low overall, reflecting a generally manageable comprehension and ease among respondents.

Overall analysis of this category of content of class IX revealed that the chapters 'Real Numbers' and 'Triangles' emerged as the most challenging topics among respondents. In Real Numbers, Euclid's Division Lemma and The Fundamental Theorem of Arithmetic were notably difficult, with 43.75% and 45.54% of respondents finding them challenging, respectively. These topics received the highest mean difficulty ratings of 2.99 and 2.93, indicating significant complexity. In contrast, 'Revisiting Rational Numbers and their Decimal Expansions' was perceived as relatively easier, though still challenging for 38.4% of respondents.

Similarly, in Triangles, Areas of Similar Triangles stood out as the most difficult, with 40.18% finding it challenging, closely followed by Similarity of Triangles and Criteria for Similarity of

Triangles, which presented mixed levels of difficulty. The Pythagoras Theorem was perceived as moderately challenging, highlighting varying degrees of comprehension among respondents. These insights underscore the need for targeted educational strategies to enhance understanding and mastery of these complex mathematical concepts: both REAL NUMBERS and TRIANGLES of CLASS X.

Qualitative Data Analysis

For the identification of the professional development needs of mathematics teachers of secondary schools during the first phase of the study, the researcher conducted informal interviews, interactions and classroom observations. The qualitative data so captured by the researcher during this phase of the study was analysed and the interpretations are presented below.

Analysis of the Data Captured through Informal Interviews and Interactions:

The researcher being in the education field since past two decades could closely watch the mathematics education happening in secondary schools. Through interaction and discussions with the mathematics teachers and Principals of various schools, the researcher framed a strong base for the programme development by identifying the teachers' training needs. The researcher interacted with 8 mathematics teachers of 4 secondary schools and during the interactions and informal interviews, teachers expressed the need of incorporating both content and generic related aspects to involve in the professional development programme which was aimed to be developed by the researcher. Teachers asserted the need of having 'continuous professional enrichment programmes which can enhance the quality teaching – learning. They also expressed the need of collaborative learning by conducting training sessions.

Majority of the teachers stated 'Euclid's Division Lemma' is a topic, most of the learners find it abstract and face difficulties in the conceptual understanding'. Teachers who had the teaching experience of both class IX & X expressed the need of a professional enrichment programme on the content 'Triangles', a topic in class IX which is also a topic of study in details in class X. According to them,' various theorems on triangles seem to have difficulties in understanding and producing them on exam point of view.' Few teachers feel 'congruence of triangles as very abstract for the learners and hence they avoid learning the congruence rules and few theorems

related to the congruence'. Majority of the Teachers stated 'Number systems' of class IX, its various subtopics and the 'Real Numbers' of class X are experienced as the topics difficult to understand for majority of the learners.'

Apart from the content related discussion, the researcher had interactions and discussions on certain generic aspects like methodology of teaching few topics. The pedagogical discussions also led to meaningful insights to focus on few aspects of pedagogy, while developing the professional enrichment programme. Analysis of the opinions and statements so recorded could lead to meaningful insights for the researcher for the professional enrichment programme development.

Analysis of the Data Collected through Classroom Observations:

Through the classrooms observations of 4 teachers of secondary schools (4 classes of each teacher), the researcher could understand, though technology has reached in every corner of the world, but its access and uses are very less in mathematics classrooms. Teachers were seen still following the traditional teaching methods or the 'chalk and board' method only, to teach most of the topics. It was observed, the majority of the teachers of secondary section just doing the delivery of the content given in the NCERT textbooks. The researcher observed the lack of usage of other reference materials by the teachers which in turn negatively impacting the limited knowledge gain of learners. Researcher observed, all the teachers teaching the topics only by focusing the exams and scoring marks. When asked by the researcher, the learners of the classrooms could not express the content with conceptual clarity. Few teachers' classroom observations revealed that the teachers are teaching the topics without understanding the objectives of teaching and also not knowing the expected learning outcomes from the content learning. Researcher observed the lack of awareness and familiarity on parts of teachers with respect to the important education policies and the recommendations made by the recent policy, NEP -2020. Classroom observations of these teachers also revealed the lack of involvement of real-life problem situations in the teaching areas where they can be connected, lack of implementation of activities in the teaching – learning process, lack of explanation on the interdisciplinary aspects where topics could be connected with other subjects in order to raise the curiosity and interest of learners in mathematics subject. Classroom observations enabled the

researcher to understand the need of incorporating Art integration, Experiential learning, Technology integration etc. in the teaching – learning process of secondary mathematics. Researcher observed, majority of the teacher's conducting assessment in classrooms just as a pedagogical practice, not exactly to identify the learning gaps or difficulty on part of learners. The above observations enabled the researcher with meaningful insights to decide on the components which the professional enrichment programme must focus on.

In conclusion, during the first phase of the study, from the analysis and interpretations of the quantitative and qualitative data collected through the NAQPEMT, informal interviews, interactions with mathematics teachers and the classroom observations, the researcher could identify the professional enrichment needs of the secondary section mathematics teachers. The professional enrichment needs identified by the researcher, in terms of content, generic and systemic aspects of mathematics teaching are given below.

Table-4.9 Identified Needs for the Professional Enrichment Programme Development.

Identified Content	**CLASS- IX**	**CLASS- X**
	NUMBER SYSTEMS	**REAL NUMBERS**
	TRIANGLES	**TRIANGLES**
Identified Generic and Systemic Aspects	**Involvement of Activities to Raise Curiosity and Interest in Mathematics**	
	Methodological and Pedagogical aspects	
	Technology Integration	
	Assessment Methods	
	Integration of NEP-2020 Recommendations: - Art integration, Experiential learning, Interdisciplinary approach	

The professional enrichment needs of mathematics teachers of secondary level, so identified, helped the researcher to move to the next phase of the study which is the development of content for the modules for teachers. The following section explains about the development of the Professional Enrichment Programme carried out by the researcher**.**

SECTION- II

4.2 Development of Professional Enrichment Programme

The programme development carried out by the researcher was based upon the identified needs of secondary mathematics teachers through the need identification survey conducted in the first phase of the study, administered through the self - developed Need Assessment Questionnaire for Professional Enrichment of Mathematics Teachers (NAQPEMT). The generic and content related areas, so identified were taken into consideration for developing modules for the teachers. The identified topics were short listed further and finally 4 topics of secondary mathematics namely: NUMBER SYSTEMS & TRIANGLES of Class IX and REAL NUMBERS & TRIANGLES of Class X of NCERT syllabus which were derived from the analysis as 'difficult for the learners to understand' were finally considered for developing the modules. The generic aspects which were derived from the analysis of the data collected through the survey were incorporated in the content preparation of modules as part of the development of the Professional Enrichment Programme. The development of the programme was further carried out in different phases: modules' development, validation of the content of the modules by experts, implementation of the programme and studying the effectiveness of the programme.

Strong content with clarity impacts immensely in the success of any teaching–learning programme. Hence, content of the module's development was given much importance by the researcher, with a strong desire to make an effective Professional Enrichment Programme for the secondary mathematics teachers, by keeping the objectives of the study in mind. The researcher thoroughly studied all the related literature and also referred several such modules developed earlier for the professional enrichment of mathematics teachers. The researcher, by focusing the objectives of the programme development, made all efforts in developing an effective enrichment programme in order to make a positive impact in the learning outcomes of learners, though ultimate receivers of the programme are teachers.

4.2.1 Programme Objectives:

Though the receivers of any professional development programme are teachers, but ultimately it helps children succeed and come out with good learning out comes.

The present programme is designed and developed by the researcher with the above purpose. The following are the other few objectives with which programme was developed.

1. To help the teachers to understand the various strategies of teaching the mentioned topics of secondary section mathematics, which are identified through the need assessment survey.
2. To give an understanding to the teachers, how to blend the various teaching techniques with the traditional methods.
3. To make the teachers familiarize with the new trends, techniques and terminologies of teaching mathematics, new assessment pattern etc. as emphasized by NEP-2020 and recommended by CBSE.
4. To develop an interest for the subject mathematics amongst the learners through the implementation of the developed programme by the teachers.

Overall, the programme was designed with an objective to underscore the importance of the targeted strategies to enhance the awareness and integration of educational frameworks and standards into teaching practices, ensuring a comprehensive support for the mathematics teachers. A detailed description of the works carried out in each phase is given in the following section.

4.2.2 Programme Design and Development:

With an aim to develop 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- the researcher felt the need of a strong design for the programme. For the programme designing, many reviews have been made by the researcher in order to have its strong base. After studying several programmes earlier designed by various researchers, the current programme was designed and developed by focusing the objectives of the study. The reviewed literature, study of the other programmes, teaching modules and programme principles have given a direction to the researcher for the present programme designing and development.

The review of the above such literature categories, enhanced the researcher to identify, decide and design the kind of programme required and suitable for the particular instructional and other

needs identified through the need analysis survey and the other tools, during the first phase of the study.

The effectiveness of any enrichment programme depends mostly on the ability of programme developer. All enrichment programmes are designed to make some difference and improvement in the existing system and the status of teachers. If the participants involved show positive changes in their practices, then only the programme is said to have a broader impact in the system. To make that impact possible, it is necessary to follow certain principles of programme designing. With this aim, the researcher has also reviewed certain programme principles. The researcher incorporated and followed such principles, wherever felt applicable, while developing the content of the programme.

4.2.3 Programme Principles

The effectiveness of any enrichment programme depends mostly on the ability of the programme developer. Professional development and enrichment programmes of any kind are aimed and designed to make some difference and improvement in the existing system. If the participants involved show positive changes in their practices, then only the programme is said to have a broader impact in the system. To make that impact possible, there are certain principles to be followed while developing the programme.

Anderson & McCormick (2005) suggest 10 principles that may help designers to construct pedagogically sound e-learning programme, and these 10 principles may help any designer to develop effective enrichment programme for teachers by designing teaching-learning materials and other resources and also by designing teaching learning activities. Those 10 principles are: Matching the Curriculum, Inclusion of all kind of learners, Learning Engagement of learners, Innovative Approaches, Effective learning strategies (by using a range of different approaches in the learning platforms that will allow the student to choose one that suits him/her), Providing Formative Assessment , Summative Assessment **(**able to deal with a range of achievements levels), Coherence, Consistency & Transparency (in the way the objectives, content, student activity and assessment match to each other), Ease of use and Cost-Effectiveness.

National Curriculum Framework for Teachers Education (NCFTE, 2009) also had put forth several principles that need to govern the design of professional enrichment programmes. These include: designing programs with clarity about aims and strategies for achieving these aims,

allowing teachers to relate the content of the program to their experiences and also to find opportunities to reflect on their experiences, and respecting the professional identity and knowledge of a teacher and to work with and from it.

According to Manichander (2016), the process of professional development should be based on sound educational practice such as contextual teaching. It should focus on: Enriching teachers' knowledge of the subjects / topics being taught, Sharpening their teaching skills in the classroom, Generating and contributing new knowledge to the profession and Increasing teachers' ability to monitor students work in order to provide constructive feedback to students and hence to redirect teaching.

Researcher thoroughly reviewed the 'Guidelines for 50 Hours of Professional Development for Teachers, Head Teachers and Teacher Educators', based on National Education Policy (2020), published by NCERT (2022). In the guidelines, it states: "The challenge of designing relevant CPD programmes involves developing them in such a manner that they remain useful to their local contexts as well as cater to the national level concerns. Thus, question such as 'what kind of professionalism is needed by teachers?', 'how teacher training should transform into teachers' professional development?', 'what are the essential pre-requisites for the implementation of CPD?', need to be considered carefully. A well-rounded CPD programme should, therefore, address some of the following relevant concerns:

Generic concerns for professional development of teachers like - Understanding learner, Understanding teaching and its complexities, Understanding cognitive processes of understanding and learning, Understanding education, school, and society and their interrelations, Understanding health, yoga and well-being, Understanding issues of knowledge construction, curriculum development and pedagogical transaction in an inclusive classroom setup, Understanding gender with reference to school and society, Understanding the relational idea of inclusion and diversity, Understanding the development of knowledge base for school curriculum, pedagogy and assessment, Understanding the importance of language, centrality of language in learning, MLTs, Revisiting and understanding the policy documents, such as national education policies, reports of commissions and committees, curriculum frameworks,

centrally and states/UTs sponsored schemes and RTE Act, 2009, Understanding rootedness and pride in India and its human and constitutional values, culture and knowledge system.

Subject-specific competency-based pedagogical approach like - Understanding the nature of different school subjects, and their interrelations with other subjects, Getting familiar with the recent developments in respective subject areas, Understanding twenty-first century teaching-learning strategies such as, experiential learning, problem solving, and ICT based teaching-learning, Strategies for improving classroom practices, Action research, Grounded research, Experiential learning , Art-integrated learning, Sports-integrated learning ,Toy-based pedagogy, ICT-based pedagogy (other than PPT), Holistic assessment, adaptive assessment, 360-degree assessment, portfolio assessment, holistic progress card and other examination reforms, Inclusive pedagogy/education.

Systemic concerns like - Understanding supervision, leadership and management in relation to quality attainment in schools, Understanding vocational education, start-up, and entrepreneurship in relation to vocationalisation of school education, Implement the 10-day bag less period for 6–12 grade students with local vocational experts, such as carpenters, gardeners, potters, artists, etc., to learn vocational skills through team teaching approach and experiential pedagogies as per the NEP 2020 para.4.26, Understanding school initiatives and community engagement, Critically understand policy perspectives related to school education" (CPD Guidelines based on NEP 2020)

Review made by the researcher on such guidelines and other programme principles gave deeper insights and clarity on developing and implementing the present programme. Researcher immensely focused on the curriculum matching principle, while developing the content of the programme. Researcher took utmost care to assure that the programme implementation in the classrooms can benefit various kinds of learners of the heterogeneous classrooms, in terms of getting improved learning outcomes by adopting effective learning strategies. Researcher incorporated the innovative approach principle as well in the programme. The review of programme principles helped the researcher to understand the significance of few parameters to be involved while framing the programme. By keeping the above principles and other factors in mind, the researcher put sincere efforts to design the present Professional Enrichment

Programme, with an aim to make it beneficial for the secondary mathematics teachers which in turn may provide improved learning experiences for learners.

4.2.4 Structure of the Programme

The complete structure of the programme, at a glance is given in the following figure.

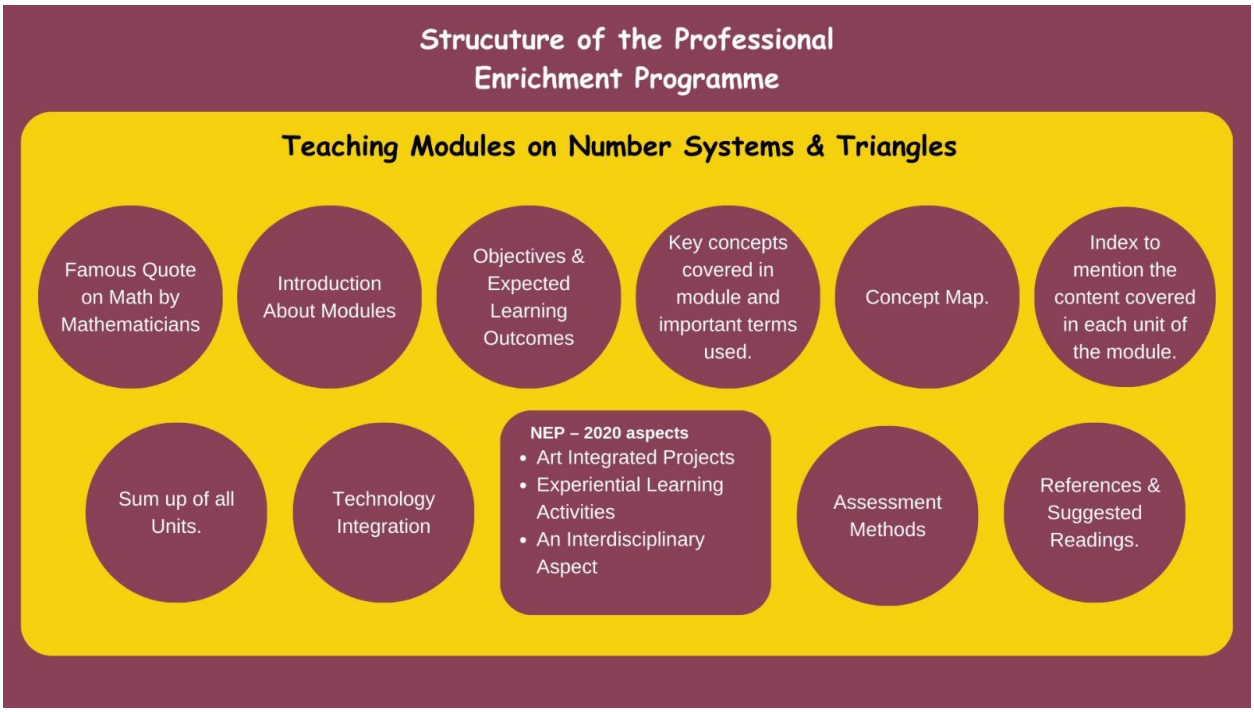


Figure - 4.1 Structure of the Professional Enrichment Programme

Researcher, by keeping the programme objectives in mind, designed and developed the present programme in the following manner.

- **Need Identification**

In the first phase of the study, the researcher identified the training needs and other professional enrichment needs of the mathematics teachers of secondary schools through the need analysis survey carried out through the self- developed questionnaire-Need Assessment Questionnaire for the Professional Enrichment of Mathematics Teachers (NAQPEMT). During the preparation of the questionnaire, the researcher has taken the guidance from experts of the field like senior mathematics teachers, Principals with mathematics background and the Professors of mathematics department of various Universities.

The researcher, being in the education field since past two decades, could closely watch the mathematics education happening in secondary schools and through interaction and discussions with the mathematics teachers and Principals of various schools, framed a strong base for the programme development.

112 mathematics teachers from Gujarat constituted the sample for the survey. The analysis of the data collected through the survey helped the researcher to identify the training and professional enrichment needs of the secondary school mathematics teachers. On the basis of the identified needs both in terms of content and generic, the researcher designed and developed the self-learning teaching modules and the entire programme. The following steps were followed in creating the content for the modules.

- **Organizing the content**

The researcher made sincere efforts in organizing the self -explanatory content of the modules. All learning parameters have been incorporated in the modules to make it more meaningful and effective for teachers by considering both content and generic aspects. Pedagogical and methodological aspects were incorporated with technology. NEP-2020 recommendations were also given importance while organizing the content.

- **Expert's guidance and opinions**

While developing the content for the programme, the researcher was constantly validating the programme through the experts' guidance. At every step of the programme development, the researcher sought opinions of the experts at regular intervals, as and when the content development was in progress. Regular discussions were made possible with few senior professors of mathematics and also with few principals of schools, who are well versed with the subject mathematics. The suggestions and opinions so sought by the experts were incorporated in the content development of the modules, wherever felt necessary and applicable. After such modifications, the researcher developed the content for 4 modules on 4 identified topics.

Each module contained: introduction, concept map, warm up activities to relate the previous knowledge, activities to enhance learning, sum up of the content, few NEP-2020 aspects like-Art Integrated Projects, Experiential Learning Activities, and Interdisciplinary aspects. Also, it

contains few Assessment methods, References and Suggested Readings for mathematics teachers.

- **Technology Integration in the Programme**

After the content development of the modules, the researcher developed the complete programme by incorporating the modules with the self-developed videos content, covering every important topic which the teachers opined as difficult for the learners to understand. For the development of the video content, the researcher took the help of professional technical experts in order to assure the quality and clarity of the self- developed videos. While developing the videos, the researcher assured that every video has matter to enhance the concept understanding of the teachers and also certain facts which are not available in the NCERT content. Every module contains 3-4 such developed videos which are incorporated by converting in the form of links and also as QR codes, by considering the user friendliness of the programme.

- **Incorporation of NEP-2020 aspects in the Programme**

Since the National Education Policy (NEP)- 2020 and its implementation in the system started echoed in air during the present study, the researcher spent good amount of quality time to understand the recommendation given by the policy makers to ensure the quality mathematics education at secondary level. With the understanding drawn from the new policy, the researcher included the relevant and required NEP-2020 aspects like Art Integration with mathematics, Experiential learning aspects related to few of the topics considered for the development of the modules and certain Inter Disciplinary aspects related to few topics of the developed modules.

- **Assessment Practices, Suggested Readings and References in the Programme**

In the developed programme, the researcher also provided the assessment practices which are essential to understand the concept clarity in learners. The researcher also gave few suggested readings and references in each module, referring which the teachers may enhance their knowledge about the particular topics chosen for modules development.

Details of the modules so developed, along with the description about the units in each module are given below.

MODULE-1: NUMBER SYSTEMS

Unit – 1	**Introduction** **Natural numbers, Whole numbers, Integers, and Rational numbers**
Unit – 2	Irrational numbers Representing irrational numbers on a number line.
Unit – 3	Real Numbers and their Decimal Expansions.
Unit – 4	Representing Real Numbers on the Number Line.
Unit – 5	Operations on Real Numbers
Unit – 6	Laws of Exponents for Real Numbers.
Unit – 7	Sum-up of all Units:
Unit – 8	NEP-2020 Aspects • Art Integrated Projects • Experiential Learning Activities • An Interdisciplinary aspect.
Unit – 9	Assessment Methods
Unit – 10	References /Suggested Readings.

MODULE-II: TRIANGLES

Unit – 1	**Introduction** **Euclid's Division Lemma (Theorem 1)** **Euclid's Division Algorithm**
Unit – 2	The Fundamental Theorem of Arithmetic (Theorem 2)
Unit – 3	Revisiting Irrational Numbers Theorem (3), Theorem (4)
Unit – 4	Revisiting Rational Numbers and Their Decimal Expansions Theorem (5), Theorem (6) Theorem (7)
Unit – 5	Sum-up of the Chapter (of all Units)
Unit – 6	NEP 2020 Aspects. • Art Integrated Project. • Experiential Learning activity. • An Interdisciplinary aspect.
Unit – 7	Assessment Methods
Unit – 8	References / Suggested Readings.

MODULE-III: REAL NUMBERS

Unit – 1	**Introduction:** **Congruence of Triangles.**
Unit – 2	Criteria for Congruence of Triangles Axiom – 1 (SAS Congruence Rule) Theorem – 1 (ASA Congruence Rule) AAS Congruence Rule
Unit – 3	Some properties of a Triangle. (Theorem – 2 and 3)
Unit – 4	Some more properties of a Triangle (Theorem 4 and 5)
Unit – 5	Inequalities in a Triangle. (Theorem 6, 7, 8)
Unit – 6	Sum up of the Chapter (of all Units).
Unit – 7	NEP-2020 Aspects: • Art Integrated Project. • Experiential Learning Activity. • An Interdisciplinary aspect.
Unit – 8	Assessment Methods.
Unit – 9	Reference / Suggested Readings

MODULE- IV: TRIANGLES

Unit – 1	**Introduction** **Similar figure**
Unit – 2	Similarity of Triangles. Basic Proportionality Theorem (BPT) Converse of BPT.
Unit – 3	Criteria for similarity of triangles. AAA similarity criterion SSS similarity criterion SAS Similarity criterion
Unit – 4	Areas of similar triangles.
Unit – 5	Theorem on Perpendicular to hypotenuse. Pythagoras Theorem: Converse of Pythagoras Theorem
Unit – 6	Sum up of the Chapter (of all Units).
Unit – 7	NEP 2020 Aspects • Art Integrated Project. • Experiential Learning Activity. • An Interdisciplinary aspect.
Unit – 8	Assessment Methods
Unit – 9	References / Suggested Readings.

4.2.5 Validation of the Content of the Programme

The modules so developed by the researcher were given to few senior mathematics teachers of secondary schools, school principals and retired professors of mathematics in order to validate the content. The researcher conducted discussions and interactions to have the suggestions and inputs from the experts and their valuable and relevant inputs were taken into considerations in making the overall content of the Professional Enrichment Programme.
The Professional Enrichment Programme so developed is enclosed in **Appendix VI.**

The next section of the chapter explains about the scheme of implementation and evaluation of the programme.

SECTION – III

4.3 Implementing and Evaluating the Effectiveness of the Programme

The following activities were carried out by the researcher for implementing and evaluating the effectiveness of the developed Professional Enrichment Programme.

4.3.1 Implementation of the Programme

Implementation of the programme was done by the researcher as mentioned in the following steps.

Step-1: **Physical training session**

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.

The session was conducted by the researcher at IIRA INTERNATIONAL SCHOOL, Bhayli,Vadodara on 8th July 2023 for 8 hours of the day. All the 4 modules developed on the four topics of secondary mathematics were presented to the participants with the help of the Power Point Presentation and also through few engaging activities. All the aspects of the programs- Concept Map, Warm up activities, Sum up of the chapters, relevant Art Integrated

project ideas, Experiential learning activities related to the topics presented, self-made Videos of the researcher, Assessment practices, Competence based question formation, Interdisciplinary aspects of the topics, Suggested readings & References for teachers- were explained in details to all the participants during the physical training session.

A feedback form was asked to fill after the session feedback /opinions so collected were both quantitative and qualitative in nature and the analysis of the same is done accordingly using quantitative and qualitative approaches. The analysis and the interpretation of the same are presented in the section – 'Evaluating the effectiveness of the programme.'

Step- 2: Online training sessions

After the physical training session of the 62 teachers, the researcher was continuously in touch with all participants online, and their queries on the programme were discussed through the platform- WhatsApp group and the researcher contacted the participants over the phone also, wherever required.

Step-3: Implementation of the programme by the selected teachers

Out of 62 participants teachers of the offline and online training sessions, the researcher selected 12 teachers as sample using the convenience sampling techniques. The researcher focused on the following aspects while doing the convenience sampling:

- Curriculum mapping was seen by the researcher while choosing the sample teachers. The researcher assured that the content of the developed programme and the curriculum followed in schools from where the sample teachers to be selected are in alignments.
- Willingness of the School Authorities and Principals of the schools in which the programme was to be implemented was seen by the researcher. The researcher approached them for the permission of the implementation of the programme in their institutes.
- Willingness and acceptability on part of secondary mathematics teachers were also taken into consideration for the sample selection.
- Convenience of the access and reaching out to the sample teachers for further interactions and classroom observations was also taken into consideration while choosing the sample teachers for the implementation of the programme.

Accordingly chosen 12 teachers were asked to explore the self- learning aspects of the programme at their convenience. The researcher was constantly guiding the teachers through online platforms and their queries were answered accordingly. Teachers were given a duration of 2 months to explore the modules. After the thorough exploration and understanding of the programme, the teachers were asked to implement the programme in their classrooms. Each teacher utilized an average number of 7 periods to implement each module in the classrooms. The researcher was constantly guiding those 12 teachers through online sessions and interactions. While implementing the programme, the researcher made classroom observations of 4 teachers, in order to understand whether the programme was implemented for the learners in its true spirit with proper understanding of the programme or not.

4.3.2 Evaluating the Effectiveness of the Programme

The effectiveness of the Professional Enrichment Programme was studied through the following steps.

1. The feedback collected from the participant teachers- both who attended the training session and implemented the programme, and also from the students for whom the programme was implemented by the participating mathematics teachers.
2. Informal interviews and online interactive sessions were conducted to understand the effectiveness of the programme.
3. Selected teachers' classroom observations were also made by the researcher.

The next section explains about the details of the opinions collected through the feedback forms and the analysis and interpretation of the data.

4.3.2.1 Feedback

In order to study the effectiveness of the programme, 3 types of feedback forms were developed by the researcher:

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

The feedback forms of teachers included statements to understand their profile and background information. Various parameters were taken into consideration while developing the feedback forms, in order to understand the effectiveness of the programme.

Detailed analysis of both quantitative and qualitative data collected through the feedback forms are presented below.

4.3.2.1.1 Analysis of the Feedback of the Participant Teachers who Attended the Physical and Online Training Sessions

The researcher took feedback from the 62 participant teachers who attended the physical training session, through the self- developed feedback form. The feedback form contained statements to collect opinions about the following aspects of the training session and also to understand the quality and effectiveness of the modules : Meaningfulness of the sessions , Relevance in the content, Quality of content delivery and presentation, Whether modules were innovative, Adaptability of the modules, Quality and usability of- Art integration ideas, Experiential learning examples, Interdisciplinary aspects, Assessment methods, Video links incorporated and the Competency based teaching- learning ideas included.

Quantitative Data Analysis

The data captured so was quantitative in nature and it was collected on a 5-point rating scale. Further the data integration was done and analysis of the same was done using the percentage calculations. The analysis of the responses received through the feedback so gathered is presented below:

Table - 4.10: Responses of the Participant Mathematics Teachers on the Effectiveness of the Training Sessions

Sr. No.	Component of the Feedback about the programme.	Total Responses	Ratings on Effectiveness				
			1 (Needs Modification)	2 (Average)	3 (Good)	4 (Very Good)	5 (Excellent)
1	Do you find the training session (workshop) meaningful?	62	0	0	1 (1.61%)	16 (25.81%)	45 (72.58%)
2	Was it relevant in your area of work(teaching-learning)?	62	1 (1.61%)	1 (1.61%)	1 (1.61%)	19 (30.65%)	40 (64.52%)
3	Rate on the content delivery and presentation.	62	0	1 (1.61%)	0	13 (20.97%)	48 (77.42%)

4		Were the teaching modules innovative?	62	0	0	1 (1.61%)	20 (32.26%)	41 (66.13%)
5		**Rate on the Usability and Quality of:**						
	1	Art integration ideas:	62	0	0	1 (1.61%)	22 (35.48%)	39 (62.90%)
	2	Experiential learning aspects:	62	1 (1.61%)	0	2 (3.23%)	22 (35.48%)	37 (59.68%)
	3	Interdisciplinary aspects:	62	0	1 (1.61%)	2 (3.23%)	25 (40.32%)	34 (54.84%)
	4	Competency based teaching learning ideas:	62	1 (1.61%)	0	2 (3.23%)	18 (29.03%)	41 (66.13%)
	5	Assessment methods discussed:	62	0	1 (1.61%)	0	24 (38.71%)	37 (59.68%)
	6	Video links shown:	62	1 (1.61%)	2 (3.23%)	3 (4.84%)	23 (37.10%)	33 (53.22%)

Participant teachers' feedback about the workshop indicated a high level of satisfaction and perceived effectiveness across various dimensions. The majority of the respondents found the workshop highly meaningful, with approximately 71% (44 participants) rating it as very meaningful and about 26% (16 participants) considering it meaningful. Similarly, a significant proportion (63%, 39 participants) deemed the workshop highly relevant to teaching-learning, reflecting its alignment with educational needs. Content delivery and presentation received overwhelmingly positive feedback, with around 76% (47 participants) of participants rating it as excellent, highlighting the effectiveness of the instructional methods employed.

The innovative teaching modules were well-received, with approximately 65% (40 participants) of respondents appreciating their creativity and 32% (20 participants) acknowledging their moderate innovativeness. Art integration ideas were valued by 61% (38 participants), indicating their perceived contribution to enhancing learning experiences. Experiential learning aspects and interdisciplinary approaches also garnered favorable responses, with about 58% (36 participants) and 53% (33 participants) of participants finding them effective, respectively. Competency-based teaching-learning ideas received high praise, with around 65% (40 participants) rating them as highly beneficial. Assessment methods discussed were deemed valuable by about 58% (36 participants), while video links shown were considered helpful by approximately 52% (32 participants).

Overall, the training session was highly regarded by the participants, who found it meaningful and relevant to their area of work in teaching and learning. The content delivery and presentation were particularly praised, with many attendees noting that the teaching modules were innovative. Art integration ideas and experiential learning aspects were also appreciated, indicating that these components were well-received. Interdisciplinary aspects and competency-based teaching-learning ideas were valued, demonstrating their effectiveness in the workshop. The discussion of assessment methods was seen as beneficial, and while the feedback on video links shown was slightly more varied, it was still generally positive. Overall, the training session was deemed effective and successful by the majority of participants, highlighting its positive impact.

4.3.2.1.2 Analysis of the Feedback of the Teachers who Implemented the Programme in the Classrooms

After having the physical training, interaction through online mode and the explanation of the developed modules, discussions were made on the implementation. Further, selected 12 teachers from Vadodara city were asked to implement the program 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 Modules. After exploring and implementing the programme in their classrooms, the researcher took feedback to study the effectiveness through the self- developed feedback form. The detailed description and analysis of the same is presented in the next section.

Feedback form contained the statements to understand the general information of the teachers like educational background, experience, tech savvy aspects, their participation in any other professional enrichment programme etc.

Apart from the general information, the feedback form included four parts to collect opinions and responses on various aspects of the modules.

Part - I contained the statements to understand the frequency, the time spent on, duration etc. in exploring the 4 modules. Part - II of the feedback contained statements to understand the quality of the following aspects of the modules: Concept Map, Clarity of the content, Organization of

the content, View on- Warm up activities, Teaching points, Teaching process, Language flow, Usefulness of the Technical aspects - i.e., self -made video links, Adaptability and usability of: - Art integration ideas, Experiential learning examples, Interdisciplinary aspects and Assessment Methods. In the next part – Part- III- of the feedback form, the researcher included 3 open ended questions to understand the further need of the training session required, which aspect/s of the modules they liked the most etc. The last part – Part-IV – of the feedback form contained statements to understand the overall effectiveness of the programme for which the responses were collected in 'YES' or 'NO' form.

The data captured through these 4 parts of feedback was both quantitative and qualitative. The data integration and analysis were done and the interpretation of the same is presented below.

Quantitative Data Analysis.

The quantitative data gathered using the Feedback of the teachers who explored and implemented the professional enrichment programme in their classrooms were analyzed by the researcher by integrating the data in table – 4.11 and converting the responses in percentage.

Table-4.11 Responses of Mathematics Teachers who Implemented the Programme

Sr. No.		Component of the Feedback about the programme	Total Responses	Ratings on the Effectiveness of the Programme.				
				1 (Needs Modification)	2 (Average)	3 (Good)	4 (Very Good)	5 (Excellent)
1		Concept Map (How helpful was it?)	12	0	0	0	3 (25%)	9 (75%)
2		Clarity of Content	12	0	0	0	4 (33%)	8 (67%)
3		Organization of the content	12	0	0	0	3 (25%)	9 (75%)
4	**Ratings on:**							
	1	Warm-up activities	12	0	0	0	2 (17%)	10 (83%)
	2	Teaching Points	12	0	0	0	2 (17%)	10 (83%)
	3	Teaching Process	12	0	0	0	4 (33%)	8 (67%)
	4	Language Flow	12	0	0	0	0	12 (100%)
5		Rate the quality and usefulness of the video links shared	12	0	0	0	1 (8%)	11 (92%)

6	**Ratings on Adaptability and Usability (how helpful was it?) of:**							
	1	Incorporated Art Integration ideas	12	0	0	0	3 (25%)	9 (75%)
	2	Experiential learning aspects	12	0	0	0	1 (8%)	11 (92%)
	3	Interdisciplinary inputs	12	0	0	0	2 (17%)	10 (83%)
	4	Assessment method	12	0	0	0	1 (8%)	11 (92%)

The feedback on the program was overwhelmingly positive, with the majority of components rated as "Excellent" or "Very Good." The Concept Map was rated "Excellent" by 75% of participants and "Very Good" by 25%, indicating its high effectiveness. Clarity and organization of the content received similar praise, with 67% and 75% of respondents rating them as "Excellent," respectively. Key teaching aspects, including Warm-Up Activities and Teaching Points, were also highly rated, with 83% of participants marking them as "Excellent." The Teaching Process received 67% "Excellent" and 33% "Very Good" ratings, while Language Flow was rated "Excellent" by 100% of the participants, highlighting the clear and effective communication throughout. The quality and usefulness of the video links were rated "Excellent" by 92% of participants, demonstrating their relevance to the learning experience. Incorporated art integration ideas and interdisciplinary inputs were rated "Excellent" by 75% and 83%, respectively, while experiential learning aspects received an impressive 92% "Excellent" rating, emphasizing the program's interactive and practical approach. The feedback on the assessment method was not explicitly provided, suggesting a need for further refinement or better communication of its effectiveness. Overall, the program demonstrated strong content delivery, effective teaching strategies, and impactful integration of additional learning tools, making it a highly successful educational experience.

The data collected through the Feedback Form to understand the overall effectiveness of the programme, was integrated and the quantitative data so collected was analyzed through percentage calculations. The integration of the data and the interpretation of the data analysis are presented below.

Table - 4.12 Responses of Mathematics Teachers on the Effectiveness of the Programme

Sr. No.	Component of the Feedback Form about the Programme	Total Responses	Responses	
			YES	NO
1	User Friendliness (Was easy to access or not):	12	3 (25%)	9 (75%)
2	Whether the content of the Modules is logically and sequentially arranged?	12	3 (25%)	9 (75%)
3	Whether the learning experiences are relevant and meaningful to the learners?	12	0 (0%)	12 (100%)
4	Do you feel it is adaptable?	12	1 (8%)	11 (92%)
5	Do you feel the content of each module can be used as self-learning materials for your professional enrichment?	12	2 (17%)	10 (83%)
6	Was it innovative?	12	2 (17%)	10 (83%)
7	Whether modules are useful for the students to get clarification on different concepts?	12	3 (25%)	9 (75%)
8	Whether the modules help in developing positive attitude towards learning Mathematics?	12	3 (25%)	9 (75%)
9	Whether the scholastic achievements of the students can be enhanced through the implementation of these modules in the classroom?	12	2 (17%)	10 (83%)

12 Participant teachers' feedback on the programme and its analysis provided valuable insights into the perceived effectiveness and usability of the content. The quantitative data collected was analyzed using percentage and the interpretation of the same is given below.

A significant majority of participants, 75% (9 participants), found the modules to be highly **user-friendly,** rating them as accessible and easy to navigate. The same percentage (75%), appreciated the **logical and sequential arrangement of the content,** highlighting its clarity and organization. All participants (100%) rated the learning experiences as **highly relevant and meaningful**, emphasizing the perceived educational value of the modules. In terms of **adaptability**, 91.7% (11 participants) viewed the content as versatile, suitable for diverse teaching environments. The modules were also seen as **suitable for self-learning and professional enrichment** by 83.3% (10 participants), underscoring their potential beyond traditional classroom settings. The perceived **innovativeness** of the modules was recognized by 83.3 % (10 participants), reflecting a moderate endorsement of their creative aspects.

Regarding **content utility**, 75% (9 participants) noted that the modules were effective in clarifying complex concepts. An equal percentage (75%) reported a **positive impact on**

developing a favorable attitude towards learning mathematics, suggesting motivational benefits. Finally, 83.3% (10 participants) believed the modules could significantly **enhance scholastic achievements** of students, reflecting optimism about their educational outcomes.
These findings provided valuable insights into participant perspectives, leading future developments to enhance module effectiveness and educational impact.

Overall, the findings emerged through the analysis and interpretation of the quantitative data captured from the selected 12 participants of the programme were positive and everyone expressed their happiness on the opportunity they got to explore such a Professional Enrichment Programme.

The qualitative data analysis of the feedback of the 12 mathematics teachers who explored and implemented the professional enrichment programme is presented in the following section.

Qualitative Data Analysis.

The researcher collected the qualitative data through few open-ended questions included in the feedback form. Qualitative data was also captured through informal interviews, discussions and classroom observations of selected teachers. The analysis and interpretation of the same are given below.

Analysis of the Opinions Collected through Feedback

The analysis of the general information collected through the feedback form of all 12 teachers helped the researcher to understand the status of the sample teachers.

The majority of respondents hold a B.Ed. degree (11), followed by M.Sc. and PG degrees with 3 respondents each. The majority of respondents (7 teachers) have 1.5-4.5 years of experience. 4 teachers have 4.5-7.5 years of experience, while only one has 7.5-10.5 years of experience. This indicates a higher concentration of teachers in the early to mid-career stages. Out of 12 teachers, 3were exposed to participate in other professional enrichment programme earlier. 11 participants responded that they have working knowledge of computer/ digital devices and all those 11 teachers are tech savvy. **7** of the participants explored the modules by using 10 hours or less and 5 teachers took more than 10 hours. Out of 12 participating teachers who explored the modules,

7 teachers mentioned that they explored the self - learning part of the modules on alternative days and the remaining 5 teachers did the same every day.

3 open ended questions included in the feedback form are as shown below:

1) Which features of the modules, you liked the most?
2) Do you have any suggestions to modify the modules further?
3) Would you prefer to have any more training on the implementation of the programme?

If YES, then which mode- online/ offline?

The qualitative data so collected for the above open-ended questions were analyzed and interpretations are given below.

All the 12 participants responded to the first question. Out of 12 teachers, 4 teachers responded about the CONTENT DEVELOPED, TEACHING METHODS MENTIONED and CONCEPT CLARITY of the programme as the most liked features and 2 teachers appreciated the ART INTEGRATION PROJECTS mentioned in the modules as the most liked feature of the programme. 1 teacher found ART INTEGRATION and the VIDEO CONTENT given as the most liked features. 1 teacher expressed the EXPERIENTIAL LEARNING IDEAS mentioned as the most effective ones where as 1 teacher liked the WARM UP ACTIVITIES mentioned. 1 teacher found the interdisciplinary aspects mentioned in the programme as the most liked feature whereas 1 teacher expressed ACTIVITIES BASED ON REAL LIFE SITUATIONS as the most interesting ones. 1 teacher appreciated all the 4 modules as a wholesome material. The respond was - “The modules are a wholesome material on the topics as each and every aspect of the topic is taken care off and well addressed. I find EXPERIENTIAL LEARNING ACTIVITIES and MIND MAPS very useful. The SELF ASSESSMENT SERIES OF QUESTIONS are also very helpful.”

As the response to the question about any modification in the modules, out of 12 participants, only 1 suggested to incorporate the competency-based questions in the modules.

As the response to the last question about the requirement of any more training and interactive sessions, 3 teachers responded as ‘no such requirements’, but other 9 teachers expressed their need for more interactive sessions on the programme, online. The researcher contacted all those

teachers online and had interaction and discussions further to keep them ready for the implementation of the programme.

Analysis of the Responses Collected through Informal Interviews and Interactions

To study the effectiveness of the PEP, (Phase V), the researcher also conducted informal interactions and interviews with teachers who implemented the developed programme. These informal interactions helped the researcher to study the impact of the programme on Teachers' Professional Development.

The researcher could capture insightful information through the informal interviews. All information and the comments were minutely recorded and analyzed during the study of the effectiveness of the professional enrichment programme presented to the secondary mathematics teachers.

Participating teachers opined about various aspects of the programme. 'Concept Map' was highly appreciated by all participating teachers. Two teachers expressed their opinion about the quotes by famous mathematicians as 'very relevant and meaningful'. One teacher highly appreciated about the pre–requisite knowledge mentioned in each module. Agreeing to it, another teacher conveyed 'pre- requisite knowledge mentioned in each module can help the teachers to focus on the areas to be emphasized while teaching that particular topic. 5 teachers commented, 'the warm activities have made all the students very much focused on the topics which are explained further in the module'. 4 teachers stated 'the Art Integration Ideas and Experiential learning activities mentioned are very useful in creating an interest in learners towards the abstract content covered in the professional enrichment programme'. The interactions with whom so ever conducted, every one opined positively about the effectiveness of the Video links provided and the Interdisciplinary aspects mentioned by connecting different topics with different subjects- English, Science, Social Science and Computer-in different modules. One teacher stated', the implementation of the video contents literally raised the interest of students in the subject aiding them with the improved conceptual clarity'. 2 of the teachers talked about the 'Assessment Methods' which they found 'essential for understanding the learning gaps and to give remedies accordingly'. During these informal sessions, 2 teachers expressed the happiness of being part of this professional enrichment programme and the

learning activities, which could really enhance their knowledge in many of the content and generic aspects incorporated in the programme. One teacher commented - 'the overall programme has opened new avenues in teaching- learning of the covered topics, leading to the scope for improved learning outcomes of the students of Class IX & X.'

Analysis of the Data Collected through Classroom Observations

For Phase V (evaluating the effectiveness of the programme) the researcher, on an average observed, four units of each module implemented in classrooms of the selected 2 mathematics teachers who implemented the programme. The content presentation by the teachers through the 'warmup activities' was observed highly impactful. Researcher observed the students thoroughly enjoying the activities mentioned in the module and hence teacher comprehending the concept very easily. The video content presented in the modules helped the teachers to explain the relevant topics effortlessly, inducing much interest in students in those topics and in the subject mathematics as a whole. Researcher observed students enthusiastically learning the 'interdisciplinary aspect' of the topic 'Real Number' with other subject- English in the form of 'Limerick poem'. 'Art integrated project' presented by the teacher on 'Congruence of Triangles' was seen very interesting for students of the class rooms. Overall, the researcher observed, teachers implementing the programme with a positive attitude and approach and students learning the topics interestingly.

4.3.2.1.3 Analysis of the Feedback of Students for whom the Programme was Implemented by the Participating Teachers

Further to understand the effectiveness of the programme in terms of students 'understanding and their learning outcomes, the researcher took feedback from the students of classes IX & X, for whom the programme was implemented by the participating mathematics teachers. The detailed description and analysis of the same is presented in the next section.

Feedback form included the statements to understand the students' understanding on**:** the Warm up activity to recollect the previous knowledge, Clarity on the content, Learning experiences of students, Whether the activities mentioned enhanced the concept understanding of the students or not, Whether it helped to develop any interest in the subject in students, Whether the features-

Art integration ideas , Experiential learning examples, Interdisciplinary aspects and Videos incorporated- in the programme could enhance their overall scholastic achievements or not.

The detailed analysis of the responses received through the feedback form from students is presented below:

- **Students' Feedback Analysis: CLASS- IX**

Below given table shows the number of students of class IX who were the part of the programme implemented by the participating teachers.

Table - 4.13 Number of students who explored Modules- I & II

Could Explore the Modules?	Explored Modules	
	MODULE - I NUMBER SYSTEMS	MODULE - II TRIANGLES
Yes	171 (99%)	171 (99%)
No	2 (1%)	2 (1%)

Total 173 students of class IX were exposed to the teaching modules: MODULE-I: NUMBER SYSTEMS & MODULE – II: TRIANGLES, out of which 171 students responded through the feedback form.

From the responses of class 9 students on various aspects of the modules, the researcher understood, both the modules; NUMBER SYSTEMS & TRIANGLES were exposed to them by the teacher who implemented them by taking an average number of 7 periods.

The data provided shows the responses of 171 students of CLASS IX regarding their understanding of two mathematical modules**: Number Systems** and **Triangles.** For the module Number Systems, an overwhelming majority of students indicated understanding, suggesting that the teaching methods and materials used for this module were highly effective, resulting in a high level of comprehension among students. Only a very small percentage of students reported not understanding this module, indicating minimal need for additional support. In contrast, the

Triangles module presented more challenges. While a majority of students indicated understanding, a significant minority reported the topics understanding as little challenging. This suggests that the content of this chapter more challenging but they expressed that the instructional methods incorporated in the module enhanced to improve their comprehension of the concepts.

Table - 4.14 The responses of students on various aspects of the modules- Class: IX

Sr. No.	Component of the Feedback about the program (Item No.)	Total Responses	Ratings on Effectiveness					
			Blank Responses	1 (Needs Modification)	2 (Average)	3 (Good)	4 (Very Good)	5 (Excellent)
1	Whether the warm up activities helped you to recollect the previously learned concepts?	173	2(1.16%)	1(0.58%)	22 (12.72%)	81 (46.82%)	34 (19.65%)	33 (19.08%)
2	Rate on the clarity of the content implemented in class (whether logically and sequentially arranged and understood)	173	2(1.16%)	6(3.47%)	16 (9.25%)	61 (35.26%)	77 (44.51%)	11 (6.36%)
3	Whether the learning experiences were meaningful?	173	2(1.16%)	3(1.73%)	26 (15.03%)	56 (32.37%)	52 (30.06%)	34 (19.65%)
4	Whether it was useful to get clarity on different concepts?	173	2(1.16%)	1(0.58%)	19 (10.98%)	71 (41.04%)	45 (26.01%)	35 (20.23%)
5	Whether it helped you to enhance your positive attitude towards the subject?	173	2(1.16%)	10(5.78%)	24 (13.87%)	56 (32.37%)	54 (31.21%)	27 (15.61%)

The feedback from students regarding various aspects of their learning experiences provided valuable insights into the effectiveness of the educational strategies employed in the programme. The area where students rated highest pertains to the clarity of content implemented in class. Students found the material as logically and sequentially arranged which facilitated their understanding. This indicates that the **instructional design and delivery were well-received**, enabling students to grasp the concepts effectively.

Another highly rated aspect is the **usefulness of the learning** activities in helping students gain clarity on different concepts. 71 students rated it as 'Good', 45 as 'Very Good' and 35 students

rated it as ‘Excellent’. This suggests that the activities and exercises were well-structured and supported students in reinforcing their understanding of the subject matter.

The **meaningfulness of the learning experiences** also received positive feedback, 56 students rating it as ‘Good’, 52 students as ‘Very Good’ and 34 students rating it as ‘Excellent’. Students felt that their engagement with the material was not only educational but also enriching, contributing to a deeper comprehension of the subject.

Warm-up activities designed to help students recollect previously learned concepts were also appreciated by 81 students rating them as’ Good’, 34 as ‘Very Good’ and 33 as ‘Excellent’. These activities appear to have been effective in refreshing students' memories and preparing them for new content, thus enhancing their overall learning experience.

Lastly, the **enhancement of positive attitudes towards the subject** received favorable responses 56 students found the programme ‘Good’, 54 rated it as ‘Very Good’ and 27 students rated it as ‘Excellent’ in enhancing the positive attitudes towards the subject mathematics. The educational approaches employed seem to have fostered a more positive disposition towards learning among the students, making them more enthusiastic and engaged in the subject.

Overall, the feedback highlighted the success of the teaching methods in providing clear, meaningful, and supportive learning experiences that not only clarify concepts but also enhance students' attitudes towards the subject.

Table - 4.15 Responses on overall scholastic achievements of students- Class: IX

Sr. No.	Component of the Feedback about the Programme	Total Responses	Ratings on the Effectiveness of the Programme					
			Blank Responses	1 (Needs Modification)	2 (Average)	3 (Good)	4 (Very Good)	5 (Excellent)
1	Art Integration ideas	173	2 (1.16%)	36 (20.813%)	24 (13.87%)	60 (34.68%)	37 (21.39%)	14 (8.09%)
2	Experiential learning activities	173	2 (1.16%)	11 (6.36%)	26 (15.03%)	79 (45.66%)	34 (19.65%)	21 (12.14%)
3	Interdisciplinary aspects	173	2 (1.16%)	28 (16.18%)	30 (17.34%)	43 (24.86%)	51 (29.48%)	19 (10.98%)
4	Videos incorporated	173	2 (1.16%)	19 (10.98%)	32 (18.5%)	33 (19.06%)	61 (35.26%)	21 (12.14%)

The feedback on how various aspects enhanced students' overall scholastic achievements provided a comprehensive overview of their perceptions.

The highest-rated aspect was the **incorporation of videos**. Students found that videos significantly enhanced their learning experience, making complex concepts more accessible and engaging. This indicates the effectiveness of multimedia tools in supporting student understanding and retention. **Experiential learning** activities also received high ratings, reflecting their positive impact on students' scholastic achievements. These hands-on activities helped bridge the gap between theoretical knowledge and practical application, fostering a deeper understanding of the subject matter. **Interdisciplinary aspects** were also appreciated by students. The integration of multiple disciplines into the learning process provided a holistic approach to education, enriching students' perspectives and enhancing their ability to make connections across different subjects. **Art integration ideas**, while still valued, received relatively lower ratings compared to the other aspects. Although many students found these ideas beneficial, the feedback suggests that there might be room for improvement in how art is integrated into the curriculum to better support scholastic achievements.

Overall, the feedback highlights the significant positive impact of videos, experiential learning activities, art integration ideas, and interdisciplinary approaches on students' educational experiences.

- **Students' Feedback Analysis: CLASS- X**

Below given table shows the number of students of class X who were the part of the programme implemented by the participating teachers.

Table-4.16 Number of students who explored Modules - III & IV

Could Explore the Modules?	**EXPLORED MODULES**	
	MODULE-III REAL NUMBER	**MODULE – IV TRIANGLES**
Yes	**47(97.92%)**	**48(100%)**
No	**1(2.08%)**	**0**

Total 48 students of class X were exposed to the teaching modules: MODULE-III REAL NUMBER & MODULE - IV TRIANGLES, out of which 47 students responded for Module III and 48 students responded for Module IV, through the feedback form. From the responses of these students on various aspects of the modules, the researcher understood, both the modules; REAL NUMBERS & TRIANGLES were exposed to them by the teacher who implemented them by taking an average number of 7 periods.

The data received on their understanding of these two mathematical modules, Real Numbers and Triangles, indicates a high level of comprehension among the students. For both modules, nearly all students indicated that they understood the material, suggesting that the teaching methods and materials used were highly effective. The complete comprehension of the Triangles module reflects a successful instructional approach. Overall, the data points to the efficacy of the current teaching strategies in ensuring that students grasp the concepts presented in these modules.

Given below is the summary of the responses of students on various aspects of the modules.

Table - 4.17 The responses of students on various aspects of the modules- Class: X

Sr. No.	Component of the Feedback about the program (Item No.)	Total Responses	Ratings on the Effectiveness of the Programme					
			Blank Responses	1 (Needs Modification)	2 (Average)	3 (Good)	4 (Very Good)	5 (Excellent)
1	Whether the warm up activities helped you to recollect the previously learned concepts?	48	1 (2.08%)	0 (0)	6 (12.5%)	14 (29.17%)	14 (29.17%)	13 (27.08%)
2	Rate on the clarity of the content implemented in class (whether logically and sequentially arranged and understood)	48	1 (2.08%)	2 (4.17%)	2 (4.17%)	18 (37.5%)	20 (41.675)	6 (12.5%)
3	Whether the learning experiences were meaningful?	48	1 (2.08%)	2 (4.17%)	9 (18.75%)	18 (37.5%)	13 (27.08%)	6 (12.5%)
4	Whether it was useful to get clarity on different concepts?	48	1 (2.08%)	2 (4.17%)	5 (10.42%)	17 (35.42%)	11 (22.92%)	13 (27.08%)
5	Whether it helped you to enhance your positive attitude towards the subject?	48	1 (2.08%)	2 (4.17%)	12 (25%)	11 (22.92%)	14 (29.17%)	9 (18.75%)

Based on the feedback provided by students on various aspects of the class, it is evident that a significant number of students found the clarity of the content to be well-structured and logically presented, which facilitated their understanding. They appreciated how the warm-up activities effectively helped them recall previously learned concepts, contributing positively to their learning experience. Many students also felt that the sessions were meaningful, indicating that they found value in the content covered and in gaining clarity on different concepts. Moreover, a considerable portion of the class noted that these activities enhanced their positive attitude towards the subject, reflecting a beneficial impact on their engagement and motivation. However, a smaller proportion of students felt these aspects could be further improved, suggesting areas where adjustments in teaching methods or content organization might enhance overall satisfaction and learning outcomes.

Table - 4.18 Responses on overall scholastic achievements of students - Class: X

Sr. No.	Component of the Feedback about the programme	Total Responses	Ratings on Effectiveness					
			Blank Responses	1 (Needs Modification)	2 (Average)	3 (Good)	4 (Very Good)	5 (Excellent)
1	Art Integration ideas	48	1 (2.08%)	10 (20.83%)	9 (18.75%)	7 (14.58%)	9 (18.75%)	12 (.25%)
2	Experiential learning activities	48	1 (2.08%)	3 (6.25%)	7 (14.58%)	9 (18.75%)	15 (31.25%)	13 (27.08%)
3	Interdisciplinary aspects	48	1 (2.08%)	6 (12.5%)	4 (8.33%)	8 (16.67%)	13 (27.08%)	16 (33.33%)
4	Videos incorporated	48	1 (2.08%)	5 (10.42%)	8 (16.67%)	4 (8.33%)	14 (29.17%)	16 (33.33%)

Based on the feedback provided by students regarding aspects that enhance their overall scholastic achievements, **videos incorporated** into the curriculum received the highest positive ratings. Students appreciated the use of videos as an effective tool for learning, indicating they found them beneficial in understanding and reinforcing concepts. **Experiential learning** activities were also well-received, with students valuing hands-on experiences that enhanced their understanding through practical application. **Interdisciplinary aspects** were perceived positively, suggesting students recognized the value of integrating knowledge from various subjects to deepen their learning. **Art integration ideas**, received slightly lower scores compared to other aspects, but still positively rated by majority of the students (25% as excellent, 18.75%

as very good and 14.58% as good) revealing the positive impact of Art Integration on students' overall scholastic achievements.

4.4 Major Findings of the Study

Through the data analysis, integration of the data and interpretation, the researcher could identify and derive the following key findings from the present study which are aligned with the objectives of the study.

1. The study revealed that the majority of the teachers teaching at secondary schools are female (59%). Almost half of the teachers (49%) are with less than 10 years of experience.
2. It is emerged from the study that majority of the teachers (99%) believe in the networking for sharing expertise and enhancing their knowledge. Majority of them (94%) opined that they are very keen to participate in the professional enrichment programmes, which will be offered to them.
3. The majority of the teachers opined that learning mathematics aids in real life problem solving, indicating the importance of mathematics education for life, hence the need of professional development programme focusing on introducing the concepts through real life situations.
4. It is revealed from the study that the majority of the teachers have the consensus on prioritizing understanding over memorization of mathematics and the majority opined that existing curriculum focuses more on learning procedures rather than the skills enhancement of learners, indicating the need of a systemic change in mathematics education.
5. Majority of the teachers opined that the practice of linking new topics with prior knowledge of students benefits for comprehension and retention of mathematics facts, which indicated the need of attention in this area while developing the professional enrichment programme.
6. The study revealed the need of inclusion of innovative methodological aspects of teaching mathematics, as majority of the teachers opined that reasoning in mathematics and using visual aids to relate the concepts are very essential in teaching mathematics.
7. The study revealed that the majority of the teachers follow CBSE Assessment pattern. It also revealed the mixed opinions of teachers on the effectiveness of the current assessment practices. Teachers showed moderate support only, for diagnostic tests, indicating the scope

for improvement in implementing diagnostic tests to have a deeper understanding of learners' learning difficulties.

8. The study revealed that the professional development programme for mathematics teachers needs to include innovative methods of motivating students to learn mathematics; updating knowledge for applications of mathematics; preparing instructional and learning activities and also for evaluating students' progress, time to time.
9. It was emerged from the study that the mathematics teachers have specific professional development needs in the pedagogic areas. These include providing remediation for low achievers; updating knowledge of mathematics -related career opportunities; selecting appropriate instructional strategies and learning new methods of teaching mathematics.
10. ICT integration in teaching mathematics was found as a need for professional development for mathematics teachers.
11. The study revealed that most of the teachers have difficulty in conceptual understanding and explanation of the topics: NUMBER SYSTEMS & TRIANGLES of Class IX and REAL NUMBERS & TRIANGLES of Class X of the NCERT syllabus.
12. Majority of the teachers opined that the programme developed by the researcher was found interesting and insightful for the teachers.
13. Majority of the teachers opined that the Self-learning Modules integrated with Technology helped them to enhance their pedagogical competencies.
14. It was found from the study that the program inputs in terms of content presentation, illustrations, relevance to day-to-day life, current developments in mathematics research, and innovative pedagogies were found interesting and meaningful by the mathematics teachers.
15. The majority of the students have opined that the Experiential learning and Art integration in teaching mathematics were interesting and enhancing the concept clarity.
16. The study also revealed that the classroom activities incorporated in the modules and the video content support developed by the researcher were relevant, useful and helpful for the conceptual understanding and competency building in learners.
17. The study revealed that the programme developed by the researcher was found effective as perceived by the teachers in terms of content clarity, self-directed learning, relevant activities, incorporation of NEP-2020 aspects, user friendliness and adaptability.

18. It was found from the study that the effectiveness of the programme was appreciated by the participant teachers due to its:
    a) Self -explanatory nature
    b) User friendliness
    c) Provided resources to many References and Assessment
    d) Well-structured pedagogy and design of each module.
    e) Relevant content and exercises.
    f) Clarity in the content presented.
    g) Outputs in terms of expected learning outcomes.

4.5 Conclusion

The analysis of the data collected during different phases of the study, is given in details in this chapter. The first section of the chapter presented bot the quantitative and qualitative data integration, analysis and interpretation to identify the professional development training needs of mathematics teachers of secondary schools. On the basis of the findings from the first phase of the study, the researcher developed the content of the programme. The second section explained about the programme development procedure and the design of the programme. There after the programme was validated and then implemented through 12 mathematics teachers who were conveniently selected by the researcher. After the implementation, the effectiveness of the programme was evaluated in the last phase through the feedback collected through feedback form and opinions collected through informal interview and discussions. In the last section, the quantitative and qualitative data analysis to evaluate the effectiveness of the programme is presented. The outcomes and the results so derived through the analysis enabled the researcher to come out with meaningful suggestions.

The analysis of the data enabled the researcher to derive and present the major findings of the study. The major findings drawn are presented and discussed in the following chapter. Also, on the basis of this study, suggestions in various categories are presented in the next chapter.