DEVELOPMENT OF A BRIDGE PROGRAMME FOR ENHANCING ACHIEVEMENT IN MATHEMATICS OF STANDARD XI STUDENTS

Thesis submitted for the Degree of

DOCTOR OF PHILOSOPHY IN EDUCATION

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DECLARATION

I, **Philip Joseph**, do hereby declare that this thesis entitled as **DEVELOPMENT OF A BRIDGE PROGRAMME FOR ENHANCING ACHIEVEMENT IN MATHEMATICS OF STANDARD XI STUDENTS** is a genuine record of the research work done by me under the supervision of **Dr. Noushad. P P**, Associate Professor, School of Gandhian Thought and Development Studies, MG University, Kottayam and co-guided by **Dr. Umer Farooque. T.K**, Assistant Professor of Education, Farook Training College; and that no part of the thesis has been presented earlier for the award of any Degree, Diploma, Associateship or other similar title of recognition in any other University.

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"When you want something, all the universe conspires in helping you to achieve it."

– *Paulo Coelho, The Alchemist*

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CHAPTER 1

INTRODUCTION

- *Need and Significance of the Study*
- *Statement of the Research Problem*
- *Title of the Study*
- *Definitions of Key Terms*
- *Variables selected for the Study*
- *Objectives of the Study*
- *Hypotheses of the Study*
- *Methodology in Brief*
- *Scope and Limitations of the Study*
- *Organization of the Report*

Over the years, Research in Mathematics Education has been undertaking to study a variety of topics for ensuring quality in Mathematics teaching-learning. The main purpose of those studies is to be of help in improvement of classroom teaching and learning. Mathematics as a core subject in the school curriculum undoubtedly occupies a prime place and the need for improvement in the areas of content and pedagogy has been emphasized by all persons concerned. Thus, many efforts in the form of initiatives and interventions in the area of Mathematics teaching-learning at various levels have been contributing immensely to Mathematics Education.

Generally, education is meant for betterment by bringing about certain changes in the behaviour of the individual. It stands for the modification of undesirable behaviour into a desirable one. It is education by which knowledge, character and behaviour of the persons are attained, shaped and moulded. Modification of the behaviour in an individual by various experiences is learning. All the subjects taught in the schools have a direct relation for the modification of the behaviour of the child in a better way. Mathematics as a subject occupies itself in front of the queue to attain this common goal. In fact, it plays a prominent role in school education.

It is well known that Mathematics is the gateway and key to all sciences. During the present digital age, it has become increasingly important for all people to learn, assess and apply mathematical knowledge effectively and quickly. Mathematics is regarded by society as the cornerstone of scientific and technical knowledge, which is essential in developing a nation's social and economic development. Investigations have shown that Mathematics as a topic impacts all elements of human existence on many levels.

Mathematics consisting of arithmetic, algebra, geometry, trigonometry, coordinate geometry, statistics and probability is definitely one of the most important subject and component of the school curriculum. The imparting of Mathematics lessons in schools assumes importance due to the weightage given to Mathematics as a subject in the school curriculum. The National Education Policies (1986, 2020) have constantly envisaged the importance of Mathematics in general education. The former one firmly suggested that Mathematics should be visualized as the means of training a child to think, reason, analyse and to articulate logically. Apart from being a specialized subject, Mathematics should be treated as concomitant to any subject involving analysis and reasoning (NPE, 1986, p.29). Mathematics has a significant potential for boosting student's creativity, ability to think critically and problem solving. No other science around us is more useful and beneficial than that of Mathematics. Hence, the study of Mathematics has long been considered essential, as arithmetic and logical thinking are inevitable components of science and technology.

In addition, Mathematics is inevitable for studying other subjects as part of one’s academic life. It forms the base for every other subjects. Mathematics skills are important to understand other allied subjects and streams such as engineering, social sciences, sciences and arts. It is a fact that neglect or omission of Mathematics does injury to all fields of knowledge, as it has connection with all other subjects.

Further, in this contemporary age one cannot avoid the learning of the subject Mathematics which is indispensable for career building. Students live in a competitive world. Quality of Mathematics learning has become the key factor for personal achievement. They desire that their performance should become as high a level as possible. This desire for a high level of achievement puts a lot of pressure and efforts from students as well as teachers and parents. Thus, Mathematics education in the new era has become very challenging for learners as well as educators and hence each and everybody has to give more attention to Mathematics education.

Mathematics is used in day-to-day life; it has a crucial role in practical life too. As Jain and Dowson (2009) say Mathematics education is essential for both personal and professional success in a variety of fields. Aside from that, Lipnevich et al. (2016) discovered that mathematical achievement was related with well-being and life satisfaction as well as health, income, employment, and lifespan.

So, the educational authorities place a high value on student's mathematical abilities like computational and problem-solving skills. It nowadays requires students to develop specific mathematical characteristics, such as (i) correctly performing arithmetic operations, (ii) correctly applying mathematical rules/formulas, (iii) having a higher level of mathematical reasoning, and (iv) becoming a good problem solver.

In order to achieve these goals, the 10+2+3 pattern, first proposed by the Education Commission (1964-66) and approved by the National Policy on Education (1986) has been continuing for a long period. It was on the basis of this pattern that Higher Secondary Education (HSE) came into existence in Kerala in 1990.

The course of study that can provide a link between secondary and higher education is considered as HSE and it is for a period of two years. The HSE which comes last of general education serves as a stepping stone to higher education sector and is expected to prepare adolescent students for the modern world. Higher Secondary Schools (HSS) prepare students for universities and centres of academic excellence. At present Mathematics is included as an optional subject in Science and Commerce streams. Possibility to go for higher studies makes Mathematics more important for students.

In view of the above context, the content of the Higher Secondary Mathematics course is designed as follows.

- Learning of numbers from real to complex
- Combinatorics and Probability
- Transformation of Trigonometric relations to Trigonometric functions
- Three-Dimensional Geometry, Algebra of Geometry and the higher level of Two-Dimensional Geometry
- Vector Algebra
- Mathematical logic & Mathematical induction
- For solving practical situations, Linear inequalities and Linear programming problems become part of the content
- To solve system of equations, Matrices & Determinants are included
- For linking and problem solving in other subjects, basic facts of Differential calculus and Integral calculus are essential parts of the syllabus at this stage.

In Kerala, at present, the constructivist instructional practices based on the philosophy of constructivism proposed by Vygotsky and others are followed for transacting the above given content. It is a learning theory which states that pupil learn by actively constructing their knowledge based on prior knowledge. In constructivism, learning is the process of the construction of knowledge. It involves more of exploration and discovery. Each learner constructs knowledge by linking it with his/her previous experiences. Here learning is adaptive as it integrates new knowledge with the existing ones and helps to produce innovative and useful knowledge. Thus, the central idea of constructivism is that learning is constructed. The learners build new knowledge upon the foundation of previous learning.

As far as higher education is considered the quality of HSE should be assured and safeguarded. Being a logical science, Mathematics consists of a highly organized and systematized body of knowledge in a connected or interlinked way. Hence the very nature of the subject demands rigorous training in the subject at the beginning of higher secondary stage, namely standard XI to perform well in future too. Standard XI students, their parents and teachers give high priority to academic achievement in Mathematics.

Though Mathematics is considered very important by all, the learning and achievement in the subject of many students at Higher Secondary stage are not up to a desirable level because of much learning loss and learning gaps due to many reasons. In spite of many efforts and inputs to the teaching and learning process rendered by the authorities, it is found that students are not able to perform up to the level that is expected of their standards. The academic achievements in Mathematics of many students remain poor. Majority of the students are incompetent in the subject. They are not motivated, interested and confident in learning the subject. Their performance in the subject gradually comes down to the stage of fear and failure. Mathematics is seen to be a night mare for many students. Many students consider Mathematics as one of the most tough subjects. There may be number of reasons for these. Of course, unhealthy attitude, lack of essential basic knowledge, weak concept formation in the subject, improper understanding of the subject and poor strategies are major reasons. No doubt, lack of fundamentals and basics is a serious reason of difficulty in learning higher concepts in Mathematics at HSS level.

Similar type of observations is reported by the National Achievement Surveys (NAS), nation-wide sample surveys of learning and achievement in school subjects. The reports of National Achievement Surveys, for instance, NAS, 2021 observe that the standard of Mathematics and Science subjects among school children in Kerala is poor. The performance of students recorded a decline as classes forwarding, for instance, the average Mathematics score was 60 in class third, dropping to 41 in class fifth, to 31 in class eighth and 29 in class tenth of students in Kerala state (NCERT,2021). It is noted that such category of students is admitted into the plus one class at HSS level.

Besides, the investigator referred the Academic Master Plans (AMP) developed by various HSS in Kerala to get an overview of present scenario in Mathematics teaching and learning. During the academic year 2017-2018, all schools in Kerala had been asked by the Government to prepare AMP with a view to improve the academic standards. Parents Teachers Association (PTA), school development committees, representatives of local self-government, alumni associations of students and teachers, educational experts of the region, social and cultural activists and the people of the locality were involved in the process. State Council of Educational Research and Training (SCERT), Kerala provided guidelines and the template for preparing AMP. AMP was a record that explained the academic duties or activities to be undertaken after a proper plan on how an educational institution would be. All types of academic activities were documented there. Details of the activities to be implemented were written there. The AMP was expected to reflect the basic needs including the remedial measures to improve academic standards of all subjects, with special reference to Mathematics too.

List of schools whose AMPs were referred is given in Appendix A.

Some of the observations collected from AMPs are given below:

1. Mathematics is a cumulative subject so that the students need a strong foundation. But there is serious problems and difficulties in basic Mathematics of HSS students. They often find the subject to be tedious or difficult because

they haven't taken time to master the fundamentals. Students at HSS level should be diagnosed, guided and trained in fundamentals of Mathematics.

2. The subject Mathematics by nature demands a strong foundation in basic concepts. If students are not well versed with what they have learned earlier, it becomes extremely difficult to study new content. Thus, it is good to check previous content knowledge before learning new chapters. Prerequisite testing will help to identify needs of the students. The purpose of this test would be to identify whether the students are experts in the prerequisites for the selected chapter. The contents of the test may be included the basic Mathematics required for the plus one and plus two Mathematics, namely, Arithmetic, Algebra, Geometry, Coordinate Geometry, Trigonometry, Statistics and Probability.
3. It is good to prepare a table of fundamentals and special modules and let the students be familiarized of them. Teachers should arrange remedial classes based on the module without fail.
4. Students by-default ignore daily study. They spend little time in studying and revising Mathematics at home. They must be aware of the importance of self-learning.
5. Some of the students are irregular in school and studies. They are absent in class continuously and miss the lessons taught in the class.
6. Pupils can't face examinations confidently and even don't know how to prepare for examination.
7. Students are stressed and tensed. They are under the pressure of electronic gadgets like mobile phones and computers, engaging in social media. Really, they need guidance and support.

8. Students are not properly motivated and interested. They are not aware of the wide opportunities that the subject Mathematics ought to bring to their lives in future in the areas of skill development, higher studies and research.
9. Students don't know best methods of learning the subject Mathematics. They are unable to study the subject meaningfully.
10. They are very reluctant to resolve their doubts properly and study in groups.
11. Similar students' problems should be addressed by the concerned authorities.

In this context, the statement of the NEP (2020) is worth-mentioning: "The gap between the current state of learning outcomes and what is required must be bridged through undertaking major reforms that bring the highest quality, equity, and integrity into the system, from early childhood care and education through higher education" (NEP, 2020, p.3). Hence, the students who have completed standard X and enrolled in standard XI may be provided bridging through psychological and mathematical foundations of learning and achievement.

At this juncture, the present study is undertaken to find out solutions to the following questions.

- What are the factors contributing and promoting mathematical learning and achievement of standard XI students?
- Why do the students in standard XI feel so many problems and difficulties in better learning and achievement in Mathematics?
- How can quality of Mathematics learning and hence Mathematics achievement of standard XI students be safeguarded and improved?

Also, those standard XI students at HSS level with learning loss and learning gaps in the subject need additional helps during their study to enhance learning and achievement in Mathematics. Innovative programmes make the teaching-learning more efficient and mathematical achievement better.

Thus, the present study is an attempt to develop a Bridge Programme for enhancing standard XI students' learning and achievement in Mathematics at HSS level under the assumption that Mathematics learning and achievement can be enhanced with the help of various educational programmes.

Need and Significance of the Study

There is no doubt that quality education is pupils' right. Each and every student has the right to get quality education in Mathematics too. In 1966, the Education Commission (Kothari) report underlined the need for Mathematics and Science in school as well as in higher education. The report emphasized the importance of children learning Mathematics and recommended Mathematics as a compulsory subject for students at secondary school level. Also, quality Mathematics education is a major concern to all those who work in this field. For the past three decades, there has been considerable concern about students' achievement in Mathematics too. The prime goal of Mathematics education is to attain excellent achievement by the students and hence all activities need to gear up in this direction.

Even though much efforts have been taken on Mathematics teaching and learning, the students' learning and achievement are not at the desired level. Now a days Mathematics learning as well as teaching is more oriented to prepare the child for public examinations and competitive examinations and achievement in the examinations is considered as the index of child's level of learning in Mathematics. Further, Mathematics education in our schools is beset with different kinds of problems and deficiencies also. Most of the students find it difficult to follow the learning of Mathematics. Students' achievement is significantly below the level expected of them. It is a matter of common experience of many HSS teachers teaching Mathematics that although many students are capable of learning the subject, their actual performance especially in the learning and achievement level is very poor.

Many school teachers in Mathematics who attend the subject cluster meetings are of the opinion that the difficulties they felt in teaching-learning of Mathematics are mainly poor Mathematics background of the students; lack of prerequisites related to basic principles and fundamentals (for example, base of the subject is not thoroughly clear at the school level), inappropriate study habits and lack of motivation, interest and confidence among the students (for example, most of the students come to the classroom with negative attitude towards Mathematics). The same observations are made by workshops conducted by various associations, parents and teachers' meetings and in particular by various media too. Several studies conducted in this area also highlighted in detail the same problems. Also, the surveys conducted by National and State Educational Agencies like National Council of Educational Research and Training (NCERT), Annual Status of Education Report (ASER), SCERT Kerala, Samagra Siksha Keralam (SSK) revealed the pathetic conditions of school education especially in the basic concepts of language (writing, reading and spelling) and subjects like Mathematics.

Majority of the students generally feel that Mathematics is a very difficult subject. Mathematics has been a subject with a large number of student failures, a reason for students dropping out of school and a cause of fear and anxiety among students. A phobia has been created in the minds of the children that Mathematics is very tough to learn. Negative attitude, lack of interest, lack of motivation from the part of the students to learn Mathematics, lack of confidence in them while solving mathematical problems, anxiety about performance in Mathematics are growing among the students. Sometimes the subject is blamed as uninspiring, dry and dull. As a practising teacher for the last 24 years at HSS level, the researcher himself felt the same that the students found it as an extremely tedious effort to learn Mathematics and they differed in their performance. Briefly the prevailing situations in schools, in particular after the COVID-19 pandemic situations, are not so good especially in case of Mathematics learning and achievement. These are problems always felt by the educators requiring close scrutiny and study.

All the above-mentioned facts indicate that the need for providing support programmes for enhancing achievement in Mathematics still exists. So, the researcher sought whether there were any academic programmes scientifically developed for enhancing achievement in Mathematics of standard XI students. Several studies have been conducted across primary schools, junior and senior high schools, undergraduate and graduate universities on mathematical achievement. Those studies are mostly to find out the relationship between attitude and performance in Mathematics, attitude and beliefs or study habits and achievement in Mathematics. Some studies are found on development of programmes, but majority of them are related with languages, science subjects and psychological dimensions (Jade, 2008; Bhagwat, 2009; Chavan, 2010; Waghmare, 2010; Parmar, 2013; Todkari, 2015; Godse, 2016; Altaf, 2017; Shahila, 2018; Suneera, 2019; Premchandran, 2019). They proved that such programmes were effective in enhancing academic achievement as well as other allied entities. Also, a good number of studies are there on development of e-learning programmes, programmed instructional materials and models of teaching (Muthaiah, 1994; Nair, 2002; Chandradoss, 2011; Leo, 2012; Ramesha, 2014; Vyas, 2014; Anju, 2016; Gurpreet, 2018, Kurukkan, 2018). It is noteworthy that there is an exemplar study on development of a programme for enhancing achievement of the students of class X in Mathematics (Patel, 2007).

However, no significant study has been conducted on development of a programme for enhancing achievement in Mathematics of standard XI students in Kerala. In addition, the review in chapter II reveals that such type of programmes combining the selected factors; attitude, beliefs, basic concepts and study habits were not yet available for students of plus one in Kerala to enhance their achievement in Mathematics and this necessitates the development of quality based alternative educational programmes, new approaches and innovations to be experimented in Mathematics education to lay solid foundations for the future. It will be very useful to students as well as teachers if a programme bridging the essentials on Mathematics and efficient learning techniques is developed. Such practices would be very essential to boost-up student achievement in Mathematics and will remedy the main causative factors for the poor learning and achievement.

Though many teaching-learning programmes such as Ganithavijayam, Maths Clinic, Quality Improvement Programmes are implemented to benefit the students at HSS level by the HSE Department, the researcher feels the need of improving the quality of teaching- learning in Mathematics through concerted efforts. As a practitioner, the investigator found it relevant to develop Bridge Programme in Mathematics (BPM) which contains essential enrichment and supportive materials for studying Mathematics at HSS level, since in present education system there exist no special efforts taken in schools to enrich Mathematics learning and to enhance achievement in Mathematics on a regular basis. A properly developed Bridge Programme would be helpful to a great extent for enhancing learning and achievement in Mathematics by reducing all kind of negative factors and increasing all positive factors in the pupils. Through the Bridge Programme, learning and achievement in Mathematics can be increased. Hence the present topic of research involving the development of a programme for enhancing achievement in Mathematics is significant.

In the present study the investigator selected standard XI in HSS section as it is the stepping stone to higher education and its results have much importance for higher studies in Mathematics. In addition, HSS section has become very crucial as it influences the entire future of the students. Further, Mathematical enrichment provided in the plus one plays an important role in the mathematical achievement in the plus two level. Hence the investigator wants to develop a Bridge Programme to achieve better results at this stage of education. Also, this will help the students who are not having enough basis for their future learning in Mathematics. It would be much helpful to students, if extra training is provided by the investigator or other practitioners for improving the performance in the coming stages. As a result, these will act as means to eradicate the academic lag and flaws in learning Mathematics so that interest and motivation will be developed among the students and they could be trained in how to learn by one self. Keeping these facts in mind, the researcher initiated to conduct the present study.

Statement of the Research Problem

Mathematics learning and achievements of standard XI students at HSS level are to be enhanced, as they have been seriously affected by the learning loss and learning gaps due to many reasons. It has been identified that a Bridge Programme will support and supplement to remove the learning loss and bridge the learning gaps of the students who have completed standard X and got admission in standard XI. Thus, the present study is an attempt to develop a Bridge Programme for enhancing achievement in Mathematics of standard XI students. The programme is intended to administer along with the usual classroom instruction and routine learning in Mathematics. The prime motive is to facilitate learning and achievement in Mathematics of standard XI students.

Title of the Study

The present study aims at developing a Bridge Programme with a view to enhancing learning and achievement in Mathematics of standard XI students. So, the problem for the present study is entitled as DEVELOPMENT OF A BRIDGE PROGRAMME FOR ENHANCING ACHIEVEMENT IN MATHEMATICS OF STANDARD XI STUDENTS.

Definitions of Key Terms

The key terms included in the statement of the research problem are literally and operationally defined as follows.

Development

According to New Oxford Advanced Learner's Dictionary (2005), development means new product- the process of producing or creating something new or more advanced; a new or advanced product.

The term development, in the present study, is defined as the process of preparation and validation of the Bridge Programme in Mathematics (BPM).

Programme

According to New Oxford Advanced Learner's Dictionary (2005), programme means a plan of things that will be done or included in the development of something.

In the present study, it is a definite set of plans of activities employed as inputs for bringing about changes in the students' behaviour in the desired direction.

Bridge/Bridge Programme

According to New Oxford Advanced Learner's Dictionary (2005), Bridge means a thing that provides a connection or contact between two different things**.**

BPM stands for an organized set of eleven plans with twenty-one strategies based on psychological and mathematical foundations of learning. They are personalised, individualised and guided activities designed to produce changes in attitude, beliefs, basic concepts and study habits in Mathematics of standard XI students. It acts as a bridge connecting the current state of Mathematics learning and achievement of standard XI students and what is required by bridging the gaps between secondary school and HSS Mathematics learning.

Enhancing

It means increasing or raising the current level of something or making something better.

In the present study, enhancing means improving the existing level of achievement in Mathematics of standard XI students by changing the level of attitude, beliefs, basic concepts and study habits in Mathematics after implementing the BPM.

Achievement

This term is used more generally to describe the performance of the individual in the subjects of the curriculum.

Actually, it is the knowledge acquired and skills developed in school subjects, usually indicated by the scores or grades obtained in a standardized or teacher-made test.

Achievement in Mathematics

According to Good (1975), achievement in Mathematics is the relative accomplishment or proficiency of performance in a given skill or body of knowledge related to Mathematics as a subject of study which can be measured by standardized achievement tests in Mathematics.

In the present study it refers to the level of accomplishment in some specific areas of Mathematics (Complex Numbers and Quadratic Equations for standard XI Mathematics) and is measured in terms of scores obtained by the students in the achievement test in Mathematics prepared by the investigator under the guidance of the supervising teacher.

Standard XI Students

Students enrolled in standard XI.

It refers to the students who are studying in plus one in the recognised HSS of Kerala state.

Variables Selected for the Study

The purpose of the present study is to prepare and validate a Bridge Programme for enhancing learning and achievement in Mathematics of standard XI students. Accordingly, there are independent (treatment), dependent and control variables selected for the study.

- The independent variables are the teaching- learning strategies at two levels; together with and without the Bridge Programme in Mathematics.
- The dependant variable is the achievement in Mathematics of standard XI students in terms of scores on standardized achievement test.
- Certain control variables are pupils' age, unit of instruction, prior achievement and knowledge level of students, locality of school, type of school and teacher characteristics.

Objectives of the Study

The major objectives of the present study are

1) To prepare a Bridge Programme in Mathematics; and
2) To study its effectiveness in enhancing achievement in Mathematics of standard XI students.

To attain these two major objectives seven specific objectives are formulated by the investigator. They are the following:

1) To explore the level of standard XI students' attitude towards Mathematics learning and achievement, beliefs in mathematical abilities and study habits in Mathematics.
2) To identify standard XI students' needs and requirements with respect to Mathematics learning and achievement.
3) To prepare a Bridge Programme based on students' attitude towards Mathematics learning and achievement, beliefs in mathematical abilities cum pre-requisite (basic) knowledge in the subject and study habits in Mathematics for enhancing achievement in Mathematics of standard XI students.
4) To study the effectiveness of the Bridge Programme in terms of achievement in Mathematics of standard XI students.
5) To study the effectiveness of the Bridge Programme on retention of achievement in Mathematics of standard XI students.
6) To test whether the Bridge Programme is effective to improve standard XI students' attitude towards Mathematics learning and achievement, beliefs in mathematical abilities cum pre-requisite (basic) knowledge in the subject and study habits in Mathematics in the desired direction.
7) To study the efficacy of the Bridge Programme in terms of students' feedback regarding the prepared and implemented Bridge Programme.

Hypotheses of the Study

Previous studies have proved that the academic achievement can be enhanced by special programmes in various subjects. Accordingly, the assumption of the present study is that there will be significant improvement in Mathematics achievement of standard XI students by the implementation of the Bridge Programme. Hence the study tests the main hypothesis that the Bridge Programme would exert a significant effect on the achievement in Mathematics of standard XI students. So, the null hypothesis (H_o) states that teaching-learning together with the Bridge Programme would exert no significant effect on the academic achievement in Mathematics of standard XI students.

This main hypothesis was split into nine sub-hypotheses that would be presented as follows.

1. There is no significant difference between the pre-test mean scores of achievements in Mathematics of the experimental and control group students in standard XI.
2. There is no significant difference between the post-test mean scores of achievements in Mathematics of the experimental and control group students in standard XI.
3. There is no significant difference between the means of gain scores of achievements in Mathematics of the experimental and control group students in standard XI.
4. There is no significant effect of the Bridge Programme on achievement in Mathematics after controlling pre-experimental status in terms of pre-test scores of achievements in Mathematics.
5. There is no significant difference between the delayed post-test mean scores of achievements in Mathematics of the experimental and control group students in standard XI.

6. There is no significant difference between the pre-test and post-test mean scores of students' attitude towards Mathematics of the experimental group students in standard XI.
7. There is no significant difference between the pre-test and post-test mean scores of students' beliefs in mathematical abilities of the experimental group students in standard XI.
8. There is no significant difference between the pre-test and post-test mean scores of basic Mathematics (pre-requisite knowledge in the subject) of the experimental group students in standard XI.
9. There is no significant difference between the pre-test and post-test mean scores of students' study habits in Mathematics of the experimental group students in standard XI.

Methodology in Brief

Method Used

The present study focused on the preparation and validation of the Bridge Programme for enhancing achievement in Mathematics of standard XI students at HSS level. Initially, survey method was employed to assess the level of HSS students' attitude towards Mathematics learning and achievement, beliefs in mathematical abilities and study habits in Mathematics and to establish the need of a Bridge Programme for enhancing the achievement in Mathematics of standard XI students. Experimental method was finally used to establish the effect of the prepared Bridge Programme.

The study was conducted through the following steps:

1) Review of Academic Master Plans and other related literature
2) Survey of present level of attitude, beliefs and study habits towards Mathematics of students of plus one and seeking their opinion on additional and supportive programmes

3) Preparation of the Bridge Programme in Mathematics
4) Selection of sample groups (experimental and control groups)
5) Preparation of achievement test
6) Administration of the pre-test to both the groups
7) Implementation of the BPM to the experimental group
8) Administration of the post-test to both the groups after the teaching-learning process
9) Administration of the delayed post-test to both the groups
10) Seeking students' feedback

Accordingly, combination of methods of survey and experiment was adopted for conducting the present study.

Design of the Study

The present study adopted survey at the first phase and experiment using quasi- experimental design with pre-test- post-test non-equivalent groups at the second phase. Since the purpose of the study is to develop a Bridge Programme for enhancing achievement in Mathematics, experimentation too became necessary along with the survey to develop the Bridge Programme.

Thus, the study consists of two phases.

Phase I

Survey of standard XI students' attitude towards Mathematics learning and achievement, beliefs in mathematical abilities and study habits in Mathematics was conducted. It was for identifying the existing level of standard XI students with respect to the above-mentioned areas. Also, their opinions about additional and supportive programmes are to be explored. On the basis of the survey conducted, a Bridge Programme for enhancing the achievement in Mathematics was prepared.

Phase II

This is experimentation phase. The prepared Bridge Programme was implemented and validated. The researcher was interested in the area of creating positive and favourable attitude, efficient mathematical abilities and inculcating proper study habits and observing the effect of it on the mathematical achievement of the students. For that purpose, the achievement test is conducted among the experimental and control groups three times; pre, post and delayed post times. The results are cross checked based on the selected determining factors also and finally based on the feedbacks of the students from the experimental group.

Sample Selected for the Study

The survey was conducted on a random sample of 660 standard XI students from 39 Higher Secondary Schools of Kozhikode district, Kerala. For the experiment, the sample consists of 231 students in four intact standard XI classes from two schools in Kozhikode Educational district. The total 231 students in the sample were divided into two groups; the experimental group consisting 118 and control group 113 students of standard XI.

Tools used for the Study

The following tools are prepared for the present study.

1) Mathematics Study Attitude and Belief Scale (Philip & Noushad, 2019)
2) Mathematics Study Habits Scale (Philip & Noushad, 2019)
3) Questionnaire for the Assessment of Need of Bridge Programme (Philip & Noushad, 2019)
4) BPM for Standard XI Students (Philip & Noushad, 2020)
5) Achievement Test in Mathematics for standard XI (Philip & Noushad, 2020)
6) Prerequisite Test in Basic Mathematics (Philip & Noushad, 2020)
7) Questionnaire for Seeking Students' Feedback on Bridge Programme (Philip & Noushad, 2020)

Statistical Techniques Used

The following statistical techniques are adopted to analyse the data collected from the samples.

1) Preliminary descriptive statistics like mean and standard deviation
2) Percentage analysis
3) Test of significance of difference between mean scores (t- test)- independent samples t test and paired sample t test. The former is used to compare the mean scores of two different groups; and the latter is used when to compare the mean scores for the same group on two different occasions.
4) ANCOVA
5) Estimation of effect size by Cohen's d or Partial Eta Squared value

Scope and Limitations of the Study

In Mathematics teaching-learning process, various concepts and ideas are interlinked and hierarchical in nature. The content of Mathematics is organized in such a way that learning in each class is dependent on prior learning. Unlike other subjects or languages at each stage of learning thorough knowledge of basics and fundamentals of previous stages is very essential i.e., mastering of one topic is a pre-requisite for the next stage. It is very difficult to make students learn the new content without knowing the previous knowledge and experiences. But it is sad to say that many students are not attaining enough basic knowledge and as a result the future learning of the subject is seriously hindered and better achievement and performance in Mathematics are lagged. These lack of previous knowledge and inefficiencies in learning of Mathematics are great hurdles for Mathematics teachers and students as a whole. Further it will take time and energy to discuss the related previous knowledge every time before presenting the new topics and during the time of problem solving, leading to not completing the current syllabus. The investigator being a Mathematics teacher at HSS level has also observed the same. Hence the problem of improving learning and achievement in Mathematics at HSS level is to be addressed so as to enhance the performance level of the learner.

Keeping these observations in mind, the researcher thought of helping the students to perform better in learning and achievement in Mathematics at HSS level. The teacher community, including the researcher, has a great role to play. They need to identify the factors affecting learning and achievement in Mathematics and to help the students of standard XI by encouraging them to create favourable attitude, to develop needed mathematical abilities and to cultivate better study habits in the subject. Thus, the present study aims to develop a Bridge Programme which is based on above mentioned factors for enhancing the learning and achievement in Mathematics of standard XI students at HSS level.

At the beginning, the study focuses on assessing the existing levels of standard XI students' attitude towards Mathematics, beliefs in mathematical abilities and study habits in Mathematics. Then it aims to prepare a programme for changing their attitude, beliefs, basic concepts and study habits in the desired direction so as to improve the mathematical achievement of the standard XI students. In addition, the effectiveness of the programme is to be examined.

Thus, the present study is to focus on development of the Bridge Programme for enhancing achievement in Mathematics of standard XI students of Kerala. The programme includes psychological foundation of learning Mathematics, improving mathematical abilities and necessary study habits in Mathematics at HSS level. This programme will surely help the students for enhancing their learning and achievement in Mathematics by providing extra, supplementary and intermediate support. Thus, a solid foundation in the subject can be built at HSS level. This will reduce the failure rate in Mathematics at HSS level. Also, the study is oriented to the enhancement of achievement in Mathematics of standard XI students. Therefore, the researcher initiated to take up the study. The present study has the following delimitations.

Select Factors

First of all, the bases of the Bridge Programme are limited to the factors, namely, attitude towards Mathematics, beliefs in mathematical abilities cum basic concepts in the subject and study habits in Mathematics, though there are a number of other factors such as intelligence, creativity and so on.

Participants

The population of the study consists of all students in standard XI at HSS level who follow Kerala State Board Syllabus. The study has been confined only to the Higher Secondary Schools situated in Kozhikode district, Kerala and not in schools with any other syllabi like Central Board of Secondary Education (CBSE), Indian School Certificate (ISC) and International General Certificate of Secondary Education (IGCSE). For conducting survey in phase I, the sample comprised 660 students of Standard XI studying in the schools of three educational districts of Kozhikode Revenue District of Kerala state. For conducting experimental validation in Phase II, four intact classrooms of standard XI in two Higher Secondary Schools in Kozhikode Educational District to use as Experimental and Control groups were selected. In phase II, it is conducted between two groups of samples available in two Higher Secondary Schools and not a wider part of the population within a short period of time schedule. In addition, sample groups were selected from Aided schools and Science stream only, though HSE is conducted in Kerala by Government, Aided and Unaided schools and Mathematics is an optional subject in Commerce stream too.

Duration

Implementation of the programme is planned for thirty days.

Content

The study is delimited to chapter 5 (Complex Numbers and Quadratic Equations) of plus one Mathematics though there are 16 chapters in the text book of Mathematics. The study has its limitations too.

The Bridge Programme is not an instructional strategy; instead, it is a set of plans and strategies to be employed along with the usual classroom instruction and routine learning in standard XI. Hence willingness of the students was required continuously and constantly. In addition, sincere cooperation of parents and other authorities is needed abundantly.

There were not available many studies related with present research study, causing some difficulties in theoretical frameworks.

Phase I survey was conducted on a sample of 660 students of 2019-2020 batch, afterwards the Bridge Programme was prepared and the phase II experimentation was conducted among the students of 2020-2021 batch. This was done with the assumption that the attitude, beliefs, basic concepts in the subject and study habits of standard XI students would not be remarkably different in consecutive years.

Certain factors like social background, intelligence, home environment of the students were beyond the control of the researcher and their effects were not considered in the present study. The results obtained in this study may not be applicable to students in other classes and syllabi.

Because of COVID-19 pandemic situation the schools remained closed for a long period in the academic year 2020-2021 and unfortunately school settings were entirely different. The researcher could not collect data smoothly as expected and planned. Further due to the limitations of time some parts of the study had to be conducted in online mode.

The same research tools were used at various times, putting the items or questions in different order using google forms. The researcher could not ask many probing questions to the participants using interview schedule.

In spite of all these limitations and restrictions, the researcher has identified that the study is yielding dependable results. Besides, the implications of the present study would be of great help to the students, teachers, parents, administrators and educators for developing new trends and approaches in Mathematics teaching-learning at HSS level.

Organization of the Report

The present study is systematically organized in six chapters.

Chapter 1 - Introduction

The present chapter comprises of the general introduction and the relevant details of the problem under study. It presents rationale for selecting the present problem, need and significance, statement of the problem, definitions of key terms, variables of the study, objectives, hypotheses, a brief description of the procedure adopted, scope, delimitations and limitations of the study and finally organization of the report.

Chapter 2 - Review of Related Literature

This chapter deals with the literature review; the theoretical aspects of the present study, review of the previous research works, findings in this area and a trend report of the studies reviewed along with the gaps which were to be filled in by the present study. The investigator decided to overcome certain above-mentioned gaps.

Chapter 3 - Research Methodology

This chapter describes the method of investigation. This includes details of variables, objectives, hypotheses, design and procedure of the study including Bridge Programme plans and strategies, samples selected for the study, tools employed for data collection, data collection procedures, scoring and consolidation of data and statistical techniques used for analysis.

Chapter 4 - Analysis and Interpretations

This chapter deals with the details of data analysis using appropriate statistical techniques in tune with the objectives of the study. Interpretations of the results with relevant discussion therein are also included.

Chapter 5 - Summary, Findings and Conclusions

This chapter presents a summary of the study, findings, tenability of the hypotheses and conclusions of the study.

Chapter 6 - Implications, Recommendations and Suggestions

This chapter presents certain implications obtained, some recommendations for improving the educational practices and suggestions for further research in the area of study.

Finally, the report is followed by References and Appendices related to present study.

CHAPTER 2

REVIEW OF RELATED LITERATURE

- *Theoretical Overview*
- *Review of Related Studies*
- *Discussion*

Review of related literature in the selected area of the problem is an essential part of a research study. Both previous theories and related studies must thoroughly be familiar to the researcher so that an insight into the problem of the study be obtained. It provides sufficient information on the amount of work done in the selected area of study so that replication and duplication can be avoided. It also helps to identify the method and procedures to be used in the present study. It would help to identify what gaps in the existing situation be removed through the present study. Hence the present chapter elaborates a theoretical overview of the study, previous studies carried out in the present field of research and a critical review of those studies along with the gap to be resolved that supports the research objectives and the distinguishing characteristics of the present study.

Theoretical Overview

The quality of Mathematics teaching and learning has long been a source of concern for educators. When a group of students is considered, a few students are identified as high achievers, while others are identified as poor achievers. The question then becomes why such a disparity in achievement exists. Is this discrepancy attributable to any particular factors? Or is there a single or a collection of elements that explain all of the variations in mathematical achievement? These issues frequently arise in the thoughts of educators and psychologists but seldom receive satisfying responses. The purpose of this section is to conduct a complete evaluation of the pertinent literature in order to ascertain the factors impacting students' success in Mathematics learning.

Academic achievement in general and mathematical achievement in particular, is associated not just with cognitive ability, but also with emotional and motivational abilities. Students' intellectual talents, perceived mathematical proficiency, perceived mathematical value, intrinsic drive to study, Mathematics anxiety, and causal attributions can all be considered effective for their mathematical advancement. Self-determination and self-concept judgments are important motivating factors for students and have an effect on performance. Teachers can aid students in building these motivating resources by designing classrooms that foster autonomy and promote a positive self-concept. As a result, the theories described below can be considered advantageous for this research since they help to better explain students' Mathematics learning and hence achievement.

Students' learning and their performance in Mathematics is impacted by a variety of factors, including demographic, individual and instructional. These are explored in depth in the following overview of the relevant literature. Identifying the factors that contribute to mathematical achievement is essential for effectively educating future generation. Besides that, it provides instructional designers with more information on which to base their design decisions.

Learning and Achievement in Mathematics

In recent years, researchers have become increasingly interested in Mathematics learning and achievement and how it affects accomplishment patterns, which they attribute to Mathematics' importance to informal education and everyday life. The most significant aspect is that pupils love learning Mathematics because it allows them to demonstrate their interest, value and effort towards achievement, do well, and persist in school. That is why the study of Mathematics learning and achievement has long been considered a basic topic, owing to the fact that arithmetic and logical thinking are essential components of science and technology advancement. A consequence of this is that educational authorities place a high value on students' mathematical learning and achievement.

Deci and Ryan examined a Self-Determination Theory (SDT) for focusing on mathematical learning and accomplishment. SDT is a motivation theory that focuses on people's intrinsic motivational resources (Deci & Ryan, 1985). They discovered that self-determined motivation of pupils was favourably associated to their mathematical performance. According to self-determination theory (SDT), self-determined or autonomous motivation (intrinsic motivation and identified regulation) is associated with positive academic and emotional outcomes, whereas non-self-determined motivation (amotivation & external regulation) is associated with negative outcomes. Non-autonomous motivation was connected with a higher rate of dropout, decreased interest, less value, and decreased effort towards achievement (Vallerand et al., 1997). Numerous researchers have found that students' perceived autonomy (Grolnick & Ryan, 1987), competence and relatedness all have a significant impact on their performance and persistence in school (Hardre & Reeve, 2003) and hence on their achievement. Otoo et al. (2018) also found self-motivation helped to learn Mathematics. This study examined the effects of students' confidence and motivation on their interest in Mathematics.

It is a fact that teachers teach all students collectively, but students are varying in their achievement. There can be many reasons for this and a large number of factors have been examined as determinants of academic achievement. Achievement in Mathematics has been studied in relation to a number of factors ranging from personal, student related, psychological, cognitive, affective, school related, teacher related, home related, mathematical and environmental.

Personal factors such as gender, age, health and so on influence students' academic performance in Mathematics. The most preferred psychological variables are intelligence, personality, aptitude, heredity, creativity, academic achievement motivation, attitude towards Mathematics, self-concept, self-efficacy beliefs, level of interest, motivation, confidence, memory, learning styles, study habits and anxiety. The mathematical determinants such as comprehension, numerical ability, prior achievement, problem-solving ability, logical thinking and reasoning ability are the best predictors of achievement in Mathematics. Among the social variables, the most frequently preferred variables are socio-economic status, home environment, family background, annual income, birth order, parental involvement, parental education and many other factors. Mathematics achievement is also affected by various factors such as school type, locality, management and environment including library and laboratory, teacher quality and characteristics, class room instruction and strategies. All these have a significant impact on their mathematical performance and hence on their achievement in Mathematics.

Researchers have confirmed that intelligence and socio-economic background are major contributors to Mathematics achievement (Singh, 1983; Rajput, 1984). Reasoning power, space visualization, attitude towards Mathematics were found significantly related to Mathematics achievement (Patel, 1984). Mathematical aptitude also plays a vital role in increasing mathematical achievement. The researchers investigated the role of gender and parental educational level in determining Mathematics achievement in children. According to recent studies, gender gaps in Mathematics education appear to be diminishing in a number of countries throughout the world. The third International Mathematics and Science Study, for example, discovered that in the primary and middle school levels, Mathematics achievement results for each gender group were equivalent. The educational level of parents has an impact on their children's academic achievement. There seems to be consistency in the finding that classroom environment, students' past Mathematics accomplishment, and teacher-related characteristics are among other things.

Although earlier research has explored the impact of cognitive elements on Mathematics achievement, less attention has been paid to the impact of emotional or motivational variables on Mathematics success. There are researchers who observed that IQ did not account for a greater proportion of academic success than did emotional or motivational components, to be more specific. According to a more recent study, Garcia et al. (2016) discovered that Mathematics motivation and enjoyment were major predictors of Mathematics achievement. According to the findings, while IQ was a major predictor of mathematical success, students' attitude about the subject played a crucial role in explaining their improved performance. According to Zimmerman (2008), statistics indicated that students' abilities and skills did properly explain for the amount or type of mathematical achievement they had.

Another point to mention is that learning is plagued with anxiety and a range of emotional responses in general, and mathematical pursuits in particular. A recent study conducted by Chang and Beilock (2016) discovered a connection between motivation and fear of Mathematics. It is a sensation of unease and concern that is experienced when thinking about Mathematics or engaging in a mathematical activity. Maths anxiety can be described as negative attitude towards Mathematics, which usually shows as a desire to avoid Mathematics classes and a deficiency in numerical skills. Summarizing, numerous writers have emphasized the statistically significant relationships that exist between Mathematics fear and motivation and achievement, highlighting that the lower a student's perceived mathematical competence, the poorer his or her desire and performance in Mathematics (Lee and Stankov, 2013). Lack of essential basic knowledge and improper internalization of the subject are some among the ones that contribute to aversion towards the subject (Vijayakumari & Kavithamole, 2014).

In contrast, Mathematics anxiety and students' knowledge of Mathematics' utility were conceptualised as having an indirect effect on students' interest in Mathematics, moderated by students' confidence and motivation. Motivational factors are the primary determinants of attitude towards Mathematics which directly affects students' interest in Mathematics learning and achievement. Additionally, students' motivation to learn Mathematics is heavily influenced by their understanding of Mathematics' use. At the same time, a strong understanding of Mathematics instils confidence in students which avoids anxiety and worry and directly increase their interest in Mathematics by directly boosting their confidence and drive to learn the subject.

The educational level of parents has an impact on their children's academic achievement. In order to encourage their children to attain high educational goals and ambitions, parents must serve as role models and mentors by providing educational materials in the home and adopting particular attitude and views about their children's learning. As a result, parental educational attainment may be used as a proxy for the attitude and beliefs that parents adopt in order to create a home environment favourable to their children's learning and achievement. A large number of studies have discovered a substantial link between student achievement and the educational attainment of the students' families. Children whose parents did not complete high school, for example, had lower grades in Mathematics than children whose parents did complete high school (Campbel, et al., 2000). It has been demonstrated that parents' educational level has an impact on their children's attitude towards learning as well as their numerical success scores. Multiple studies have demonstrated that parents in higher socio- economic positions are more involved in their children's education than parents in lower socio- economic positions; as a result of this increased involvement, children develop more positive attitude towards school, classes and academic performance. The lack of access to a diverse range of educational materials and tools, as well as the creation of a stressful environment at home (potential interruptions in parenting or an increased chance of family conflict), are considered to have a negative impact on academic success (Jeynes, 2002). These considerations combine to make a student's social and economic circumstances a strong predictor of academic and mathematical achievement.

Though many of these factors are difficult to be changed and also out of control of the educators, of all the affective factors influencing Mathematics achievement, following three student related factors are worth mentioning as they are consistently related with learning and achievement in Mathematics. Attitude towards Mathematics learning, beliefs in mathematical abilities cum pre-requisite(basic) knowledge in the subject and study habits in Mathematics are selected for the present study found most relevant by the investigator. The fact that those are significant and important determinants influencing learning and achievement in Mathematics is further established by the following theoretical background too.

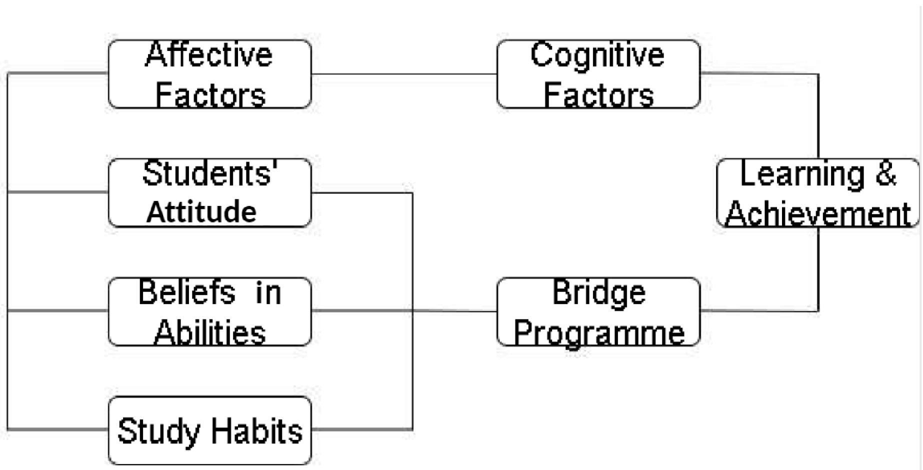
The present study relies heavily on the Affective- Cognitive Consistency Theory by an American psychologist Rosenberg (1925-2018). It states that the changes in the individuals' affective components will produce changes in ones' cognitive components so that it will bring consistency between the two components (Capuno, et al., 2019). In other words, affective behaviours and cognitive behaviours are inter related. The students' affective domain consisting of attitude and feelings towards the subject, beliefs in mathematical abilities and study habits towards the subject will affect the cognitive domain, that is, how they learn and achieve in the subject. In other words, purely non cognitive factors too play a significant role in the learning and achievement of the subject. A student with favourable attitude, sound perceptions on mathematical abilities and proper approaches in the subject will be naturally motivated to learn and achieve well in the subject; whereas he or she will not perform well in the subject if he or she holds unfavourable attitude, low level beliefs with poor mathematical abilities and inefficient approaches towards the subject.

Thus, Mathematical achievement which is a measure of students' proficiency in the field of Mathematics is influenced not only by the intellectual factors but also by the psychological factors. Inculcation of the right kind of attitude, beliefs and habits should be given due importance. These factors were shown to influence students' mathematical achievement in specific ways. Moreover, these psychological and mathematical factors are found to be significant correlates of achievement in Mathematics.

The following figure shows how learning and achievement in Mathematics and the selected affective factors are related. It is generally believed that students' attitude towards Mathematics, beliefs in mathematical abilities and study habits in Mathematics determine their learning and achievement in Mathematics.

Figure 1

Conceptual Framework of the Study



Attitude towards Mathematics Learning

Several studies have been conducted in different countries to determine the factors that influence the students' learning and achievement in Mathematics. Of all the factors, student's attitude towards Mathematics has been consistently studied because many researchers found a positive relationship between attitude, performance and achievement. Nicolaidou and Philippou (2003) established that there was a strong relationship between attitude of students and achievement in Mathematics.

Attitude towards Mathematics denotes a positive or negative emotional feeling and the perception of students towards Mathematics learning. It indicates pupils' opinion, liking and disliking about mathematical concepts and problems. As Neale (1969) says, it is the pupils' feelings such as 'like' or 'dislike' towards Mathematics learning, tendency to engage in or avoid learning Mathematics. According to McLeod (1992) the attitude towards Mathematics is just a positive or negative emotional disposition towards the subject. It plays a central role in Mathematics learning and achievement.

Favourable and positive attitude is considered as the most valuable approaches to Mathematics learning and positive attitude can be considered as the main cause in excellent achievement in Mathematics. It is a fact that anything can be learnt if the individual is ready and motivated. Interest, confidence, motivation and all are manifestations of the favourable attitude towards Mathematics. Better the favourable attitude a student has towards Mathematics learning, the higher the achievement level in Mathematics. Similarly unfavourable attitude towards the subject may cause poor achievement in the subject. Generally, there is a positive correlation between attitude towards the subject and the achievement in the subject.

It has been scientifically proven that the decisive factor for the effectiveness of an action depends on one's attitude before, during and after that action. The significant activity here is the child's Mathematics learning. Its success leading to high level achievement is decided by the factor that attitude before, during and after the study. A number of studies (Jayanthi, 2019; Jayarani, 2019; Jyothi, 2019; Kaur, 2012; Hui-Ling, 2001; Mumthas, 2001; Sumangala, 1995) support that students' favourable attitude towards Mathematics is related to their achievement in the subject.

Students generally show less enthusiasm in Mathematics and have a negative attitude towards the subject. Most of the students exhibit a lack of motivation, interest and confidence in Mathematics. High achievers have favourable attitude such as motivation, interest and confidence towards the subject than others. Thus, the most significant aspect is that students' love for learning Mathematics.

Student views of Mathematics' relevance and benefits in their lives are described by the phrase "perceived utility of Mathematics, " which refers to their perceptions of the subject's relevance and benefits in their lives. There is a positive relationship between students' judgments of the subject's worth and their ability to acquire new concepts and do better in Mathematics. Motivational factors are the primary determinants of attitude towards Mathematics and hence success in learning. Also, involvement in deep learning involves both actual and perceived cognitive capacity on the side of the students, as well as a strong dedication to the task on their part. Motivation for learning may be characterized as the act of starting a learning process, determining a course of action, and remaining committed to the chosen path.

According to Hammoudi (2019), kids who were more motivated sought out learning opportunities and outperformed their colleagues in Mathematics. Indeed, while both types of motivation are positively associated with perceived mathematical competence intrinsic motivation is associated with increased enjoyment of Mathematics. Students' mathematical achievement can be optimized through the building of self confidence in learners. It can be achieved by inculcating self-awareness, self-efficacy and emotional intelligence.

Finally, learning in general, and Mathematics activities in particular, are linked to anxiety and a variety of emotional responses (Rosário et al., 2008). It denotes a feeling of tension or fear interfering with one's performance in Mathematics. Chang and Beilock (2016) recently established a connection between motivation and Mathematics fear. Maths anxiety is a state of unease and worry that happens when one contemplates Mathematics or completes a mathematical project (Buckley et al., 2016). Arithmetic anxiety, in particular, is defined by negative attitude towards Mathematics, which is likely to manifest itself through the avoidance of Mathematics classes and the demonstration of inadequate arithmetic skills (Pizzie & Kraemer, 2017). High levels of anxiety, stress, tension and nervousness influence mathematical learning and achievement. Mathematics anxiety and students' knowledge are considered as having an indirect effect on students' interests. Students' anxiety and perceptions of Mathematics' use have a direct effect on their confidence and enthusiasm to learn Mathematics. In short, various authors have emphasised the strong connections between Mathematics fear, motivation, and achievement, emphasising that the lower a student's perceived mathematical ability, the worse his or her motivation and performance in Mathematics (Lee & Stankov, 2013; Chang & Beilock, 2016; Passolunghi et al., 2016). These can be addressed to some extent by the adequate and timely intervention of the parents and teachers.

Accordingly, the attitude of HSS students towards Mathematics learning and their Mathematics achievement are seen to be related. Their attitude towards Mathematics plays an important role in Mathematics learning and achievement. Hence, it is imperative to develop desirable attitude in the students of standard XI at HSS level.

Beliefs in Mathematical Abilities

Another factor such as attitude is belief regarding mathematical abilities; a belief that one is good or bad in Mathematics. It also plays an important role in Mathematics learning and achievement. A substantial link has been found in the literature between students' assessments of their competence in a given area and their willingness to participate in activities related with that topic. Researchers discovered a statistically significant, positive, and large connection between perceived competence and mathematical performance. Perceived competence, perceived utility, motivation, and academic success are all interrelated phenomena. Peixoto et al. (2017), for example, discovered a strong, significant and favourable relationship between perceived competence and Mathematics achievement. In addition, perceived competence in Mathematics is viewed as students' perceptions of themselves as learners and their ability to complete mathematical activities successfully. This perception may or may not correspond to reality, but it is an important source of motivation for students. To summarize, perceived competence, perceived usefulness, motivation, and academic achievement are all interconnected characteristics that may be thought of as a whole.

The expectancy-value theory (EVT) of accomplishment motivation stretches all the way back to the early twentieth century (Atkinson 1957; Weiner 1992), although Eccles and Wigfield's more recent work is the most widely used expectancy-value model (Eccles & Wigfield, 2002). This paradigm, which is founded on personality, social and developmental psychology, places a premium on students' academic performance expectations and their perceived value of academic tasks (Pintrich & Schunk, 2002). The expectation component of the paradigm is concerned with an individual's beliefs and judgments about his or her ability to complete and succeed at a task and it has strong resemblance to concepts from other theoretical traditions such as self-schemata, self-concept and self-efficacy. The value component of the model is concerned with the numerous reasons why individuals engage in or avoid a task, as well as the strength of those values. Both of these factors have been shown to be important predictors of academic achievement behaviour (Wigfield & Eccles, 1992).

Also, mathematical conceptual comprehension, procedural fluency, strategic competency, computational and problem-solving skills are helpful in order to achieve mathematical proficiency. The capacity of students to comprehend mathematical ideas and the relationships between them is referred to as conceptual comprehension. Researchers discovered a statistically significant, positive, and large connection between perceived competence and mathematical performance.There is a positive relationship between students' judgments of the subject's worth and their ability to acquire new concepts and do better in Mathematics; there is a link between perceived usefulness and the use of self-regulated learning approaches to improve quality of learning. This is due to the fact that students usually do see a substantial relationship between the use of cognitive methods, high-quality learning, and academic success. To assist students in developing their ideas and correcting any misconceptions, the researchers created a number of technical as well as non-technical scaffolding and feedback tools. Procedural fluency, on the other hand, is the ability to do calculations accurately and quickly. Students must have a working grasp of calculation rules and practice the procedure without making any mistakes in order to increase procedural fluency and speed of execution.

The majority of pupils believe Mathematics is a challenging subject. To educate a diverse set of pupils, teachers must employ a range of instructional techniques. Teachers must have an understanding of their students' prior knowledge before beginning to teach the topic. One of the major reasons of mathematical backwardness is lack of command over basic mathematical skills (Rastogi, 1983). It is a fact that lack of or deficiencies in basic Mathematics concepts, problem solving leading to poor achievement. Thus, expertise in previous content knowledge, definite comprehension power in order to comprehend mathematical concepts and efficient problem-solving ability are needed to be successful in Mathematics learning and achievement. As students' grasp of fundamentals of Mathematics improved, their attitude towards Mathematics improved and their achievement in Mathematics grew. The students who are confident in their mathematical abilities can perform better.

The problem-solving ability in Mathematics means the ability of handling the mathematical problems and finding solutions for them. It lies at the heart of the subject and central to learning and achievement in Mathematics. Studies revealed that problem solving ability and achievement in Mathematics were positively correlated (Kumar, 2021). Problem solving is an integral part of mathematics learning and hence to enhance achievement in Mathematics, problem solving ability needs to be given importance.

The students should develop confidence in their own mathematical abilities and performance. They should recognize that they are able to do better in understanding Mathematics and succeed in mathematical learning, even if they experience some sort of difficulties.

Study Habits in Mathematics

The study habit in Mathematics is one of the factors that can also largely influence students' learning and achievement in Mathematics. It is the tendency of the student to study the subject in a systematic and efficient way. It means whether they have cultivated regular study as a habit or not. It refers to a set of procedures of doing tasks related to students' study so as to learning make effective. Preparation of the list of daily tasks and following without fail, having a fixed place at home for study, using study aids wisely and using most effective method of studying are some of the study habits followed by high achievers in school. Subject- specific study techniques need to be known to them. Thus, the absence of this would lead the students to poor performance in learning and achievement.

Many researchers found that there was an influence of study habits in Mathematics learning and achievement (Kasat, 1991; Thirunavukarasu, 2008; Rai, 2013). Rajyaguru (1991) found that high achievers would possess positive attitude towards Mathematics and follow better study habits. Good study habits help in improving the mathematical learning and achievement. These considerations combine to make them strong predictors of academic achievement. Numerous researches have concluded that the majority of these habits are necessary for academic achievement (Lowe & Cook, 2003). By cultivating good study habits, the students can excel in learning and achievement in Mathematics.

Since Mathematics education is to be acquired through effective study, it is essential to be expert masters in study habits related with the subject. In the absence of practice of study habits, the students tend to develop distaste for studies which will cause many problems of study such as inability to concentrate, memory issues, examination anxiety and so on. The teachers can talk on the issues of study habits or study skills or strategies or techniques either as part of classroom teaching or as guidance. It is essential that strategies of studying Mathematics are made known to the students so that learning of the subject becomes a meaningful experience. Mathematics teachers have to teach not the subject alone but the techniques to learn their subject as well. The students will be more confident if they are taught the strategies to learn Mathematics.

Although research has explored the impact of cognitive elements on Mathematics achievement, less attention has been paid to the impact of emotional or motivational variables on Mathematics success. It is note-worthy that enhancing any one of the above-mentioned factors may result in the improvement of learning and achievement in Mathematics of students in any level of group of students. Moreover, these factors need to be improved through various efforts and thereby to enhance the students' learning and achievement in Mathematics. In addition, achievement in Mathematics is made enhanced when one knows how to change his/her attitude, beliefs and abilities and study habits. Moulding in such a way that the students can be successful learners of Mathematics.

Experiments in Mathematics Education

The creation of educational environments, situations, approaches and solutions that assist students with diverse skill and ability levels in reaching their learning goals continues to be a significant and ongoing issue. Many studies have been done over the last three decades to explore and assess the role and implications of technology in Mathematics education and learning at the cognitive level and many more are currently being conducted. Methods of instruction, competitive games, Computer Assisted Instruction (CAI), various packages and modules are found to be generally successful in improving learning and achievement in Mathematics. Researchers have discovered that computer assisted, game based or other such programmes can assist students to increase their Mathematics learning and achievement.

Programme Development in General

There are various popular and useful models of teaching-learning, namely, Bruner's concept attainment model, Ausubel's advanced organizer model and so on, and instructional design models, namely, ARCS by John Keller, Backward Design by Wiggins and McTighe, Dick and Carey Model, David Merrill Model, Gagne's Nine Events of Instruction by Gagne, ADDIE Model by Branch, Gerlach and Ely Model by Gerlach and Ely. These models provide with guidelines or frameworks to organize and structure the process of creating effective instructional activities.

Generally, the following steps are adopted for programme development in educational set up:

1) Collection of facts- a programme must start with the pupils and situation as they are. Various facts are collected from available records and by the survey of the existing situations.
2) Analysis and Assessment of situation- the existing situation is analysed by the persons concerned to get a proper picture of the present scenario.
3) Need Identification- problems are identified and priorities are fixed on the basis of the felt needs.
4) Setting goals and objectives- the objectives are set forth on the basis of the relevant needs identified; ways are planned to solve those problems using the available resources within the limits of time.
5) Determination of a plan of work and ways of execution- all essential details are included in this plan such as resources, time, approaches and calendar of activities etc.
6) Implementation of the plans- transforming the plans into action
7) Evaluation and Revision- assessing the programme and making needed improvement

Bridge Programmes in General

The New Oxford Advanced Learner’s Dictionary (2005) defines bridge as connection; a thing that provides a connection or contact between two different things. Schlossberg (2008) defines transition as an event or non-event that modifies an individual's connection, roles and assumptions. It emphasizes the critical role of transition programs in assisting students in coping with or overcoming challenges associated with changes in routines, assumptions, roles and relationships associated with the transition from high school to college. He continued by stating that such a transition is difficult because circumstances such as separation from family and friends, as well as differences in academic and social responsibilities, all influence how each student adjusts to the change. Hillman (2005) emphasized the critical role of orientation in facilitating the transition process for first-year students.

Students’ early experience on campus is critical to their transfer to higher institutions and their first-year experience. Apart from the curriculum and fundamental features of instruction, institutions’ commitment to first- year transition is a more significant prerequisite. Students’ success is more likely to be determined by the number and quality of their involvement. It is found that colleges that offer counselling and orientation programs have a better graduation rate. Lang (2007) had shown that a student's first year experience and adjustment to the university environment have a greater impact on their achievement. Florida and West Virginia policymakers view education investment as a necessary component of economic development and hence place a premium on bridging the gap between school and college courses. Bridging programs, study groups, and learning communities that aided newly admitted students were found to result in high graduation rates. As a result, colleges and institutions can use bridge programs to effectively facilitate transition while also closing the college readiness gap that exists between students' school education and their college education. Reduced readiness gaps help institutions retain students and students improve their success and assignment completion rates.

The residential summer bridge program was designed to bridge the gap between high school and four-year universities for freshmen at selective institutions around the University of California (Berkeley, 2010). The Texas Higher Education Coordinating Board offers fall and spring semester bridge programs. It discovered that newcomers who completed orientation classes retained more information than those who did not, which culminated in the construction of a "National Resource Centre at the University of South Carolina". It synthesized his research on first-year student transition experiences in Australia, the United Kingdom, Canada, the United States of America and Asia, and identified several factors that contribute to first-year student success during transition, including psychological characteristics, social and institutional factors, demographic characteristics, prior performance, and assessment outcomes.

Summer Bridge Programs provide intensive and short-term academic and social resources to provide an exposure to college culture. These programmes primarily recruit senior high school students who are on pace for remediation or persons who are placed in remediation upon admittance into an institution. Bridge programmes are intended to assist students who have recently been admitted to an institution and have been placed in a developmental course. Current students who have been going through a predetermined developmental course sequence are occasionally allowed to participate in the programme as well. While the major goal of bridge programmes is to provide a review of high school arithmetic concepts, bridge programme implementation varies from institution to university. Many programmes are available on a weekly basis, while others are available for three or four weeks or even longer. Furthermore, some programmes will provide technology-based training, while others will provide face-to-face instruction, or a combination of the two (Quiroz & Garza, 2018).

The purpose of summer bridge programmes is to bridge the gap between high school and college. These are often rigorous multiweek events that occur before to a student's first year of college and are intended to assist them in adjusting to the collegiate academic environment. Students in the treatment group were assigned to the summer bridge programme treatment group, whereas students in the control group were able to access any other college resources save the summer bridge programme. In the first year and a half, students in the treatment group completed their college-level Mathematics course at the same rate as students in the control group (Barnett et al., 2012), but they were more likely to pass college level Maths and writing in the autumn semester following the summer programme (Wathington et al., 2011). The Bridge program's study has concentrated on the program's effect on student retention in college engineering programmes through an examination of factors such as overall academic abilities, peer interactions, students' sense of self-efficacy and social skills (Strayhorn, 2011).

Refresher Mathematics course interventions, as part of developmental Mathematics instructional reforms, include summer bridge programmes, boot camps, and other sorts of brush-up programmes that provide a short-term review of Mathematics skills to facilitate Mathematics college preparedness. These programmes are often offered during the summer, between high school and the first semester of college, and vary in terms of curriculum, programme size, and length (Quiroz & Garza, 2018; Sablan, 2013). Bridge programmes primarily focus on improving students' Maths skills and performance on placement tests (Scherer & Grunow, 2010). Bridge programmes, on the other hand, provide a condensed, intensified review of high school Maths concepts, and at the end of the review, students take a placement exam in the hopes of being placed into a higher-level developmental course.

The benefits of bridge programmes have been proved in a variety of ways. They can assist students by providing support services to facilitate the transition from high school to college, both academically and socially. Students can develop ties with mentors, peers, and instructors (Barnett et al., 2012). Furthermore, proponents of accelerated course choices, such as bridge programmes, say that if students are assisted in completing requirements more quickly, a greater proportion of them will be able to finish developmental courses and on to college-level work. Thus, bridge programmes are designed to help students who would otherwise be unprepared for the rigours of their studies and who would benefit from acclimating to the academic environment of the institution.

Mathematics Programme Development

Many low-achieving pupils are very certainly the result of teacher-led education, which continues to predominate in Mathematics classes across the world. It should be emphasized that each child in each classroom has unique abilities and has achieved extraordinary achievement as a result of those qualities. Unfortunately, with teacher-led education, all students are expected to learn from the instructor in the same way and at the same speed, which does not always work out well for everyone. Low-achieving pupils are compelled to passively absorb information because they do not have enough time. Educators underlined the need of providing low-achieving students with more opportunity to learn Mathematics at their own speed in order to improve their overall performance. They proposed one-to-one technology, in which each student is provided with a gadget that allows them to study seamlessly in school and at home.

Furthermore, students who consistently score poorly in Mathematics may lose interest and eventually refuse to continue their studies. This is a really serious situation. In order to inspire youngsters to learn, researchers create educational programmes that are really interesting and motivating. Multiple studies have discovered that game-based or technology-based learning can assist students increase their motivation and learning effects, spatial abilities and attention, contextual learning (including problem-solving) and problem-solving skills. Many academics have demonstrated that instructional programmes for Mathematics may help students improve their Mathematical ability, pleasure, and self-efficacy by providing them with opportunities to solve problems (McLaren et al., 2017).

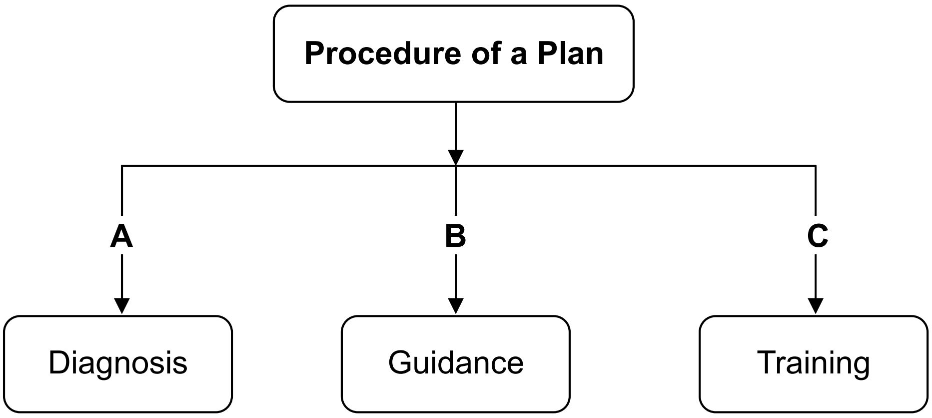
Generally, teachers arrange a variety of learning experiences such as projects, lab works, assignments and so on. For keeping the standard of learning and achievement in Mathematics at HSS level extra efforts should be taken by teachers as well as students (mentor-mentee relationship). All teachers should take on the responsibility- additional to Mathematics teaching- of helping students to learn how to learn. The Right to Education Act passed in 2009 in India considers the teacher as a mentor. A teacher should function not as a person who distributes/ dispenses knowledge, but as a facilitator who coordinates the various opportunities of students to gain knowledge. Only when a teacher becomes a mentor and facilitator (scaffolder) who helps to gain learning outcomes, he/she will be a teacher of the new era. When the teacher becomes a co-guardian, students get guidance, advice, support and opportunity to improve. The teachers as mentors should make interventions in the role of an experienced predecessor. Of course, students should get the opportunities to practise additional Mathematics learning strategies as they engage in Mathematics learning. During this venture there arises the importance of teaching-learning programmes like Bridge Programmes.

Bridge Programme in Mathematics

Bridge Programme in Mathematics (BPM) focuses on boosting students' mathematical learning and achievement. Its efficacy is revealed by the enhancement of pupils' mathematical achievement. Assistance for awareness and guidance are part of this programme. A mentor is a person who discovers the unrealized potential in a student and brings it out. An effective mentor can bring out the hidden talents of the students. All students in Mathematics should get an experience of mentoring so that Mathematics learning could become a meaningful experience. This enrichment is designed with the help of diagnosis, guidance and training in Mathematics as depicted in figure 2, which is found to be very effective and yielding high results.

Figure 2

The Three-pronged Steps for the Procedure of a Plan in the Programme



The term diagnosis means strength-weakness identification; finding Mathematics study related problems and difficulties, especially with attitude, beliefs, abilities, habits and the procedures they follow during their study. Students are expected to introspect and find their strong and weak points experienced while learning Mathematics. Also, various instruments can be administered for this purpose by the researcher or persons concerned. In fact, the diagnostic approach is clinical in nature. As found by Rastogi (1983), diagnosis and remedial approaches were very effective and yielding positive results. Thus, personnel services given to the students had positive effects on their academic performance.

The term guidance means systematic assistance given to the students to understand and use wisely the educational and other opportunities they have; a mentoring, facilitating, scaffolding-remediation approach; helping the students to overcome their problems and strengthening their abilities either in group or for individual depending on the situation. It is done in face-to-face interaction mode. It is some form of assistance or help given by one person to another in making adjustments for solving problems and taking proper decisions and choices. It is based on the assumption that students are always in need of help. Good (1975) defined guidance as a form of systematic assistance (aside from regular instructions) to the pupils and others to help them to acquire knowledge, wisdom free from compulsion or presumptions and calculated to lead to self-direction. A well-organized plan of guidance is helpful for the maximum development of pupils.

The term training means drawing out the best-grooming and finishing in nature; specific training in how to form favourable attitude, how to work and how to study effectively using the strategies proposed with a view to help students to perform well and also to fortify and groom them for excellent learning and achievement. Mastering the essential foundations and fundamental mathematical concepts and ideas in the HSS stage is very necessary for excellent performance and achievement in the subject. The prime aim of education should be to draw out the best in the learner and make it perfect. In fact, the very essence of education itself requires the same that it is a process of training the individuals through various experiences of life so as to draw out or lead out the best in them. Above all, Mahatma Gandhi visualized education as “an all-round drawing out of the best in child and man-body, mind and spirit” (Gandhi, 1937, p.197). ‘Drawing out the best in child' has been focused by Gandhi. The real teacher must work for drawing out the best from the child. It is, in fact, a process of training the individuals through various experiences so as to nourish or to bring up the best in them. In pursuit of this, Mathematics teachers can play a significant role by providing proper instructions and practice.

The keynote ideas presented here are flowered in the concept of Bridge Programme in Mathematics which is a supplementary programme consisting of diagnosis, guidance and training that attempts to compensate for the deficiencies by providing specialized activities to bring students to an up to the mark level of achievement. This concept of Bridge Programme can be best implemented in school education especially in the field of Mathematics education. It is an intervention programme in Mathematics that contains psychological foundations (students' attitude towards Mathematics and beliefs in mathematical abilities), study habits in Mathematics and essential fundamentals and prerequisites in learning Mathematics which are undoubtedly worth exploring as they have a connection to students' academic achievement in Mathematics. It focuses on creating favourable attitude towards Mathematics, beliefs in mathematical abilities, training in basic concepts and good study habits in Mathematics. The aim is to provide supplements by tutoring or bridging in which students are found wanting when they learn in standard XI for enhancing the learning and achievement in Mathematics. A good teacher has to identify individual abilities of the students and provide suitable enrichment programmes and remedial measures so that the innate potentialities of the students must be developed. It has been designed new and to be incorporated in the context of Mathematics education. Thus, present programme is different from regular school activities in the subject and has appeared something new in the system of Mathematics teaching and learning. These observations suggest the importance of developing certain type of programmes for enhancing learning and achievement in Mathematics.

Based on these ideas and procedures, the investigator planned to develop a Bridge Programme for enhancing achievement in Mathematics of standard XI students. It is imperative to look for the ways to enhance students' learning and achievement in Mathematics. The Bridge Programme consisting of psychological foundations, better study habits and essential fundamentals in Mathematics including basic Mathematics is developed for preparing each student to enhance the performance in Mathematics at HSS level.

Review of Related Studies

In this section the previously conducted or published information in the relevant research area is discussed and analysed. The purpose of this section is to get a complete understanding of the pertinent literature in order to ascertain the factors affecting students' Mathematics learning and achievement and various programmes in practice. Thus, all the studies reviewed below are related to achievement in Mathematics, experiments and practices in Mathematics teaching-learning at different levels.

Most of the studies in Mathematics education are relational studies, especially related with Mathematics achievement. The investigator has reviewed the research works related to the present study in areas of methods, measures, approaches, treatments, tools, experimental designs and findings and presented 127 studies all together which were conducted both in India and abroad.

Studies Related to Learning and Achievement in Mathematics

Appiah et al. (2022) studied on the impact of teacher- students' relationship, student self-efficacy, and student perception on Mathematics achievement. Survey method was used. A structured questionnaire for data collection was employed among 400 students (112 males and 298 females) from two public senior high schools in the Ashanti region. The structured equation model was the statistical technique used. The investigators concluded that students' self-efficacy and students 'perception had a positive impact on Mathematics achievement, where as the influence of teacher- student relationship on Mathematics achievement was significant. They also recommended that teachers should give importance to promote students' attitude towards Mathematics as well as their self-efficacy for accelerating their performance in the subject.

Milan (2021) investigated on problem solving ability in Mathematics, aptitude in Mathematics and interest in Mathematics as predictor variables of achievement in Mathematics among secondary school students. The study was conducted in descriptive as well as correlative ways. The sample of the study consisted of 688 students in Karnataka state. The results of the study revealed that the select variables had very low positive correlation with achievement in Mathematics. But they were all the predictors of achievement in Mathematics.

Tiigga (2021) analysed the effect of learning styles on Mathematics achievement. The purpose of the study was to find out the correlation between Mathematics achievement and learning styles of high school students. The study followed the descriptive survey research design which was conducted among 1200 high school students from 40 high schools in Surguja district. The study revealed that there was moderate effect of learning styles on Mathematics achievement.

Reddy (2020) conducted a study on achievement in Mathematics with special reference to general intelligence, logical reasoning and problem-solving ability as determinants. The major purpose of the study was to enquire the role of general intelligence, logical reasoning and problem-solving ability of high school students with regard to their academic performance in Mathematics. The survey method was employed among a sample of 540 standard IX students in Kanchipuram region. The study revealed that general intelligence, logical reasoning and problem-solving ability were the influencing factors to achievement in Mathematics.

Bora (2019) investigated to determine the influence of parental engagement on the academic success of secondary school children in Mathematics. The population comprised all ninth-grade pupils registered in Assam's Karbi Anglong district secondary schools. This study used a sample survey approach. This research enrolled 900 students from 30 secondary schools. The study sampled 460 male and 440 female pupils and 449 male and 551 female parents. The investigator developed two research instruments: one to assess parental involvement in adolescents' education and another to assess their mathematical achievement. It was found that there existed effects of parental involvement on the mathematical achievement of secondary school students.

Hemavathi (2019) studied on mathematical achievement of students in relation to certain factors. The purpose of the study was to know various socio-demographic and psychological factors which would affect the academic achievement in Mathematics. The study was survey type investigation. 1200 secondary school students were selected for the sample. The investigator found that gender, locality, management, age, annual income of the family, economic position of the family, father, mother, teacher characteristics, library and lab facilities in school, students' participation in mathematical fairs and exhibition, facilities in home, interest in the subject, achievement motivation, intelligence, personality, self-concept and study habits all contributed significantly to achievement in Mathematics of secondary school students.

Jayarani (2019) studied on mental alertness, attitude towards Mathematics and parental encouragement of higher secondary students in relation to their mathematical achievement. The purpose of the study was to find out how far the select variables help to improve or deteriorate the mathematical achievement of the students. The normative survey method was used in the study. The sample of the study included 800 second year higher secondary students from Nagapattinam, Tamil Nadu state. The study revealed significant positive relationship between achievement in Mathematics and mental alertness, attitude towards Mathematics and parental encouragement of higher secondary students.

Bosman (2018) examined the connections between Mathematics success and seven distinct learning styles and the learning styles of high and poor achievers, using the Dunn and Dunn and VARK models. To do this, the inquiry used a predominantly quantitative research approach with 240 students from a single high school in the North-West Province South Africa. The students responded to a standardized questionnaire. The findings indicated that an individual's learning style had the strongest correlation with mathematics achievement. The study also discovered that context affected learning style preferences: in addition to individual learning at home, high achievers favoured reading/writing and group learning in the classroom. The research suggests that instructors foster a pleasant learning environment in the classroom and employ instructional strategies that suit a range of learning styles. Additional study is needed to ascertain the effect of demographic factors on preferred learning styles in mathematics. To this aim, further teacher training may be necessary. These recommendations are especially pertinent for educators in developing nations because mathematics has the potential to alter society.

Chakrabarty (2017) explored learning and achievement in Mathematics at secondary level of students in relation to their IQ, self-concept and achievement motivation. The purpose of the study was to find students' achievement in

Mathematics by relating it to the above factors. The study was descriptive in nature. The total sample consisted of 600 standard VII and VIII students from ten schools in West Bengal. The study found the effect of achievement motivation, intelligence quotient and self-concept as well as taking together on achievement in Mathematics.

Nongrum (2017) conducted a study on creativity and self-concept in relation to Mathematics achievement of upper primary school students in East Khasi Hills District of Meghalaya. In this study the investigator wanted to find out whether creativity and self-concept were the factors affecting Mathematics achievement. A descriptive method of study was employed. A sample of 792 students from upper primary schools was selected for study. The study revealed that there were significant relationships between creativity, self-concept and Mathematics achievement.

Pandey (2017) explored the mathematics achievement of class X secondary school students in relation to their sexualized economic status. The present research utilised a descriptive or survey research approach. The research population included all students enrolled in class X in government and private secondary schools in the Bageshwar district. A representative sample of 243 class X students from government and private secondary schools in Bageshwar district was randomly selected for this study. As a conclusion to this study, it is stated that female students, rural students, and rural female students in class X had worse mathematical achievement than their male counterparts. There is still an opportunity to improve female students' success levels by altering parents' and instructors' attitudes regarding female students' mathematics learning. It may be accomplished by eliminating gender prejudice in the classroom and home environment and by educating both teachers and parents about their female students' mathematics performance. It is advised that rural parents give greater or equal learning chances to their female children as they do to their male pupils in order for them to study mathematics to the maximum extent possible.

Sonia (2017) explored the relationship between certain cognitive abilities and achievement in Mathematics of secondary school students with left, right and integrated hemisphericity. For the study the investigator adopted survey method. The sample of the study consisted of 1125 students in standard VIII. The study revealed the significant relationship between cognitive abilities such as creative thinking ability, logical thinking ability, problem solving ability, spatial ability of students and achievement in Mathematics with different hemishericity. The study implied that better teaching strategies could enhance proper development of students which in turn would help the students to achieve the best in Mathematics.

Garcia-Planas et al. (2016) studied on the e-portfolio as a teaching tool in a linear algebra courrse. The purpose of this study was to determine the preferences for learning styles, study habits, and academic success of students enrolled in applied science courses at a campus of a public higher education institution in the Philippines. The study utilized a descriptive correlational research design with a purposively chosen sample of seventy-five respondents. The researcher used two distinct sets of standardized instruments. The survey's findings indicated that students enrolled in applied sciences courses favoured visual, social, and kinaesthetic learning modes while exhibiting a moderate degree of study habits. Additionally, they have a high degree of academic success. The difference test indicated that academic achievement, father's employment, and the sort of high school from which they graduated all predicted substantial differences in their perceptual learning styles. They showed variations in their study habits when classified according to their high school academic status, writing abilities, moms' education and test anxiety. The study's conclusions can assist instructors in planning and delivering appropriate instructional interventions.

Kumaravelu (2015) conducted a study to explore information processing skills and general mathematical aptitude of higher secondary students in relation to their academic achievement in Mathematics. Descriptive survey method of investigation was used. The sample consisted of 927 first year higher secondary students from Puducherry region. The study revealed that there didn't exist significant relationship between academic achievement in Mathematics and information processing skills of students and the relationship between academic achievement and general mathematical aptitude was positive.

Gafoor and Kurukkan (2015) discussed the emotional elements that influence students' perceptions of school Mathematics learning. A questionnaire survey was administered to a random sample of 51 standard IX pupils to ascertain their expectations, task value views, self-efficacy beliefs, epistemological beliefs, goal orientation, interest, and anxiety towards Mathematics. 88% of these kids identified mathematics as their least favourite subject, while just 6% identified it as their favourite. The most common reasons for disliking Mathematics were difficulties with the subject matter and instructor or instructional issues. While 20% ranked Mathematics as a complicated topic, 54% assessed it as a medium-difficult subject, and just 10% evaluated it as an easy subject. Around 42% of students are unable to find solutions to problems presented in their textbooks. Many pupils employ blind methods when studying Mathematics and have lower adaptive self-efficacy and epistemological views. Students acknowledge Mathematics' practical value, but they place little personal value on it. Thus, even if people dislike Mathematics, they may study it for its practical utility. However, if a task is challenging for them, their likelihood of avoiding it increases. Students hold the bright idea that they can perform better if they work hard; they recognize the worth of effort. Thus, there are reciprocal correlations between all attitudinal measures and Mathematics success, and the sense of enjoyment directly affects Mathematics accomplishment. It encourages teachers to pay close attention to how their students' learning is affected. Students' low engagement in Mathematics results from perceived obstacles, a lack of self-efficacy, dislike, boredom, negative beliefs, and a lack of work value. Teachers must employ successful strategies for motivating pupils to study Mathematics regardless of their level of difficulty. Teachers can contribute to students' increased interest in a subject by enhancing students' emotional beliefs.

Krishnan (2015) had shown keen interest in the study on achievement in Mathematics with certain selected variables. Normative survey method was adopted in the study. The investigator collected data from 850 higher secondary students studying in the schools situated in Cuddalore district of Tamilnadu. Achievement test in Mathematics, Problem Solving Ability test, Risk Taking Behaviour scale and Self- efficacy scale were the tools used for gathering data. The investigator concluded that the factors affecting achievement in Mathematics or the factors that caused the mathematical achievement were problem solving ability, risk taking behaviour and self-efficacy of the higher secondary students. These psychological factors of students contributed to the overall improvement in mathematical achievement.

Parekh (2015) conducted a study on the correlates of achievement in Mathematics of students of class VII with respect to certain variables. The purpose of the study was to find out the relationship of selected variables with achievement in Mathematics for students of standard VII. The study revealed that variables like intelligence, attitude towards Mathematics, SES and weaknesses in Mathematics influenced Mathematics achievement.

Sreeraj (2015) studied on the relationship between multiple intelligences and achievement in Mathematics of students at secondary level. The survey method was employed for the study. The sample consisted of 1500 high school students from three districts of Kerala state. The study revealed that the relation between the selected components of multiple intelligence, namely, logical mathematical intelligence, spatial intelligence, inter-personal intelligence, intra-personal intelligence and achievement in Mathematics was positive and high.

Ramachandran (2014) conducted a study on secondary school students' achievement in Mathematics in relation to their mathematical phobia, self-efficacy and family acceptance. The purpose of the study was to measure the secondary school students' achievement in Mathematics in relation to above variables. The normative survey research method was employed. The study was conducted among a sample of 1000 secondary school students from Cuddalore educational district of Tamil Nadu. The study revealed that there was a significant negative relationship between achievement in Mathematics and mathematical phobia, mathematical phobia and family acceptance of students and there was positive relationship between achievement in Mathematics and self-efficacy, achievement in Mathematics and family acceptance of the students.

Kaur (2012) investigated on the causes of low achievement in Mathematics at secondary stage. The purpose of the study was to identify low achievers in Mathematics in secondary schools and to enlist the causes of low achievement in Mathematics of the students. A sample of 354 students from Malwa region who had passed matriculation examination from Punjab School Education Board during 2008-09 had been taken. The investigator collected information regarding their personal, social, psychological and economic causes of low achievement in Mathematics from these students, their parents and teachers. The study revealed that the level of intelligence, academic achievement motivation, attitude towards Mathematics and socio-economic status all significantly contributed to students' mathematical achievement.

Sankar (2012) conducted a study on designing concentration strategies and determining their effect on mathematical learning and achievement of students in Tirunelveli region. The investigator adopted experimental method for studying the effectiveness of the experimental variable concentration strategies in changing the cognitive characteristic achievement in Mathematics of standards IX and XI pre-test post-test, control-experimental group design was adopted. The study found that the concentration strategies were highly useful in promoting students' mathematical achievement.

Sonar (2012) explored the relationship between mathematical aptitude and achievement of secondary school students. The study used descriptive survey research method. The investigator found a positive relationship between mathematical aptitude and achievement in Mathematics of secondary school students.

Liu and Koirala (2009) used regression analysis to examine the link between Mathematics self-efficacy and Mathematics achievement of high school sophomores throughout the United States. The following research questions were specifically addressed: (1) Was there a significant link between Mathematics self-efficacy and success in Mathematics? If so, what was the magnitude of the correlation coefficient? (2) Is Mathematics self-efficacy a significant predictor of high school sophomores' Mathematics achievement? A correlation study revealed a favourable relationship between Mathematics self-efficacy and Mathematics achievement. Students who had a high level of mathematical self-efficacy demonstrated a high level of mathematics achievement. The survey's linear regression analysis revealed that mathematical self-efficacy was a strong predictor of mathematics success.

Students who were confident that they could perform well on math tests comprehend the most challenging material presented in math texts, comprehend the most challenging material presented by their maths teachers, perform well on math assignments, and master the skills taught in their math classes were more likely to have a positive attitude toward maths.

Jayasree (2008) investigated on the influence of emotional intelligence, locus of control and rigidity on mathematics achievement of students at degree level. The investigator adopted normative survey method. 800 second year degree students in Mathematics were included in the sample. The study revealed significant correlation between each independent variable and dependent variable; emotional intelligence as the highest influencing independent variable on the scores of mathematics achievement of students, followed by locus of control. Rigidity explained only negligible variation in the scores of mathematics achievement.

Nirmala (2006) investigated on the factors influencing mathematical achievement of students. The study was conducted among 900 students from higher secondary classes in Chennai district. The data was collected using standardized tools including Achievement Test in Mathematics. Among the factors influencing the academic achievement of the students in Mathematics at higher secondary school level, Maths information processing skills, decision making skills and attitude towards Mathematics had made significant contribution towards mathematical achievement of the students.

Rajni (2006) evaluated teacher-parent support for mathematics studies, aptitude for mathematics, and attitude towards mathematics as predictors of mathematical accomplishment. At the 0.01 level of significance, the researcher determined a substantial link between mathematics aptitude and achievement in mathematics. It is critical to highlight that the difference in spatial skills between males and girls is relatively minor. Even if convincing proof of a biological basis for sex variations in spatial abilities is established, this does not indicate that these disparities are uninfluenced or modifiable by culture. It has been proposed that boys are encouraged to play with toys that need spatial ability and are encouraged to pursue mathematics and scientific endeavours more frequently than girls. Additionally, parents assume that boys excel at mathematics and girls excel at reading.

Sebastian (2005) investigated on some psychological variables discriminating between under- and over- achievers in Mathematics of secondary school pupils of Kerala. The comparative survey approach was used for the investigation among a sample of 1000 standard IX pupils. The study revealed that mathematical problem-solving skills, mathematical aptitude, mathematical creativity, mathematics interest, achievement motivation and mathematics anxiety were identified as the factors influencing mathematical achievement of pupils. Under-, normal- and over-achievers could be discriminated on the basis of the select psychological variables.

Ma and Xu (2004) conducted a study to ascertain the simple ordering of secondary school students' aptitude for mathematics and achievement in mathematics. The results indicated that across the entire secondary school, success revealed a casual predominance over aptitude. There was no gender difference in this causative association, but elite rank in mathematics mitigated it. Students with high aptitude scores performed well on mathematics examinations, whereas performance of low aptitude pupils was poor on examinations. The study discovered a clear correlation between student aptitude and achievement.

Bradley and Ma (2003) in research entitled, "Individual Differences and School Effects on the Development of Mathematics Achievement in Secondary School" examined the influence of students' characteristics on their mathematical performance and advancement. The features of the school setting and atmosphere and the cluster impact of the school are addressed. The purpose of this study was to assess students' initial mathematical performance and their annual mathematics progress over their secondary school years. The pattern of change is determined by examining the link between students' starting mathematical status and their growth rates. This study underlined the importance of the relationship between the student and the school on mathematics success. Students' individual, peer, and familial factors are utilized to account for both their starting Maths achievement and development trajectory. This research includes factors about the school setting and atmosphere and variations in student motivation and attitude. Socioeconomic level of parents was strongly associated with the socio-economic status of eighth-grade mathematical achievement. Students who attend schools with a lower socioeconomic background typically have poorer Mathematics results. Parents' engagement, particularly parents' emphasis on Mathematics, aided kids in making significant progress far more quickly. The features of the school environment – general support for Mathematics had a substantial beneficial influence on the trajectory of Mathematics achievement growth. As a result of this discovery, schools should give more help to Mathematics students. Additionally, this study discovered a positive link between the pace of growth and the null model's starting ninth grade Mathematics achievement status. It demonstrates that kids who do poorly in eighth grade also perform poorly in mathematical thinking and understanding over their secondary school years. Alternatively, pupils at a higher starting position also learned more quickly. As a result, the attainment gap in Mathematics continues to increase over time.

Geevarghese (2003) conducted a study on the influence of certain school related variables and intelligence on process outcomes in Mathematics at the secondary school stage. The purpose of the study was to analyse the attainment of process skills (basic, integrated and total) in Mathematics of the students on the basis of intelligence, locale of the schools, type of schools, physical facilities, learning environment, gender(teachers), qualification of teachers, teacher effectiveness, teaching methods, assignments and evaluation. The study was conducted among a sample of 874 secondary school pupils selected from the schools in Thiruvananthapuram district. The study revealed positive and significant relationship between Mathematics process outcomes and intelligence as well as selected school related variables.

Hui-Ling (2001) conducted a study on the various factors affecting eight grade students' mathematical learning and achievement. The purpose of the study was to find the internal factor structure of the six latent factors examined, namely, home environment, peer influences, school environment, educational aspirations, attitude towards Mathematics and study habits and to test the effects of these factors on mathematical achievement. 14651 eighth grade students from South Korea, Singapore and United States were included in the sample of the study. The study revealed that family background and home environment, attitude towards Mathematics and educational aspirations all had influenced students' learning and achievement.

Mumthas (2001) conducted a study on the relationship between select psychological variables and achievement in Mathematics of secondary school pupils of Kerala. The study was designed to test for the ability of sixteen psychological variables (numerical reasoning, ability to use symbols, spatial ability, abstract reasoning, inductive reasoning, deductive reasoning, problem solving ability in Mathematics, fluency, flexibility, originality, Mathematics interest, self-concept in Mathematics, attitude towards Mathematics, attitude towards academic work, Mathematics anxiety and achievement motivation in Mathematics) in predicting achievement in Mathematics of secondary school pupils and hence to identify the significant predictors of achievement in Mathematics. The study was conducted on a sample of 500 (244 boys and 256 girls) secondary school pupils of Kerala. The sample was selected from 12 secondary schools of six different districts (Thiruvananthapuram, Kollam, Thrissur, Malappuram, Kozhikode and Kannur) of Kerala by using stratified sampling technique. The study revealed that all the sixteen psychological variables had significant effect on the achievement in Mathematics.

Vijayakumari (2000) investigated on some psychological variables contributing to mathematical giftedness of secondary school pupils of Kerala to find out the presence or absence of which of those psychological variables contributed significantly to mathematical giftedness. The sample comprised of 564 secondary school pupils of Kerala by stratified sampling technique from twelve schools belonging to six revenue districts of Kerala. The study found that the significant psychological variables contributing to mathematical giftedness are problem solving ability in Mathematics, abstract reasoning, achievement motivation in Mathematics, mathematics interest, self-concept in mathematics, mathematics anxiety and attitude towards Mathematics.

Warrick (2000) examined the association between parental support with mathematical homework and higher student achievement. The experimental group comprised of thirty children of thirty parents, while the control group consisted of thirty-five children of thirty parents. The experimental group outperformed the control group on all sections of the ITBS (Iowa Test of Basic Skills) and also completed more homework. These data imply that educating parents to assist their children with mathematics homework results in student achievement being overlooked.

Timmel (1999) studied the factors affecting the mathematics success and engagement of female high school students. The purpose of this study was to compare the effects of teacher influence, student self-esteem, school culture/organization and parental support on high school girls' involvement and achievement in advanced Mathematics classes at two suburban Westchester, New York high schools. According to the data analysis, boys and girls demonstrate no difference in their cognitive level of mathematical performance, parental support, self-esteem, and teacher mentoring and encouragement were significant determinants of females' academic success and perseverance in Mathematics. No one trait or dimension was a significant predictor of females' Mathematics success and involvement. The recommendations included increasing the use of classroom approaches that promote gender parity, increase student self-esteem, and thus raise mathematics proficiency and achievement.

Maria (1998) investigated on cognitive and non-cognitive variables in relation to achievement in Mathematics of the pupils of standard X. The purpose of the study was to find the extent of relationship between achievement in Mathematics and each of the selected independent variables, namely, cognitive style, level of aspiration, attitude towards Mathematics, classroom environment for Mathematics, home environment for Mathematics and home practice for Mathematics. The study was conducted on a representative sample of 740 students of standard X. The level of aspiration was not significantly correlated with achievement in Mathematics according to the study. All the other factors were significantly related to achievement in Mathematics. Also, out of those factors attitude towards Mathematics influenced the achievement of the pupil maximum.

Sumangala (1995) examined certain psychological characteristics associated with good and low mathematics achievement. The study used a stratified sample of 750 (362 boys and 388 girls) standard IX pupils recruited from twenty schools in Kerala's five revenue districts. Mathematics aptitude and its components, namely

Numerical Ability, Numerical Reasoning, Symbolic Ability, Spatial Ability and Abstract Reasoning, Attitude towards Mathematics and Self-Concept in Mathematics distinguished considerably between high and low achievers in Mathematics. Mathematics, aptitude, and its components, including numerical ability, numerical reasoning, symbol ability, spatial ability, and abstract reasoning as well as attitude towards Mathematics and self-concept in Mathematics, all had a significant and positive relationship.

Panchalingappa (1994) investigated to identify the causes of underachievement in secondary school Mathematics. The study also provided suggestions for the improvement of achievement of underachievers in Mathematics in the light of identified causes of underachievement. For this purpose, three predictor tests and criterion test were administered to a sample 501 students studying in IX standard. The study revealed that poor attitude towards Mathematics, higher general anxiety, and exam anxiety, poor educational adjustment, poor study habits and poor achievement motivation were the causes of under achievement in Mathematics; whereas lower self-confidence and higher emotion were not the causes of underachievement in Mathematics. Helping underachievers to understand both the mechanics and methods of effective study, counselling treatment, achievement motivation training was given as some of the suggestions for improving Mathematics achievement of underachievers.

Thampuratty (1994) investigated the interaction effects of creativity, attitude towards problem solving, and social position on secondary school pupils' mathematical achievement. Seven hundred seventy school children were sampled for the study. Sumangala and Thampuratty's Test of Achievement in Mathematics, Sumangala's Comprehensive Test of Creativity for Secondary School Pupils, and the Scale of Attitude were employed. Pillai's Problem-Solving test and Sumangala and

Thampuratty's Scale for Social Position were also used. The major findings were as follows: “(i) Significant disparities in mean achievement scores in mathematics existed between the three group pairs of creativity. ii) Significant differences in mean mathematics achievement scores existed between three group pairs with regard to attitude towards problem solving. iii) A positive, significant, and high correlation exists between attitude towards problem solving and mathematical achievement.

Rangappa (1992) examined the link between self-concept, reading competence, and mathematical achievement. A stratified random selection strategy was used to pick a sample of 1,000 students in standard seven. The researcher employed a self-concept assessment, a standardized reading test designed by Deve Gawda and Shivananda, and the Achievement Test in Mathematics. The primary findings were as follows: i) There was no significant difference in achievement amongst pupils with varying degrees of self-esteem. ii) There was a considerable disparity in achievement between rural and urban students. iii) There was a statistically significant difference in achievement across students with varying degrees of reading ability.

Setia (1992) discussed the theoretical underpinnings of learners' achievement in modern mathematics at the senior secondary level in relation to socio-psychological and educational aspects. Five hundred and ten senior secondary pupils and forty-two teachers were included in the sample. Tondon's Group Test of General Mental Ability was employed, as was Trivedi and Udai Pareek's Socio-economic Status Scale, the Modern Mathematical Concept Test, and the Classroom Behaviour Questionnaire. The study discovered that the intellectual level of quick and average learners, the socioeconomic status of slow learners, the personality characteristics of quick and average learners, and the adjustment of rapid learners all had a strong correlation with their achievement in modern mathematics.

Srivastava (1992) examined the learning outcomes in Mathematics in terms of objectives. The sample comprised of 1,030 students who were chosen using a multi-stage random selection process. The study employed the Achievement Test in Mathematics, the S.P. Kulshreshta Socio-economic Status Scale, and R.B. Cattell's Culture-Free Test of Intelligence (Form A). Both intelligence and socioeconomic level had a large and beneficial effect on the development of learning and competence. Male and female pupils in urban schools demonstrated greater gains in all types of Mathematics learning outcomes than their rural counterparts. Male and female students with a higher socioeconomic status performed better on all four types of learning outcomes as compared to students with a lower socioeconomic status.

Baskaran (1991) investigated the association between motivation for achievement, attitude towards problem-solving, and mathematical achievement. A stratified sampling strategy was used to pick the sample. There were hundred boys and hundred girls among the two hundred students. The researcher developed a tool consisting of three components: an Achievement Motivation Inventory Test, an Attitude Scale, and an Achievement Test in Mathematics for standard tenth grade. There was a favourable correlation between problem-solving attitude and Mathematics achievement. There were no significant differences between urban and rural students in terms of (a) achievement motivation and (b) attitude towards Mathematics. Mathematics achievement is highly different between urban and rural students.

Kasat (1991) sought to determine the causes of the high rate of mathematics failures among Marathi medium high school students in Palghar Taluka's SSC test. Between October 1988 and October 1989, the study sampled 200 students who had failed mathematics in twenty-five Marathi medium high schools in Palghar Taluka.

To obtain data, standardized assessments of numerical ability and self-created questionnaires for teachers were used. The primary findings were as follows: i) Low intelligence, poor numerical ability, weak comprehensive and recall abilities, lack of enthusiasm in mathematics, and bad study habits were all factors contributing to boys' and girls' high failure rates. ii) In mathematics, percentage, rational, algebraic expressions, variation, probability, and statistics were all challenging topics. iii) Because the parents were illiterate, they were unable to assist the children at home. There were no funds available in the classrooms for audio-visual aids. iv) The teacher discovered that the mathematics curriculum was not designed with children in mind. Percentages and shares were challenging to teach in arithmetic, while circles, arcs, and area were challenging to teach in geometry.

Ngailiankin (1991) conducted a study to find the factors influencing mathematical achievement of secondary school students in the states of Nagaland, Meghalaya and Manipur. The standardized tools such as Achievement test in Mathematics, Attitude scale, educational aspiration scale, Occupational aspiration scale, Differential aptitude test and Personality questionnaire were employed to collect required data. The research concluded that achievement in Mathematics was significantly related with attitude towards Mathematics, educational aspiration, numerical ability and abstract reasoning.

Rajyaguru (1991) examined the mathematical achievement of overachievers and underachievers, as well as their personal and environmental variables. A stratified, proportionate sampling technique was used to pick the sample of 1,093. Six metropolitan, six semi-urban, and thirteen rural schools were used to pick the subjects. There were 133 overachievers and 114 underachievers in all. The Desai-Bhatt Group Test of Intelligence was employed. Bhavsar Numerical Aptitude Test, Mathematics Achievement Test produced by the researcher, Patel J. Z.'s

Mathematics Anxiety Scale, Patel B.V.'s Study Habit Inventory, Desai, H. G.'s Mathematics Aptitude Scale, Bhogayata's Interview Schedule, and Rotter's Locus of Control Scale (in Gujarat). The study discovered a positive and statistically significant link between (a) intelligence and mathematical achievement, (b) mathematics achievement and numerical aptitude, and (c) intelligence and numerical aptitude. There were no differences between overachievers and underachievers in terms of (a) intelligence, (b) numerical aptitude, (c) locus of control. Overachievers exhibited (a) superior study habits, (b) a more favourable attitude towards mathematics, and (c) a decreased level of mathematics fear. There was no correlation between mathematical achievement and (a) the pupils' gender, (b) their birth order, (c) their father's income, or (d) their location. There was a correlation between mathematics achievement and (a) fathers' academic achievement and (b) whether they received external assistance or not.

Chel (1990) made an attempt to diagnose and remediate underachievement in the compulsory mathematics portion of the madhymik examination in West Bengal. The sample was drawn from West Bengal's urban, semi-urban, and rural pupils in Class VI to X. The data were gathered using the case study method. The significant findings were as follows: 1) The primary issues encountered by students were subject gaps, misunderstanding with mathematics terminology, a stereotypical presentation of content, and a lack of openness in training. 2) The most frequent errors observed in the performances of students and teacher trainees in this area are the interpretation of mathematics outcomes and the acquisition of new mathematical topics. 3) Underachievement was caused by a lack of comprehension of previous level mathematics ideas and the abstract nature of mathematics.

Lockheed et al. (1989) examined the role of parents and family in mathematical learning and achievement of children in Thailand and Malawi. Family background and prior achievement had a significant influence on children's educational expectations, perceptions of ability, hard work, patience, resilience and learning goals which would be determinants of mathematical achievement.

Pal (1989) sought to identify students' affective outcomes as determinants of their mathematical competence. Six hundred kids from rural and urban schools were included in the sample. The instruments utilized were a questionnaire on Academic Motivation, a test of Self-concept in Mathematics, a test of Attitude towards Mathematics, a test of Anxiety against Mathematics, and a test of Anxiety towards Mathematics. Boys demonstrated a more positive self-concept than girls. There was a significant relationship between mathematical self-concept and anxiety, as well as between mathematical self-concept and attitude and academic motivation.

Jain and Burad (1988) investigated the issue of low performance in obligatory Mathematics in the secondary level examinations in the state of Rajasthan and gave suggestions to remove them. The study sampled rural and urban boys and girls from 100 government and private schools in Rajasthan with lower test scores than private students. Data collection tools included questionnaires for subject experts, institution heads, subject teachers, and students. Administrative factors contributing to the shortage included a shortage of Mathematics teachers due to late appointments and frequent transfers, a lack of appropriate classrooms, blackboards, and other physical facilities, irregular student attendance, teachers' habit of leaving headquarters daily, and a lack of residential facilities in some difficult areas. Academic causes included a lack of text books, a failure to correct homework on time, an overworked and uninteresting curriculum, a lack of child-centered instruction, overcrowded classes, insufficient time for the subject, student usage of guidebooks, and a lack of competent supervision.

Flory (1987) conducted a study on certain factors in relation to underachievement in Mathematics of university entrants of Kerala. The purpose of the study was to develop a guidance profile on the basis of the findings of the study. The study was based on a sample of 681 university entrants of Kerala. Standardized tools such as Raven's Progressive Matrices Test of Intelligence, Achievement Test in Mathematics, Personality Factor Questionnaire, Attitude, Socio-economic Scales and Students' Activity Inventory were used for data collection. The study found that the incidence of underachievement in Mathematics among University entrants is not a negligible one. Effective measures of guidance and counselling programmes in all colleges of Kerala would be evolved so as to minimise the incidence of underachievement.

Manika (1983) examined the link between concept acquisition in Mathematics and a variety of personal and environmental characteristics among elementary school learners in Bombay. The data were obtained from 524 kids in grades one to five from a variety of metropolitan institutions. Raven's coloured progressive matrices and a Mathematics concept test were employed as tools. The primary findings were as follows: i) The majority of kids advanced to the next grade did not demonstrate acquisition of lower school concepts. ii) While pupils did not acquire a concept in its entirety in a single grade, concept growth occurred at all levels, with varying degrees of individual variation in the acquisition of Mathematical concepts at the primary school level. iii) Higher mathematical hierarchical concepts could not be produced without first acquiring lower concepts. iv) Individualized education was proven to be beneficial for the development and acquisition of mathematical ideas.

Jain (1979) examined the key predictors of high school Mathematics and English failure. The results were gathered through the use of measuring instruments that included an English ability test and a Mathematical ability test. Two groups of pupils were isolated and selected: those who were successful and those who were unsuccessful in both disciplines. The key finding was that intelligence, abstract reasoning, numerical aptitude, mathematical background, and knowledge of mathematical concepts, rules, and principles all influenced learning Mathematics.

Sarma (1978) examined the mathematics achievement of secondary school students with a focus on the state of Assam. The purpose of the study was to find out the achievement in school Mathematics and the possible reasons for the low achievement in the subject. 1295 students from ten different schools participated in the study. The research focused on elementary school Mathematics' arithmetic and algebra components. A battery of sequential achievement assessments was developed for students in grades five through ten. Inadequate knowledge imparted, blind application of the mathematical rules, a dense syllabus, unscientifically prepared textbooks, a lack of natural desire, insufficient drill at the elementary level, and a lack of a systematic approach to classroom instruction have all been identified as significant contributors to low Mathematics achievement.

Lalithamma (1973) investigated several factors affecting secondary school students' Mathematics achievement. The study enrolled 732 kids in standard nine who were randomly selected. A standardized mathematical achievement test, a study habit inventory, and Raven's standard progressive Matrices were utilized as tools. The study's significant and major findings found that Mathematics achievement was positively connected to intelligence, mathematical interest and curiosity, study habits, and socioeconomic status (having separate rooms for study, provision of necessary equipment and facilities). Moreover, studying lessons daily, studying by writing, doing home works independently, seeking the help of others, spaced learning, over learning, repetition in learning, having a separate time table for study and adopting meaningful learning have an excellent effect on mathematical achievement.

The studies examined in the area of learning and achievement in Mathematics and their findings are consolidated in table 1.

Table 1

Summary of Studies on Learning and Achievement in Mathematics

Year	Author	Findings
2022	Appiah et al.	Students' perception of Mathematics and students' self-efficacy both have impact on Mathematics achievement
2021	Milan	Problem solving ability, aptitude and interest all are the predictors of mathematical achievement
2021	Tiigga	The learning styles of the students are of great importance in teaching-learning process and they influence Mathematics achievement
2020	Reddy	General intelligence, logical reasoning and problem-solving ability are significant determinants of academic performance in Mathematics
2019	Bora	Effect of parental involvement on the mathematical achievement of the students is identified
2019	Hemavathi	The significant predictors of mathematical achievement include certain personal, demographic, family, home, school, social and psychological factors
2019	Jayarani	Achievement in Mathematics is influenced by mental alertness, attitude towards Mathematics and parental encouragement of students
2018	Bosman	The first significant finding was that individual learning had the strongest correlation with Mathematics proficiency. This type of education is necessary to enable self-study at home. However, group learning in class, facilitated by a skilled instructor and peers, is critical for struggling learners to develop the required skills for independent learning.

Year	Author	Findings
2017	Chakrabarti	Intelligence, self-concept and achievement motivation are three predictors of mathematical achievement of students
2017	Nongrum	Emphasis on the need to increase the creativity and self-concept of students so that their achievement may be higher
2017	Pandey	The mathematical excellence may be explained in terms of gender differences and social affiliation
2017	Sonia	Achievement in Mathematics depends on cognitive abilities such as creative thinking, problem solving, logical thinking and spatial ability of the students
2016	Garcia-Planas et al.	Substantial correlations were found between students' learning styles, study habits and academic achievement in Mathematics.
2015	Kumaravelu	There exists positive relationship between mathematical aptitude and academic achievement in Mathematics
2015	Gafoor & Kurukkan	Mathematics learning is badly affected by various variables including learner's cognitive, emotional, psychomotor characteristics, subject content and learning environment
2015	Krishnan	Achievement in Mathematics is influenced by students' risk-taking behaviour, problem solving ability and self-efficacy.
2015	Parekh	Intelligence, attitude towards Mathematics, SES and weaknesses in Mathematics have impact on achievement in Mathematics
2015	Sreeraj	The mathematical achievement is positively related with the selected components of multiple intelligence
2014	Ramachandran	Students' mathematical phobia, self-efficacy and family acceptance are significant predictors of mathematical achievement of students

Year	Author	Findings
2012	Kaur	Students' intelligence, academic achievement motivation, attitude towards Mathematics and socio-economic status influence mathematical achievement of the students
2012	Sankar	Confirmed a positive influence of concentration strategies or meditation practices (breathing exercises, exercises to bring forth hidden energy, naval chakra concentration techniques) over mathematical achievement of students
2012	Sonar	There is positive relationship between mathematical aptitude and achievement in Mathematics of students
2009	Liu & Koirala	Mathematics self-efficacy was found to be a significant predictor of Mathematics success. Pupils who were confident in their mathematical abilities tended to do better in Mathematics.
2008	Jayasree	The study revealed the influence of emotional intelligence, locus of control and rigidity on Mathematics achievement of students
2006	Nirmala	Students' abilities to understand mathematical information, to make positive decisions and attitude towards Mathematics influenced achievement in Mathematics
2006	Rajni	Teacher-parent support for Mathematics studies, aptitude for Mathematics, attitude towards Mathematics and study habits as predictors of mathematical accomplishment.
2005	Sebastian	Mathematics problem solving process skills, Mathematics creativity, Mathematics aptitude, Mathematics interest, achievement motivation in Mathematics and Maths anxiety are the important predictors of mathematical achievement
2004	Ma and Xu	Aptitude in Mathematics and mathematical achievement were associated.
2003	Bradley and Ma	Emphasised the importance of the relationship between students and school on their Mathematical achievement

Year	Author	Findings
2003	Geevarghese	Pupils' Mathematics process skill attainment is influenced by their intelligence, school locale, type, physical facilities, learning environment, teacher effectiveness, teaching method, assignment and evaluation.
2001	Hui-Ling	The home environment, attitude towards Mathematics and educational aspirations were the contributing factors influencing mathematical learning and achievement of the children
2001	Mumthas	Significant effect exists on achievement in Mathematics, of all the select sixteen psychological variables, namely, numerical reasoning, ability to use symbols, spatial ability, abstract reasoning, inductive reasoning, deductive reasoning, problem solving ability in Mathematics, fluency, flexibility, originality, Mathematics interest, self-concept in Mathematics, attitude towards Mathematics, attitude towards academic work, Mathematics anxiety and achievement motivation in Mathematics.
2000	Vijayakumari	The significant psychological variables contributing to mathematical giftedness are problem solving ability in Mathematics, abstract reasoning, achievement motivation in Mathematics, Mathematics interest, self-concept in Mathematics, Mathematics anxiety and attitude towards Mathematics
2000	Warrick	Training parents to assist their children with arithmetic homework results in increased student mathematical achievement. With homework as a necessary component of the school program, this study recommended that in addition to modifying teaching methods, giving remedial instruction, and other similar measures, efforts might now be made to 'train parents, ' in order to improve student progress in Mathematics.

Year	Author	Findings
1999	Timmel	The impact of parental involvement, self-esteem and teacher mentorship and encouragement as major predictors of girls' academic achievement and persistence in Mathematics.
1998	Maria	If proper attention is given to the aspects such as cognitive style, level of aspiration, attitude towards Mathematics, classroom environment for Mathematics, home environment for Mathematics and home practice for Mathematics, the students will definitely become successful in the learning of, and achievement in Mathematics
1995	Sumangala	Mathematics aptitude and its components including numerical ability, numerical reasoning, symbol ability, spatial ability, and abstract reasoning as well as attitude towards Mathematics and self-concept in Mathematics all have been shown as significant predictor of Mathematics achievement.
1994	Panchalingappa	Poor attitude towards Mathematics, higher general anxiety, higher examination anxiety, lack of educational adjustment, poor study habits and low achievement motivation are certain major factors affecting mathematical achievement
1994	Thampuratty	A positive, significant and high correlation exists between Mathematics creativity, attitude towards problem solving and mathematical achievement.
1992	Rangappa	Identified a significant difference in mathematical achievement across students with varying degrees of reading ability
1992	Setia	Distinct elements including the intellectual level as well as the personality features of rapid, average and slow learners strongly connected with Mathematics achievement
1992	Srivastava	Intelligence and socio-economic levels of pupils had significant effect on the development of learning and achievement in Mathematics

Year	Author	Findings
1991	Baskaran	Identification of a favourable correlation between problem solving attitude and Mathematics achievement.
1991	Kasat	Among the causes of the high rate of Mathematics failures, there found many mathematical errors including conceptual errors.
1991	Ngailiankin	Attitude towards Mathematics, educational aspiration, numerical ability and abstract reasoning all were associated with mathematical achievement of students.
1991	Rajyaguru	Overachievers and underachievers differed in terms of study habits, their attitudes towards Mathematics and anxiety. Intelligence did play a factor in mathematical achievement. An emphasis might be placed on improving study habits, attitude and anxiety reduction.
1990	Chel	Students had issues such as topic gaps, misunderstanding with Mathematics terminology and stereotypical presentation of the content
1989	Lockheed et al.	Emphasis on the role of parents and family in learning and achievement in Mathematics
1989	Pal	Achievement correlates were identified as self-concept and academic motivation
1988	Jain and Burad	Identified a lack of infrastructure, a shortage of teachers, a lack of child-centred training and an uninteresting curriculum as some of the causes contributing to low Mathematics achievement.
1987	Flory	Underachievement in Mathematics is due to various factors such as personality characteristics, students' attitudes and involvement in undesirable activities. Guidance and counselling are helpful in leading the students to the success

Year	Author	Findings
1983	Manika	Unless lower mathematical concepts are developed, higher mathematical concepts cannot be developed. The acquisition of concepts at the lower grade level must be prioritized.
1979	Jain	Intelligence, abstract reasoning, numerical aptitude, mathematical background and knowledge of mathematical concepts, rules and principles all determined learning Mathematics
1978	Sarma	Inadequate knowledge imparted, blind application of rules, a dense syllabus, a lack of natural desire, insufficient drill at the elementary level, and a lack of a systematic and methodical approach to classroom instruction have all been identified as significant contributors to low Mathematics achievement
1975	Lalithamma	Mathematics achievement was positively connected to IQ, mathematical interest and curiosity, study habits and socio-economic status. Also, daily revision and repetition have good effects on mathematical achievement

The studies in India as well as abroad on correlates of mathematical achievement revealed the factors affecting learning and achievement in Mathematics. These exploratory studies mentioned in the discussion above tried to find the factors responsible for both better and poor achievement in Mathematics. According to the findings of reviewed studies on mathematical achievement, it can be concluded that mathematical achievement is related to a variety of correlates such as gender, age, intelligence, creativity, socio-economic factors, self-concept, Mathematics anxiety and fear, lack of pre-requisites and remedial instruction, home environment, attitude towards the subject, beliefs in mathematical abilities, reasoning power, spatial visualization, study habits and lack of specialized training in Mathematics instruction. As cited by many authors, attitude towards Mathematics, mathematical abilities and study habits in the subject are regarded the most important determinants which affect the performance level in Mathematics. They also serve as fundamental factors that affect the students' performance either positively or negatively, again depending on individual student. As a result, any endeavour to improve mathematical achievement must render due importance to these factors.

Studies Related to Attitude towards Mathematics, Beliefs in Mathematical Abilities, Study Habits in Mathematics and Achievement in Mathematics

Jenije (2022) conducted a study on the relationship between attitude and students' academic achievement in Mathematics in Sapele local government area of Delta state, Nigeria. The ex post factor research design was employed. The sample comprised of 400 students drawn from seven schools. The self-structured questionnaire for students and the second term exam scores were employed as tools of the study. The study revealed that there existed significant relationship between students' attitude towards Mathematics, students' Mathematics anxiety, students' Mathematics self-confidence, students' attitude towards Mathematics teacher and students' academic performance in Mathematics. The investigator recommended that the teachers should consider learners 'diversities, minimise fear and enhance interest in learning the subject.

Hwang and Son (2021) studied on the relationship between students' attitudes toward Mathematics and achievement in Mathematics. The study used latent profile analysis to examine the existence of different groups of students with regard to attitude toward Mathematics. The sample consisted of 4,853 Singaporean eighth- grade students from 153 schools. The study revealed that the following students were more likely to have high Mathematics achievement: (i) Students who like to study Mathematics and pursue Mathematics-related activities, (ii) Students who believe that learning Mathematics will lead to a positive outcome, (iii) Students who trust in their mathematical abilities. The investigator recommended to provide appropriate support to stimulate the development of a positive attitude toward Mathematics.

Jayanthi (2019) investigated on lateral thinking among higher secondary students in relation to their Mathematics attitude, problem solving ability and achievement in Mathematics. Normative survey method was adopted for the study. The sample of the study comprised of 730 higher secondary students from Tiruchirappalli, Tamil Nadu. The study revealed significant and moderate positive relationship between lateral thinking and Mathematics attitude, lateral thinking and problem-solving ability, lateral thinking and achievement in Mathematics, attitude and problem-solving ability and problem-solving ability and achievement in Mathematics.

Jyothi (2019) investigated on secondary school students' attitude towards Mathematics and their problem-solving ability. The purpose of the study was to find the relationship of achievement in Mathematics of the students with the attitude of the students and their problem-solving ability. The research method was survey method. A sample comprising 1008 standard IX students from six districts of Andhra Pradesh was selected for the study. It was found that there existed a positive relationship between the above-mentioned variables.

Anjana (2018) conducted a study on mathematical achievement in relation to problem-solving ability, mathematical attitude and anxiety of secondary school students. The focus of the study was to explore the impact of mathematical achievement in relation to mathematical attitude, problem solving ability and mathematical anxiety. The investigator used survey method. 800 secondary school students from Haryana state were selected in the sample. A significant positive relationship was found between mathematical achievement and the select variables.

Mazana et al. (2018) revealed that students' Mathematics learning and performance are influenced by a variety of factors, including their attitude towards the subject, their instructors' instructional techniques and their school environment. The purpose of this study was to ascertain students' views about Mathematics education in Tanzania. Additionally, it aimed to establish why people enjoy or dislike Mathematics and the link between attitude and performance. They investigated students' attitudes towards Mathematics and related aspects using the ABC Model and Walberg's Productivity Theory. A survey was used to collect quantitative and qualitative data from 419 primary school students, 318 secondary school students, and 132 college students from 17 schools and six institutions across mainland Tanzania. Percentages, means, standard deviations, ANOVA, correlation, regression, and thematic analysis were used to analyse the obtained data. The findings indicate that while students initially have a good attitude towards Mathematics, their attitudes change as they progress through higher levels of schooling. A substantial positive weak connection was discovered between students' attitudes and performance. In their findings, students' enjoyment and attitude towards Mathematics were strong predictors of their success. Students' aptitude attributes and instructional and social psychological contextual variables influenced their likes or dislikes of Mathematics. The findings indicate that examination failure results from didactic instructor techniques, institutional resources, ineffective learning and examination procedures, and a failure to comprehend instructions. The findings provide avenues for further study and suggest improvements in teaching-learning techniques that will increase students' love of Mathematics and, therefore, their success in the subject. According to the study's findings, teachers should employ instructional approaches that consider learners' differences or obstacles to learning, minimize fear, and promote active engagement and enjoyment in what is taught and learned. They should use remedial actions that alleviate stress and give assistance to their kids as needed. It will promote mutual understanding within a safe teaching and learning environment. Additionally, students should manage their time well to have sufficient time to practice and internalize mathematical ideas acquired in class. They should be taught how to use compelling study and examination techniques for Maths. From primary schools on, students should be supported in developing their English language abilities. It may aid in their acquisition of skills and their mathematical performance. The government should give resources for teaching and learning. These should contain many trained teachers, books, computers, and other instructional tools necessary for effective Mathematics learning.

Krishnan (2018) investigated on achievement in Mathematics of higher secondary students in Cuddalore district, Tamilnadu in relation to achievement motivation, attitude towards Mathematics and self-confidence. The study attempted to identify the factors blocking the way to achieve in Mathematics. The investigator selected the descriptive form of research by incorporating a four-stage design of investigation. 900 higher secondary students in different higher secondary schools in Cuddalore district were included in the sample by stratified random sampling technique. The study revealed that significant correlation existed between the mathematical achievement and the select psychological variables.

Maiti (2017) studied on academic achievement in Mathematics in relation to numerical ability, reasoning ability and attitude towards Mathematics. The purpose of the study was to identify the predictive potentiality of certain variables for the prognosis of the achievement of the students in Mathematics. The proposed study was descriptive in nature. 600 students from three districts in West Bengal were included in the sample. The study concluded that the achievement in Mathematics was positively correlated with the three independent variables; reasoning ability, numerical ability and attitude towards Mathematics.

Colomeischi and Colomeischi (2015), in research entitled, “Students’ emotional lives and attitudes toward mathematical education” introduced about Romanian students that lack enthusiasm for studying, which is especially true when it comes to Mathematics. It is critical to study Mathematics courses throughout beginning teacher education for primary and preschool teachers; thus, students must be sufficiently motivated to achieve. Learning progress is contingent upon both internal and external variables. The purpose of this study was to determine the relationship between internal variables such as emotional intelligence, self-efficacy, positive and negative emotions, and the attitude towards Mathematics learning in students enrolled in beginning teacher education. The study enrolled 160 pupils. Scales and questionnaires were utilized to assess emotional intelligence (Schutte), self-efficacy, and emotional life - PANAS (Positive Affectivity and Negative Affectivity Scale) and a questionnaire to ascertain overall attitudes towards Mathematics learning. The findings pointed students’ attitudes towards Mathematics learning and how certain internal elements defining their emotional lives impact this attitude. The findings may suggest specific indicators of attitude towards Mathematics learning and may also be beneficial in identifying new strategies for encouraging students throughout their learning process.

Mareesh (2015) studied on metacognitive awareness in relation to attitude towards Mathematics, problem solving ability and achievement in Mathematics of higher secondary students. Normative survey method was used in the study. The study was conducted among 1000 students from Cuddalore district. It was found that significant and positive relationship existed between the select variables.

Taat and Rozario (2014) studied on the effect of two variables – academic attitude and academic self-efficacy in Mathematics – on students' Mathematics success. A random sample of 200 allied health college students from Masterskill Global College's two campuses was used for this study (formerly known as Masterskill College of Nursing and Health). The questionnaire was constructed using a mix of two inventories adjusted to fit the study's objectives. The Attitudes Toward Mathematics Inventory (ATMI) and the College Academic Self-Efficacy Scale were used (CASES). Two statistical techniques were used to analyse the demographic and data analyses: descriptive statistics and inferential statistics. The studies revealed that respondents' mean scores on both conceptions were high and positive, and there were also substantial differences in respondents' mean scores across campuses and Mathematics achievement grades. Additionally, various constructs have a substantial impact on mathematical success. The findings of this study established a new paradigm for the link between both attitudes and academic self-efficacy and mathematical achievement.

Nongsiej (2013) investigated on the attitude towards Mathematics in relation to the achievement of class XI students in Shillong. The purpose of the study was to explore the students’ attitude towards Mathematics in relation to achievement in Mathematics. The descriptive survey method was followed and the study was conducted among 226 students. The study revealed a positive relationship between these two variables.

Rai (2013) conducted a study on the attitude towards Mathematics and study habits in relation to the achievement in Mathematics of class X students in east and south Sikkim. The purpose of the study was to examine the influence of attitude towards Mathematics and study habits of students of class X on their performance in Mathematics. The study conducted among a sample of 820 class X students in east and south districts of Sikkim. Descriptive method of research had been used. The study revealed that there was significant relationship between attitude towards Mathematics and achievement in Mathematics and between study habits and Mathematics achievement.

Mata et al. (2012) enquired to demonstrate how some distinct but connected elements such as background, motivation, and social support may help explain student attitudes towards Maths and the defining aspects of these attitudes in the educational setting. The participants were 1719 Portuguese students in the fifth through twelfth grades. The research adopts the "Intrinsic Motivation Inventory" to measure the primary factors of intrinsic motivation. The questionnaire's "In My Maths Class" part also measures students' impressions of instructor and peer assistance, as well as their attitudes. The findings indicated that pupils, on average, had a favourable attitude towards Mathematics and also emphasized the significant grade influences and maths achievement on these sentiments. There was no evidence of a gender impact, even though girls' views continued to deteriorate as they proceeded through school. A hierarchical study utilizing structural equation modelling revealed that motivational variables are the primary determinants of attitudes towards Mathematics and that instructor and peer social support play a significant role in understanding these attitudes.

Martino and Zan (2011), in research entitled, “Attitude towards Mathematics: a bridge between beliefs and emotions, “emphasized the need to conceptually clarify categories such as beliefs, emotions and attitudes and conduct more research on their interactions. In prior research, they concluded an attitude towards Mathematics based on students’ experiences, examining how students articulate their connection with Mathematics. The results gathered indicate a three-dimensional model of students' attitudes towards Mathematics that considers their emotional disposition, their image of Mathematics, and their perceived ability. They explored the link between beliefs and emotions in this study, focusing on the interaction between the three aspects of the proposed attitude model as revealed in the students' writings.

Liu and Koirala (2009) observed that Mathematics self-efficacy was found to be a significant predictor of Maths success. Study's goal was to explore the links between students' Maths attitudes, problem-solving self-efficacy beliefs and academic achievement. This study proved that pupils who were confident in their mathematical abilities tended to do better in Mathematics. They also found that the students who were confident that they could perform well on maths tests, comprehend the most challenging material presented in maths texts, comprehend the most challenging material presented by their Maths teachers, perform well on Maths assignments, and master the skills taught in their Maths classes were more likely to have a positive attitude towards Mathematics.

Thirunavukkarasu (2008) examined the relationship between select study techniques and their impact on improving academic achievement of students in Science and Mathematics in particular. The experimental research method was employed to evaluate the effectiveness of the select study techniques programme on the academic achievement of students. Parallel group randomized pre-test-post-test design was selected for this study. Both the experimental and control groups consisted of 160 participants each. The study concluded that the study technique programme prepared and implemented had significant influence in improving the academic achievement of the students in Mathematics and Science.

Nicolaidou and Philippou (2003) studied attitudes towards Mathematics (ATM), self-efficacy (SE) and achievement in problem solving. The purpose of this study was to examine the connections between students' attitudes towards Mathematics, their self-efficacy beliefs in problem-solving, and their academic success. Additionally, the potential for attitudes and self-efficacy to predict problem-solving performance was investigated. 238 fifth-grade students completed attitude and efficacy measures. A custom-designed exam was used to assess problem-solving ability, which included both primary and multi-step tasks. The data analysis revealed a substantial correlation between attitudes and accomplishment but a more significant correlation between efficacy and achievement. Attitudes and efficacy were also connected, and both predicted problem-solving performance. Efficacy, on the other hand, was a more powerful predictor than views. There was no gender difference in any of the factors investigated. The primary objective of this study was to examine the link between gender, students' ATM, their SE beliefs, and their problem-solving performance. ATM and SE were also tested for their ability to predict problem-solving performance.

Nagalakshmi (1996) evaluated the development of a Mathematics problem-solving ability test as well as the problem-solving abilities of Class X pupils in Hyderabad's twin cities. The study surveyed 1, 000 pupils in Class X from twin cities in and around Hyderabad using a normative survey method. The data collection tools employed were a mathematical problem-solving ability exam and a personal data blank. The primary findings were as follows: I There was a substantial difference in the problem-solving capacity of rural and urban pupils in Mathematics, favouring the latter group. ii) There was no difference in performance between males and girls in Mathematics when it came to problem-solving skills. iii) The higher the parents' educational attainment, the better the students' success in Mathematics problem-solving abilities. iv) The school climate had an effect on pupils' performance.

Wangu and Thomas (1995) examined high school students in the tribal town of Aizawl's attitude towards mathematical accomplishment. The study enrolled 300 students, both boys and girls, from Aizwal's Class IX high schools. The students were chosen using a stratified random sampling procedure. The Class IX Achievement Test in Mathematics and the Attitude towards Mathematics Scale were used to collect data. There was a strong positive relationship between attitude towards Mathematics and achievement in Mathematics for both the entire sample and the subgroups.

Singh et al. (1994) attempted to examine the relationship between attitude towards Mathematics and certain individual characteristics such as gender, age, and intellect. The sample consisted of 220 Grade IX pupils studying Mathematics in several schools run by the Education Department of the Bhilai Steel Plant in Bhilai (Madhya Pradesh). Students were classified into three groups: those with a high IQ (HIG), those with an average IQ (AIG), and those with a low IQ (LIG), as well as male and female groups aged 13+, 14+, and 15+. The General Intelligence Test created and standardised by S.M. Mohsin was utilized, as was the Suydam, M.N. Attitude towards Mathematics Scale. In comparison to pupils in the average and low intelligence groups, students in the high intelligence group had a more favourable attitude towards Mathematics. Students of medium intelligence viewed Mathematics more favourably than students of low intelligence. Males and females did not have a more favourable attitude toward Mathematics.

Rosaly (1992) sought to determine whether high school pupils have a favourable attitude towards Mathematics learning and whether their attitude has an effect on their Mathematics achievement. The sample included 200 tenth-grade students from eight secondary schools in Dindigul, Tamil Nadu. A Mathematics Attitude Scale and a Mathematics Achievement Test were developed and deployed. The attitude of high school pupils towards Mathematics learning and their achievement in Mathematics were found to be connected. Boys and girls in cities showed a more favourable attitude towards Mathematics than boys and girls in rural areas.

Tzeng Shwu-Rong (1987) investigated the links between gender, attitudes towards Mathematics and mathematical attributions among sixth-grade high, average and poor achievers in Taiwan, Republic of China. The purpose of this study was to investigate the effect of several emotive and attributional elements on the mathematics performance of Chinese (Taiwanese) pupils. The sample comprised of 432 sixth-grade pupils classed as high average, average and low. The Fennema-Sherman Mathematics Attitudes Scales and the Mathematics Attribution Scale were employed to assess attitude towards Mathematics and their perceptions of Mathematics success/failure. The significant major findings were as follows: i) The higher the achievement, the more positive attitude towards Mathematics were; ii) There were no significant differences in attitude towards Mathematics between male and female students, except for females' less stereotyped perceptions of Mathematics as a male domain; and iii) The higher the achievement, the more success was attributed to ability. The lower the achievement, the more failures were attributed to lack of ability, task difficulty, and a lack of adequate teachers or facilitative peer groups; iv) In general, there was a significant positive relationship between the variables classified as attitude towards Mathematics and success attribution. The associations between measures measuring attitude towards Mathematics and those measuring Mathematics failure attribution were significant and negative.

Rastogi (1983) found weakness in fundamentals in Mathematics as the major cause of mathematical backwardness and investigated on the remedial measures to resolve the difficulties. The sample consisted of 406 standard VIII students from nine schools of Arunachal Pradesh. The study followed the experimental method of research. The study revealed that achievement in Mathematics could be improved if students' attitude towards Mathematics became favourable that was possible by mastering fundamental Mathematics through a course of self-help in basic Mathematics skills developed during the investigation.

The studies reviewed above on attitude towards Mathematics, beliefs in mathematical abilities, study habits in Mathematics and mathematical achievement are summarized in table 2 focusing on their findings.

Table 2

Summary of Studies on Attitude towards Mathematics, Beliefs in Mathematical Abilities, Study Habits in Mathematics and Achievement in Mathematics

Year	Author	Findings
2022	Jenije	There is a relationship between students' attitude towards Mathematics and their performances in Mathematics.
2021	Hwang & Son	A positive relationship between students' attitudes toward Mathematics and Mathematics achievement has been discovered.
2019	Jayanthi	There exists high positive relationship between lateral thinking, Mathematics attitude, problem solving ability, and achievement in Mathematics
2019	Jyothi	Positive relationships were observed among the variables attitude towards Mathematics, problem solving ability and achievement in Mathematics
2018	Anjana	Significant positive relationship was found between mathematical achievement and attitude towards Mathematics, problem solving ability, mathematical anxiety
2018	Mazana et al.	Students' Mathematics learning and performance are influenced by a variety of factors including their attitude towards the subject, their instructors' instructional techniques and their school environment; students' enjoyment and attitude towards Mathematics were strong predictors of their success.

Year	Author	Findings
2018	Krishnan	Achievement motivation, attitude towards Mathematics and academic self-confidence are found to be significant predictors of the mathematical achievement
2017	Maiti	The achievement in Mathematics is positively correlated with reasoning ability, numerical ability and attitude towards Mathematics
2015	Colomeischi & Colomeischi	Ascertained students' attitude towards Mathematics learning and the relationship between internal emotional factors such as emotional intelligence, self-efficacy, positive and negative emotions and their attitude towards Mathematics learning
2015	Mareesh	There is significant and positive effect of metacognitive awareness, attitude towards Mathematics and problem-solving ability on achievement in Mathematics
2014	Taat & Rozario	Established the effect of two variables – academic attitude and academic self-efficacy in Mathematics – on students' Mathematics success.
2013	Nongsiej	There is a positive relationship between the attitude towards Mathematics and achievement in Mathematics of the students
2013	Rai	Students' attitude towards Mathematics and their study habits significantly affects their academic achievement in the subject in such a way that better the attitude and study habits higher will be the achievement in Mathematics
2012	Mata et al.	Found that motivational variables are the primary determinants of attitudes towards Mathematics and the defining aspects of these attitudes in the educational setting

Year	Author	Findings
2011	Martino & Zan	Explored the link between beliefs, emotions and attitude on the mathematical accomplishment
2009	Liu & Koirala	Found that student's belief in their mathematical abilities was a good predictor of mathematical success. Students who were confident in their mathematical ability performed better.
2008	Thirunavukkarasu	The R-4 cycle technique, the percentage-drill technique, the cognitive ladder/ order technique and the intra curricular study are the four effective study strategies in improving academic achievement of students in Science and Mathematics in particular
2003	Nicolaidu & Philippou	Revealed a substantial correlation between attitudes and accomplishment; attitudes and efficacy were also connected and both predicted problem-solving performance; significant relationships were discovered between ATM, SE and achievement. Pupils who have a positive ATM have strong SE beliefs in a particular area and perform better.
1996	Nagalakshmi	Discovered an advantage for boys and girls in terms of problem-solving skills and identified critical determinants affecting Mathematics achievement.
1995	Wangu & Thomas	Established strong relationship between attitude towards Mathematics and achievement in Mathematics.
1994	Singh et al.	Discovered that individuals with high intellect have a more favourable attitude towards Mathematics than those with ordinary or low intelligence
1992	Rosaly	Found that metropolitan boys and girls possessed a more favourable attitude towards Mathematics than boys and girls in rural areas. The attitude of high school pupils towards Mathematics learning and their achievement in Mathematics were found to be related.

Year	Author	Findings
1987	Tzeng Shwu-Rong	There is a significant positive relationship between several emotive and attributional elements such as attitude towards Mathematics and the Mathematics performance of pupils.
1983	Rastogi	Identified the causes of mathematical backwardness as poor command over basic Mathematics and discovered a link between attitude towards Mathematics and mathematical achievement.

Thus, the studies revealed that the students' attitude, beliefs and study habits towards Mathematics are significant and deciding factors that influence their learning and achievement in Mathematics. Moreover, these factors need to be improved for enhancing the students' learning and achievement in the subject. Also, when basic mathematical abilities are mastered achievement in Mathematics is naturally improved. Numerous researches in this field have demonstrated that low accomplishment in Mathematics is due to poor command over prerequisites in basic mathematical skills. Fundamental mathematical abilities might be mastered extremely quickly and easily through programmes in Mathematics because it provides the foundation to learn the subject at higher levels.

Studies Related to Experiments in Mathematics Education

To develop a good programme, it is necessary to go through the various programmes already developed in the related fields. The phenomena of mathematical achievement will gain more clarity through the application of experimental methods. By the scrutiny of available educational programmes, the researcher can understand the various dimensions of a good programme and also the effect of these programmes.

The different studies reviewed here are related to various strategies, approaches, models and programmes in Mathematics teaching-learning to make the learning and achievement in Mathematics successful.

Pambudi (2022) investigated the effect of Outdoor Learning Method (OLM) on elementary students' motivation and achievement in Geometry. The study was conducted using an experimental research design. The sample of the study consisted of 54 grade 4 students in a public elementary school in Jember, East Java, Indonesia divided into the experimental and control groups. Questionnaires, Observation Schedule and Tests were used to collect data. The study revealed that the OLM triggered the students 'motivation as well as student learning achievements in Geometry. The investigator recommended the OLM approach of instruction to enhance learning and achievement in Mathematics.

Kad (2021) examined the effect of self-regulated learning strategies on achievement in Mathematics and motivational beliefs in relation to mathematical anxiety and mathematical creativity. The sample consisted of 400 standard IX students from Chandigarh. The method of study was experimental in nature. The major finding of the study was that the group taught through self-regulated learning strategies performed significantly better than that of control group with respect to mathematical achievement and motivational beliefs.

Kumar (2021) studied on the effect of Active Learning Strategies on achievement in Mathematics and problem-solving ability among secondary school students. It was an experimental study, where the experimental group comprising 76 students was taught with the help of active learning strategies and the control group consisting of 80 students with the traditional way of teaching. The study revealed that active learning strategies were effective in enhancing the achievement in Mathematics and also the problem-solving ability in the subject.

Lalitkumar (2021) examined the effectiveness of computer aided learning material on achievement in Mathematics for students of grade seven. The purpose of the study was to prepare and validate the computer aided learning material (CALM) in Mathematics. The study was experimental in nature. The experiment was conducted among a sample of students consisting of 168. After the experiment, the investigator concluded that CALM was more effective teaching tool than the traditional teaching method.

Adeeb (2020) conducted a study on the development of Quran based teaching-learning strategies using Mathematics Park for enhancing achievement in Mathematics of secondary school students. The purpose of the study was to find out the expediency and effectiveness of Mathematics Park based teaching on optimizing students' achievement in Mathematics. The park would have exhibits of basic mathematical principles from primary to higher secondary level. Self-study, field trip, practice learning and natural Mathematics all were integrated in Mathematics Park. The design selected for the study was quasi experimental with pre-test, post-test, non-equivalent group. Toppers, average and below average students from 80 participants equally split into two equivalent groups, one for experimental group and second for control group. The experiment was conducted at the area Trigonometry of standard X. The experimental group was taught by the newly prepared strategy (Mathematics Park) and the control group was taught by the existing method of teaching. The validation of the strategy was employed using standardized achievement test in Trigonometry. It was practically proved that the implementation of newly developed teaching learning strategy using Mathematics Park is far superior over the existing methods in teaching learning Mathematics.

Bagul (2020) investigated on the effect of computer assisted instruction and traditional method of teaching on the achievement in Mathematics in relation to reasoning ability and interest. The experimental method of study was adopted. The study revealed that the CAI method of teaching was more effective than the traditional method of teaching for Mathematics of standard VIII students.

Mallikarjun (2020) examined the effect of constructive based approach of teaching Mathematics in improving problem solving, critical thinking and achievement of secondary school students. The major purpose of the study was to compare the achievement in Mathematics of IX standard students taught through constructivist-based approach and conventional method of teaching. The experimental method was adopted for the study. The study concluded that students' problem solving, critical thinking ability and achievement in Mathematics were higher, when they were taught through constructivist-based approach.

Muthulakshmi (2020) conducted a study on the effect of TIGER method on achievement of Mathematics and interest of IX standard students. It is an active learning method of Mathematics and refers to the acronym- Teacher as a facilitator, Individual work, Group work, Evaluation and Reinforcement. Pre-test post-test equivalent group design was employed. 30 students each were chosen to both experimental and control groups. Finally, the study established the effectiveness of the prepared method of teaching-learning.

Singh (2020) investigated on the role of art integrated learning in enhancing achievement and interest in Mathematics and Science an impact study. The purpose of the study was to identify the possibilities and scope of art integrated learning pedagogy. The researcher used survey method and descriptive approach in the study. Art integrated learning was found to have impacted positively the students' achievement and interest in Mathematics.

Abramovich et al. (2019) studied on teaching Mathematics through concept motivation and action learning strategies based on action learning and natural motivation derived from common sense for active learning and concept motivation across Mathematics curriculum. The study provided insights for Mathematics educators. Additionally, intriguing questions, computer analysis (including online searches) and renowned classical problems all served as essential motivating tools in Mathematics and were especially useful in the context of action learning. The investigators claimed that incorporating the whole K-20 Mathematics curriculum under a single roof was possible when concept motivation and action learning approaches were implemented across the board. The study discovered pragmatic reasons for action learning in Mathematics education at nearly every stage of a student's academic career.

Daboubi (2019) examined the effect of package based on constructivism on achievement in Mathematics and critical thinking ability of students of basic school. In the study there were 128 students from Amman city. The method of study was experimental in nature. The investigator found that the prepared package based on constructivism was found to be effective in enhancing achievement and critical thinking abilities.

Shah (2019) studied on Maths empowerment of students through creative problem solving. Maths empowerment was meant strengthening students' mathematical capabilities. The purpose of the study was to find the effect of creative problem solving in Mathematics on Maths empowerment of students. The explorative sequential mixed method research design was employed in the study. 89 teachers were included in the sample for phase I and students from three different schools in Mumbai were selected for experiment. The MCPS lesson sessions were effective in bringing out significant improvement in students' maths empowerment than the conventional lesson sessions.

Yadav (2019) designed brain-based learning approaches in Mathematics instruction for junior high school students in Prayagraj, Uttar Pradesh and tested their efficacy. The purpose of the study was to get an idea of how Junior High School Teachers comprehended brain-based teaching strategies and could incorporate and utilize those techniques in the classroom instruction. In the study, the investigator employed experimental method and a research design of pre-test-post-test group design. A sample of 60 students; 30 in the experimental group and 30 in the control group was selected for the study. The experimental group students were taught through developed instructional material based on brain-based strategies whereas control group students through traditional method only. The study revealed that brain-based teaching-learning strategies were more effective than traditional method of class room instruction.

Bhatt (2018) examined the effectiveness of diagnostic and remedial programme for learning difficulty in Mathematics of standard VIII students. The study aimed to identify the learning difficulties, to provide remedial programme for overcoming the learning difficulties and to study the impact of remedial programme with reference to the learning difficulties in Mathematics of the students.

Deshamukh (2018) developed teaching strategies for enhancing problem solving ability in Mathematics among secondary school students. The purpose of this study is to assist instructors in planning lessons around problem-solving components, namely conceptual knowledge of Mathematics, mathematical process skills, mathematical thinking, and metacognition. The objectives tend to lay the groundwork for future learning in terms of problem-solving abilities. To accomplish these goals, effective teaching techniques are important. In Mathematics curriculum, problem-solving abilities are emphasized since they are necessary for learning the topic and developing thinking skills. These teaching techniques focused on knowledge, content selection and communication that resulted in subject comprehension and application. The researcher's teaching techniques assisted students in exploring problems independently and arriving at viable answers, freeing them from rote learning. Additionally, it assisted teachers in instructing students in Mathematics through problem-solving.

Jayanthi (2018) examined the effectiveness of multimedia-based teaching and the relationship of metacognition, problem solving ability and attitude towards multimedia of eleventh standard students on their achievement in Mathematics. The purpose of the study was to find the effectiveness of multimedia-based teaching with traditional method of teaching. The sample of the study consisted of 60 standard XI students from Thalapathy K. Vinayagam Matriculation Higher Secondary School, Tiruttani, Tiruvallur district, Tamil Nadu. The study revealed that implementation of multimedia-based teaching brought great impact on the achievement of Mathematics.

Kurukkan (2018) studied on difficulties faced by high school students in learning Mathematics and developed intervention strategies to be employed for increasing achievement in Mathematics. The study identified students' affective difficulties in learning Mathematics and verified the effectiveness of an evidence based self-regulatory intervention through guided and self-practice developed on the basis of identified difficulties to enhance student achievement in Mathematics at secondary school level. The study employed a mixed method, the survey phase leading to the experimental phase in an embedded sequential design. The intervention developed based on the motivational factors like interest, values, self-efficacy, ability beliefs and learning strategies was found to be effective in increasing self-regulated learning practices and to enhance achievement in Mathematics if it was practised at least for a fortnight or longer. The study revealed that Self-Regulated Learning (SRL) strategy intervention enhanced high school students' achievement in Mathematics irrespective of gender, levels of intelligence or prerequisite knowledge, mathematical ability conception and goal orientation in Mathematics.

Mamatha (2018) attempted to study the effectiveness of teaching Mathematics with transitional background music on mathematical achievement, interest in learning Mathematics and attitude towards Mathematics among secondary school students. The study was true experimental in nature. Pre-test, post-test experimental and control group design was followed. The study revealed that the transitional background music approach was equally effective for all the three interests in music levels of students in developing academic achievement in Mathematics, interest in learning Mathematics and attitude towards Mathematics.

Rushton (2018) determined the statistical significance of error analysis's efficacy, while qualitative data were analysed to understand participants' experiences with error analysis. The results indicated that no significant change in post-test scores existed. However, a substantial difference in delayed post-test scores was observed. By and large, the teacher and students agreed that using mistake analysis aided the learning process.

Shivraj (2018) developed teaching strategies for enhancing problem solving ability in Mathematics among secondary school students. Experimental method following pre-test post-test, equivalent groups design was used. The sample of 62 students of class IX was selected by using random sampling technique. The preparatory, developmental and experimental phases were considered for the procedure of the study. Base of ADDIE model was taken to develop teaching strategies. The teaching strategies were developed according to the components of problem solving, namely, conceptual understanding, mathematical process skills, mathematical thinking and metacognition. The teaching strategies developed by the researcher were highly beneficial to enhance problem solving ability of the students. The results of the study revealed that problem solving ability was positively related to achievement in Mathematics.

Thambi (2018) studied the effectiveness of an instructional strategy based on Path-Smoothing Model on creative problem-solving ability, perceptual speed and achievement in Mathematics of students at secondary level. Experimental method was adopted for the study. For the study, the design selected was pre-test post-test non-equivalent group design. The sample of study consisted 296 standard VIII students from four schools in Thrissur district, Kerala. The study concluded that the mathematical achievement of students taught using the instructional strategy based on Path-Smoothing Model is significantly better than that of those students taught using the method, the activity-oriented method of teaching.

George (2017) conducted a study to examine the effectiveness of an instructional strategy based on Critical Thinking Skills to learn Mathematics at secondary school level. Experimental method was used to conduct the study. The sample of the study consisted of 184 standard IX students from Kollam district, Kerala. The results of the study showed that the instructional strategy based on critical thinking skills is more efficient than activity-oriented method on mathematical achievement of secondary school students.

Krishnan (2017) found out the effect of RBC (Recognizing, Building with, Construction and Consolidation) Model of Instruction on life skills Mathematics, Thinking Skills and Achievement in Mathematics of secondary school students. Experimental method was employed for the study. The study was conducted among

308 secondary school students. The findings of the study showed that RBC Model of Instruction was very effective in enhancing mathematical achievement.

Paul (2017) conducted a study to find out the effectiveness of brain-based learning strategy and circles of learning strategy over activity-oriented method of teaching and to study the effect of three instructional strategies (brain-based learning strategy, circles of learning strategy and activity-oriented method of teaching) and learning styles in case of achievement in Mathematics and self-efficacy of standard VII students of Kerala state. The study was conducted in two phases. In phase I, a preliminary survey was administered on upper primary Mathematics teachers and in phase II the experiment was conducted. The study revealed that the brain-based learning strategy was more advantageous over circles of learning strategy and activity-oriented method of teaching in enhancing student's academic achievement and self-efficacy. From the findings, it followed that brain-based learning strategy could be implemented as an instructional strategy.

Godse (2016) studied the effectiveness of brain-based program on Mathematics achievement of 5th standard students. In brain- based learning emphasis was given on meaningful learning instead of memorization. Experimental method was employed. A sample of 44 students was selected. The study revealed that there was a significant increase in the mathematical achievement of 5th standard students after implementation of the brain-based program.

Titus (2016) conducted a study to test the effectiveness of Synectics Model and Gaming Strategy on achievement and creativity in Mathematics among secondary school students. The study was conducted using experimental method and the design selected was pre-test post-test non-equivalent group design. The sample of the experiment consisted of 240 students of standard IX. The results of the study showed that Synectics model and Gaming strategy were effective with activity-oriented method on achievement and creativity in Mathematics.

Sunitha (2015) initiated a study to prepare an instructional strategy based on cognitively guided instruction for teaching mathematical concepts and to test its effectiveness in reducing Mathematics anxiety and in enhancing achievement in Mathematics of upper primary school students. The study consisted of a preliminary survey and experimental study. The preliminary survey among a sample of 400 students in Palakkad and Malappuram districts, Kerala identified the existing level of Mathematics anxiety of students in upper primary section. Then an instructional strategy based on cognitively guided instruction was developed, implemented and examined for its effectiveness. Quasi experimental method with pre-test post-test non-equivalent groups design was chosen. The sample consisted of 128 upper primary school students. The study identified the level of Mathematics anxiety of upper primary school students was below scale average value and confirmed the effectiveness of the cognitively guided instructional strategy in reducing Mathematics anxiety and in enhancing achievement in Mathematics.

Patel (2012) studied the effectiveness of laboratory teaching programme on mathematical achievement. The investigator developed the programme on the basis of laboratory teaching method and laboratory approach in the content selected from the lessons of Mathematics text prescribed for standard VIII of Gujarat state. Also, the study tested the influence of treatment, sex, intelligence and socio-economic status on achievement of students in Mathematics using factorial design. The study proved the effectiveness of the above independent variables on the dependent variable.

Binu (2011) sought to develop a Peer Tutoring Model in Mathematics for teaching Mathematics at secondary level. Peer tutoring was an instructional arrangement in which students taught their peer students for skill remediation and supplemental instruction; students got ample opportunity to develop self-concept, achievement motivation and interest in Mathematics. Experimental study was adopted for testing the effectiveness of the model. The sample comprised of 400 standard VIII students and 50 teachers and experts from three districts of Kerala. The investigator found that Mathematics could be learnt effectively in a relaxed and friendly atmosphere through Peer Tutoring Model.

Kaur and Kaur (2011) conducted a study to find the effectiveness of concept attainment model of teaching on achievement in Mathematics of secondary school students. The sample consisting of 22 ninth standard students from a school of Ludhiana district was divided as experimental group of 11 students and control group of 11 students. The mathematical concepts were transmitted to the experimental group students with the help of concept attainment model and the students in the control group were taught with traditional method by the investigators. The study revealed that students' mathematical achievement was high when they were taught using Bruner's Concept Attainment Model of Teaching.

Cheriyan (2010) studied the effectiveness of Kolb's experiential learning model on achievement in Mathematics of students at secondary level. The study was conducted by using experimental method and the design selected was pre- test post-test non-equivalent group design. The sample consisted of 326 students of standard IX. The experimental group was taught using the Kolb's experiential learning model and the control group was taught using activity-oriented method. It showed that in case of attaining Mathematics achievement, Kolb's experiential learning model (KEM) was better than the existing activity-oriented method (AOM).

Pillai (2009) conducted an investigation into the difficulties, problems and weaknesses of socially, culturally, economically and academically deprived students. For the help of those children the investigator developed some remedial measures. The major objective of the study was to examine the effectiveness of the developed remedial programmes in Mathematics. Experimental method of study was chosen with pre- test post- test non-equivalent group design. The important findings of the study were that the remedial programme developed was effective than the conventional direct instruction method.

Ridlon (2009) discussed how children's choices in middle school in the south-east shape their attitude towards and ability to accomplish Mathematics. They developed a more positive attitude about Mathematics as a result of problem-centred learning approach in Mathematics, enjoyed the class, and believed that they had learned more than traditional. Experimental method of study was employed between two groups of study. The study proved that problem centred learning was very fruitful for students of experimental group in increasing the attitude and achievement in Mathematics. It was discovered that the notions created by students aided them in keeping track of their thoughts and organizing their material. This study demonstrated the need of removing pupils from standard, stereotypical teaching and learning circumstances.

Mani (2007) conducted a study on Information Processing Models. The prime objective of the study was to test the effectiveness of Information Processing Models over the Activity Oriented Method of teaching Mathematics at secondary level with respect to achievement in Mathematics and problem-solving ability, interest and attitude towards Mathematics. The study adopted experimental method with pre-test- post-test non-equivalent group design. The sample of the study consisted of 310 standard IX students from four schools in two districts of Kerala. The study established that the instruction using Information Processing Model was superior to the instruction using Activity Oriented Method with respect to achievement in Mathematics.

Patel (2007) conducted a study to develop a programme for enhancing the achievement of the students of class X in Mathematics. The investigator chose class X pupils for the study because class X is the gateway to upper secondary education, from which students can choose a path such as science, arts or commerce. Additionally, beginning in the eleventh standard, abstract ideas of Mathematics are taught. Thus, this sort of enrichment programme assists pupils in class X in achieving a higher grade. The investigator focussed on those students who scored fifty percent or less in Mathematics on the class IX final exams. The errors committed by them should be recognised and remedial approach should be organised to enhance achievement in Mathematics. In the study, survey and experimentation were adopted. The design of the study was a single group pre-test, post-test design. The sample consisted of 70 students from 719 students who were identified as low achievers using a multi-stage cluster sampling. Information schedule for students, questionnaire for students, teachers and parents, unit tests and achievement test were administered for data collection. The developed programme consisting of prerequisite examination, remedial instruction, unit examination, several guidance and counselling sessions, pilot examination and a final accomplishment examination was found to be very effective in enhancing achievement in Mathematics of the students.

Raj (2007) conducted a study to test the effectiveness of Advance Organizer Model in the teaching of Mathematics. The investigator designed an experimental study. In order to conduct the experiment, two divisions of standard VIII were selected from Marayoor GHS, Idukki. The study revealed the fact that though the students at different intelligence level approached learning situation in a different manner, Advance Organizer Model was far superior to conventional method of teaching.

Thomas (2007) investigated to examine the effectiveness of Co-operative Learning on learning styles and academic performance of upper primary students of Kerala. Experimental method was adopted. The sample consisted of 288 standard VII students and 120 teachers and experts from three districts of Kerala. The study revealed that achievement in Mathematics depended on the learning styles of pupils and that the performance of pupils in Mathematics could be enhanced through the select co-operative learning pattern.

Minikutty (2005) investigated the impact of Concept Attainment Model of teaching in Mathematics instruction. The purpose of the study was to find out the effectiveness of Concept Attainment Model of instruction over the conventional method of teaching to academically disadvantaged students. The investigator selected experimental method appropriately. Out of 268 students in the experimental group, 123 were identified as academically disadvantaged and of 237 students in the control group, 126 were academically disadvantaged. The study revealed that the Concept Attainment Model of instruction was more effective than the Conventional Teaching Method in teaching Mathematics to academically disadvantaged students.

Sreeja (2005) developed an instructional strategy based on Vygotsky's approach for teaching basic mathematical concepts at the primary level. The experimental method with quasi experimental design using pre- test post- test non-equivalent group was employed. Two intact class room groups were selected for the experiment as standards V, VI and VII separately. The study proved that the new instructional strategies were more effective than the conventional method of teaching.

Nair (2002) conducted a study to compare the approaches of programmed instruction and the ordinary classroom method in the achievement of Mathematics of students at the higher secondary classes. The purpose of the study was to find out the effect of programmed instruction in the learning of Mathematics of students at the higher secondary level. 1139 plus one students from Thiruvananthapuram district, Kerala were selected as the sample of study. The investigator employed experimental method of study. The study established the effectiveness of programmed instruction over ordinary classroom instruction with regard to the achievement in Mathematics of the students.

Kapur and Rosario (1992) investigated intervention techniques for pupils who struggled with arithmetic learning. The sample comprised of twenty-five students in the age range of eight to eleven years old in class four who were experiencing major difficulties with arithmetic learning. The Wesheler Intelligence Scale for Children and a simplified version of the Schonell Diagnostic Arithmetic Test were employed in the study. It was discovered that despite possessing average intellectual abilities and receiving regular classroom instruction, many kids struggle with Mathematics.

Singh (1992) evaluated the results of computer-assisted instruction (CAI) with traditional methods of Mathematics instruction for a sample of selected mathematical curriculum units. Three to five BBC microcomputers were available at each of the four higher secondary schools that participated in the investigation. The students belonged to a variety of socio-economic backgrounds. Three units from Mathematics curriculum for class IX were selected for the investigation: simultaneous equations in algebra, statistical data and its graphical representation in statistics, and triangles and their congruence in geometry. The researcher developed a rating scale for the study, as well as the Genus Intelligence Test, the Attitude Scale towards Mathematics, and the educational software. For data analysis, statistical procedures such as the mean and the ‘f test' were employed. The following were the most significant findings: i) The group taught by CAT in all of the schools made significant progress. ii) A successful way of teaching Mathematics, the CAI method, had been proven to be highly effective. iii) Boys and girls both benefited from the computer treatment. iv) A statistically significant improvement in the attitudes of the experimental groups' students when compared to the control groups' students was noticed.

Srivastava (1992) investigated the efficiency of programmed learning as a function of anxiety in various motivational states. The sample consisted of 257 students from urban schools and 286 students from rural schools in grades IX and X. The Different Aptitude Test (DAT), Achievement Test, and Achievement Anxiety Test were utilized as tools. The following were the major findings: i) Using programmed learning as a teaching tool was especially beneficial for low- and average-achieving students. ii) Knowing the outcome and receiving praise from the teacher were effective motivators. The third motivational condition is one of reward in a competitive environment.

Gangopadhyay (1991) sought to determine the relative effectiveness of teachers' classroom teaching strategies in terms of student achievement. A sample of 100 class IX pupils was divided into four groups. The fifteen instructional modules were divided into four types of lessons. The instruments utilized were the Intelligence Test, a pre- and post-test for Achievement. The following major findings were made: i) Technique T2 (lecturing and explanation) was found to be more successful than T (lecturing) ii) At the post-test level, technique T3 (lecturing and explanation with questioning and replying) shown more effectiveness than techniques T2 (lecturing and explanation) and T1 (lecturing. iii) At the post-test level, technique T4 (lecturing and explanation with questioning and response utilizing a feedback sequence) shown more effectiveness than techniques T3, T2, and T1.

Chitkara (1985) investigated the efficacy of various ways for teaching mathematical achievement. The study included a pre- and post-test experimental design. Three distinct teaching styles were used: (a) lecture-discussion,

(b) inductive-drill, and (c) self-instructional group discussion. “The intelligence variable has three levels: under average, average, and above average”. A random sample of 300 students in grade IX from four Chandigarh schools was taken. Three groups of 100 pupils each were formed. One group was instructed in Mathematics by lecture and discussion. The second group received Mathematics training by inductive - drill, whereas the third group received Mathematics instruction via auto instruction group discussion. The pre- and post-test data were analysed using four-way analysis of variance (3x2 x 2x3). The following significant findings were made: i) All three tactics were found to be equally beneficial in terms of Mathematics achievement regardless of intellect level, gender, or personality type. ii) It was discovered that the lecture discussion technique favoured average ability students, as they scored significantly higher than the above- and below-average groups. iii) Inductive drill and auto instruction group discussions were more appropriate for students with above-average intelligence than for students with average or below-average intelligence.

Kothari (1985) studied on efficacy of different instructional media and examined the efficiency of several approaches to mathematical accomplishment instruction. A pre-and post-test experimental design was used in this investigation. The investigator utilized three unique teaching styles: (a) lecture discussion, (b) inductive-drill, and (c) self-instructional group discussion. There are three levels of intelligence: below average, average, and above average. It took a random sample of 300 grade IX students from four Chandigarh schools. Three 100-pupil groups were created. One group received mathematical instruction via lecture and discussion. The second group was instructed in Mathematics by inductive - drill, whereas the third group was instructed in Mathematics via auto instruction group discussion. A four-way analysis of variance was used to evaluate the pre-and post-test data (3x2 x 2x3). Significant results include the following: Each of the three strategies was as effective for Mathematics success independent of intelligence level, gender, or personality type. It was observed that the lecture-discussion approach favoured students with average ability since they scored considerably higher than students with above- or below-average abilities. Group conversations including inductive drill and auto teaching were more suited for students with above-average intelligence than those with average or below-average intelligence.

Vyas (1983) developed Symbol Picture Logic Programme (SPLP) and evaluated its effect on Mathematics achievement. This programme made students active participants in the thinking process. The experiment group students showed better achievement in Mathematics than the control group students.

Trivedi (1980) investigated the use of branching variety of computer-based learning tools as a diagnostic and remedial aid in Mathematics. 80 pupils from classes V, VI, and VII, 40 male and 40 female, were randomly separated into two groups. One group served as a control, while the other was taught using the programmed learning technique. The pre-test, the IQ test, the branching-style programmed learning material, and the post-test were employed as tools. The following were the primary findings: i) The mean scores gained by students in the traditional group are higher than the mean scores obtained by students in the programmed learning group for standards V, whereas the programmed learning group obtained higher mean scores for standards VI and VII. ii) There was no statistically significant difference in the mean achievement scores for the two approaches.

The studies examined in the area of experiments in Mathematics education and their findings are consolidated in table 3.

Table 3

Summary of Studies on Experiments in Mathematics Education

Year	Author	Findings
2022	Pambudi	Students ‘motivation and their learning achievement in Mathematics are improved after the Outdoor Learning Method (OLM) was employed.
2021	Kad	Self-regulated learning strategies are effective on students’ academic achievement in Mathematics and motivational beliefs
2021	Kumar	Active Learning Strategies are effective in enhancing the achievement in Mathematics of secondary school students
2021	Lalitkumar	The computer aided learning material is seen more effective than the traditional teaching method in terms of achievement in Mathematics
2020	Adeeb	Learning becomes easier for the children when they are taught through the Quran based newly developed system called Mathematics Park
2020	Bagul	The Computer Assisted Instruction (CAI) programmes are better in usefulness for promoting students’ achievement in Mathematics
2020	Mallikarjun	The constructivist-based approach is more useful to increase achievement, problem solving and critical thinking in Mathematics
2020	Muthulakshmi	TIGER method is a better option to be implemented in a classroom, as it surpasses the traditional method in developing achievement and interest in Mathematics
2020	Singh	Art integrated learning was found to have an impact on Mathematics and Science scores of students

Year	Author	Findings
2019	Abramovich, Grinshpan & Milligan	Concept motivation and action learning approaches are beneficial for students, school teachers and university instructors in their daily practice.
2019	Daboubi	Teaching through package based on constructivism is effective in enhancing mathematical achievement and critical thinking ability of students
2019	Shah	Students can be empowered in Mathematics performance through creative problem solving
2019	Yadav	The brain-based teaching learning strategies were found to be more efficient as compared to the traditional ways of teaching- learning
2018	Bhatt	The problems of low achievers in Mathematics can be solved by eliminating the learning difficulties faced by them
2018	Deshamukh	The developed teaching techniques will be beneficial in assisting Mathematics teachers in enhancing students' problem-solving abilities.
2018	Jayanthi	The multimedia-based teaching is very effective than the traditional method of teaching.
2018	Kurukkan	Students' feelings of difficulty in Mathematics are significantly associated to their motivational factors like interest, values, self-efficacy, ability beliefs and their learning strategies and their achievement in Mathematics can be enhanced through an intervention developed based on these evidences for developing self-regulated learning.
2018	Mamatha	The teaching Mathematics with the transitional background music approach is an effective teaching method than the conventional teaching method in developing academic achievement in Mathematics

Year	Author	Findings
2018	Rushton	Error analysis in Mathematics teaching-learning aided the students' learning process
2018	Shivraj	The teaching strategies on the basis of conceptual understanding, mathematical process skills, mathematical thinking and metacognition were found to be effective in improving problem solving ability and achievement in Mathematics
2018	Thambi	Instructional strategy based on Path-Smoothing Model is more effective than the activity-oriented method of teaching for increasing the mathematical achievement of the students
2017	George	The instructional strategy based on critical thinking skills is very effective in improving achievement in Mathematics of the students than the existing activity-oriented method of teaching in Mathematics
2017	Krishnan	There exists a positive effect of RBC Model of Instruction on achievement in Mathematics than the existing method of teaching in Mathematics
2017	Paul	The brain-based learning strategy is more superior over circles of learning strategy and activity-oriented method of teaching to enhance student's achievement in Mathematics and self-efficacy.
2016	Godse	The brain-based programme developed by the investigator proved to be very effective for enhancing mathematical achievement of students
2016	Titus	The Synectics Model and Gaming strategy are two effective methods with activity-oriented method on achievement and creativity in Mathematics

Year	Author	Findings
2015	Sunitha	The developed cognitively guided instructional strategy is very effective in reducing Mathematics anxiety of students and enhancing achievement in Mathematics
2012	Patel	The laboratory teaching programme on the basis of laboratory teaching method and laboratory approach has significant effect on the mathematical achievement of students
2011	Binu	The Peer Tutoring Model is effective in enhancing performance in Mathematics, self-concept, achievement motivation and mathematical interest of students.
2011	Kaur & Kaur	The Concept Attainment Model of Teaching is better than that of traditional method of teaching in Mathematics in enhancing the achievement in Mathematics
2010	Cheriyan	The Kolb's experiential learning model was more effective than the activity-oriented method with respect to Mathematics achievement
2009	Pillai	Learning through remedial programmes by the students in the disadvantaged group is more effective than the learning of students through conventional direct instruction method.
2009	Ridlon	Cultivating better attitude towards the subject Mathematics helped a lot in the accomplishment of the subject. Problem Centred Learning approach to Mathematics was found to be effective
2007	Mani	The instructional strategy using Information Processing Model is superior to the Activity Oriented Method of teaching in Mathematics achievement

Year	Author	Findings
2007	Patel	The seven steps teaching-learning programme consisting of administration of prerequisite tests, analysis of prerequisite tests, remedial measures based on prerequisite tests, classroom instruction, administration of unit tests, analysis of unit tests and remedial measures based on unit tests is very helpful in enhancing mathematical achievement of students.
2007	Raj	The Advance Organizer Model is far superior to conventional method of teaching in Mathematics
2007	Thomas	The select method of co-operative learning namely the jigsaw pattern on the students with varied learning styles like Pragmatists, Activists, Reflectors and Theorists is very effective in increasing the academic performance in Mathematics
2005	Minikutty	The Concept Attainment Model of instruction is more efficient in teaching- learning of Mathematics than the usual conventional method of teaching in Mathematics
2005	Sreeja	The instructional strategies based on Vygotsky's theory developed for teaching the students the basic mathematical concepts were very effective than the existing conventional method of teaching Mathematics
2002	Nair	The programmed instruction is very effective in improving the achievement of Mathematics of students
1992	Kapur and Rosario	Intervention techniques for pupils who struggle with arithmetic learning such as alternative strategies and instructional materials will facilitate learning in Mathematics

Year	Author	Findings
1992	Singh	Computer-assisted instruction (CAI) is more effective than the traditional methods of Mathematics instruction in enhancing the achievement in Mathematics
1992	Srivastava	Programmed learning as a teaching tool was especially beneficial for low- and average-achieving students in Mathematics.
1991	Gangopadhyay	The relative effectiveness of different teachers' classroom teaching strategies is examined in terms of student achievement in Mathematics
1985	Chitkara	Effectiveness of different strategies of teaching Mathematics was established
1985	Kothari	Mathematics students are profited from the activity-based nature of medium of instructions. Visual projection is considerably more successful than other instructional mediums for Mathematics teachings, such as exercises and experiments or even pre-programmed learning material.
1983	Vyas	Symbol Picture Logic Programme (SPLP) is very effective in teaching-learning of Mathematics and contributes towards raising the achievement of students in Mathematics
1980	Trivedi	The use of branching variety of computer-based learning tools as a diagnostic and remedial aid in Mathematics is fruitful.

Thus, the researchers listed above had made efforts to bring various strategies, innovations, interventions with or without technology into Mathematics classrooms to make that learning space lively and enjoyable. Many studies have been done over the last three decades to explore and assess the role and implications of technology in Mathematics education and learning at the cognitive level, and many more are currently being conducted. Researchers have stressed the importance of information and communication technology (ICT) in teaching- learning of Mathematics. The students who were taught using ICT method of teaching showed significant improvement in their achievement in Mathematics than the students who received instruction using the traditional method. Several researchers developed programmed learning materials and evaluated its effectiveness in terms of achievement. Additionally, with regard to the studies related to achievement in Mathematics, certain strategies like CAI, co-operative learning method, guidance programmes and so on were found to be effective and beneficial to improve students' learning and achievement in Mathematics. Thus, the investigator could identify certain number of interventions helpful in increasing the quality of Mathematics teaching-learning and understand the importance of the programme to be developed.

Discussion

The review helps to identify the gaps in research, and puts the present study within the context of relevant literature giving the justification for why further research is needed. Due to the efforts of many researchers, a substantial amount of work has been happened by way of improving teaching and learning of Mathematics at various levels. But a lot more need to be still achieved to improve the quality of teaching-learning of Mathematics.

The investigator has reviewed 127 related studies; 55 on correlates of mathematical achievement, 24 on select factors affecting mathematical achievement and 48 on various interventions pertaining to learning and achievement in Mathematics. All these studies focussed on factors affecting mathematical achievement, in particular, the target factors attitude towards Mathematics, beliefs in mathematical abilities, study habits in Mathematics and various strategies optimizing students' learning and achievement in Mathematics. Most of the researchers pick those factors to investigate their relationship to achievement in Mathematics, develop appropriate instruments, present them to a random sample of students, and gather the necessary data. Survey method was adopted in most of the studies reviewed. Correlation methods or, at the very least, analysis of variance has been used to analyse the majority of the data collected. Moreover, the experimental method was advocated to test the efficacy of the interventions and the enhancement of mathematical achievement could be gained more clarity through the application of experimental methods. The conclusions and findings of these studies helped the investigator to develop a programme for enhancing achievement in Mathematics at HSS level.

The literature review related with the areas of achievement in Mathematics and programme development revealed that the Bridge Programme for enhancing achievement in Mathematics of standard XI students has not been prepared yet, although there were many studies in the area of Mathematics teaching, learning and achievement as discussed in the previous section (Adeeb, 2020; Muthulakshmi, 2020; Godse, 2016; Pillai, 2009; Patel, 2007) and also a good number of studies in other areas of study (Tandel, 2021; Ranjithlal, 2019; Suneera, 2019; Singh, 2015; Todkari, 2015; Parmar, 2013; Gajanan, 2012; Chavan, 2010; Waghmare, 2010). The investigator could not find any studies on enhancing mathematical achievement of standard XI students at HSS level. Besides, it was noticed that development of a Bridge Programme for enhancing achievement in Mathematics of standard XI students, bridging the gaps in mathematical learning and achievement was not undertaken earlier. Thus, research in the development of a programme for enhancing learning and achievement in Mathematics of standard XI students is identified as that there exists the need of developing an effective programme to prepare students as well as teachers of Mathematics in standard XI at HSS level. It shows the possibility of conducting deeper studies in this area.

This situation necessitated the researcher to initiate the present study and felt a need for developing the Bridge Programme for enhancing achievement in Mathematics of students in standard XI at HSS level so that students' Mathematics learning and achievement can be optimized. The investigator has specially planned out the teaching-learning process in which diagnosis, guidance and training were administered to enhance achievement in Mathematics. Students' achievement in Mathematics can be improved employing the Bridge Programme by the way of improving attitude, beliefs, abilities and study habits of students at HSS level. So, the present study will be highly relevant in the area of Mathematics teaching-learning.

CHAPTER 3

RESEARCH METHODOLOGY

- *Variables of the Study*
- *Objectives of the Study*
- *Hypotheses of the Study*
- *Method of the Study*
- *Design of the BPM*
- *Population and Sample*
- *Description of the Tools used*
- *Data collection*
- *Statistical Techniques employed*

The present study involves the development of a Bridge Programme for enhancing achievement in Mathematics of standard XI students in Kerala State Board Syllabus. Accordingly, the methodology adopted for the present study is discussed in detail in this chapter.

The major highlights of the discussion in this chapter are the method and design of the study, preparation of the Bridge Programme and testing the effect of the teaching-learning strategy together with the Bridge Programme for enhancing achievement in Mathematics of standard XI students. Thus, the present chapter deals with the following aspects: variables of the study, formulation of objectives, setting up of hypotheses, the methods adopted in the study, the design of the BPM, population and selection of samples for each phase, description of the tools used for collection of data, their administration and scoring and finally statistical techniques used for analysis of data. Each of these aspects is being described in the following paragraphs.

Variables of the Study

The present study involves following types of variables.

Independent Variables

- Teaching-learning strategies at two levels; together with and without the Bridge Programme in Mathematics.

It was the treatment variable that the researcher manipulated in order to determine its effectiveness on the dependent variable. One group of students received the treatment condition, namely the Bridge Programme in Mathematics and the other group did not. Thus, the administration of the Bridge Programme together with the usual classroom instruction- routine learning and the usual classroom instruction-routine learning alone were the two levels of the treatment. Hence the presence and absence of the BPM were the two levels of the treatment.

Dependent Variable

- Achievement in Mathematics of standard XI students in terms of the scores on standardized achievement test.

Control Variables

- Pupils' age
- Unit of instruction
- Prior achievement and knowledge level of students
- Locality of school
- Type of school
- Teacher characteristics

Using appropriate research designs and proper statistical techniques, the variables were made controlled by the researcher so that the effect upon the dependent variable was credited entirely to the independent variable and not to some extraneous variables. Age of the participants was almost same as the students included in the study were plus one students. The unit chosen during experiment was also same. Pre-test was administered to check the achievement level of the students. Urban and aided schools were selected for conducting the experiment. Standard and classroom climate were also almost same and same teachers conducted the experiment.

In a quasi-experimental design, the treatment variable, namely, the independent variable is a planned intervention (a policy or programme) specifically aimed at influencing an outcome/dependent variable. Thus, a sound experimental design enables the researcher to largely neutralize the influence of the extraneous variables.

Objectives of the Study

The major objective of the present study is to develop (to prepare and validate) a Bridge Programme for enhancing achievement in Mathematics of standard XI students at HSS level. For achieving the major objective of the study, the specific objectives set forth for the present study are the following:

1. To explore the level of standard XI students' attitude towards Mathematics learning and achievement, beliefs in mathematical abilities and study habits in Mathematics.
2. To identify standard XI students' needs and requirements with respect to Mathematics learning and achievement.
3. To prepare a Bridge Programme based on students' attitude towards Mathematics learning and achievement, beliefs in mathematical abilities cum pre-requisite (basic) knowledge in the subject and study habits in Mathematics for enhancing achievement in Mathematics of standard XI students.
4. To study the effectiveness of the Bridge Programme in terms of achievement in Mathematics of standard XI students.
5. To study the effectiveness of the Bridge Programme on retention of achievement in Mathematics of standard XI students.
6. To test whether the Bridge Programme is effective to improve standard XI students' attitude towards Mathematics learning and achievement, beliefs in mathematical abilities cum pre-requisite (basic) knowledge in the subject and study habits in Mathematics in the desired direction.
7. To study the efficacy of the Bridge Programme in terms of students' feedback regarding the prepared and implemented Bridge Programme.

Hypotheses of the Study

Based on the objectives 4, 5 and 6, the following null hypotheses were proposed to test the effect of the Bridge Programme for enhancing achievement in Mathematics of standard XI students.

1. There is no significant difference between the pre-test mean scores of achievements in Mathematics of the experimental and control group students in standard XI.
2. There is no significant difference between the post-test mean scores of achievements in Mathematics of the experimental and control group students in standard XI.
3. There is no significant difference between the means of gain scores of achievements in Mathematics of the experimental and control group students in standard XI.
4. There is no significant effect of the Bridge Programme on achievement in Mathematics after controlling pre-experimental status in terms of pre-test scores of achievements in Mathematics.
5. There is no significant difference between the delayed post-test mean scores of achievements in Mathematics of the experimental and control group students in standard XI.
6. There is no significant difference between the pre-test and post-test mean scores of students' attitude towards Mathematics of the experimental group students in standard XI.
7. There is no significant difference between the pre-test and post-test mean scores of students' beliefs in mathematical abilities of the experimental group students in standard XI.

8. There is no significant difference between the pre-test and post-test mean scores of basic Mathematics (pre-requisite knowledge in the subject) of the experimental group students in standard XI.

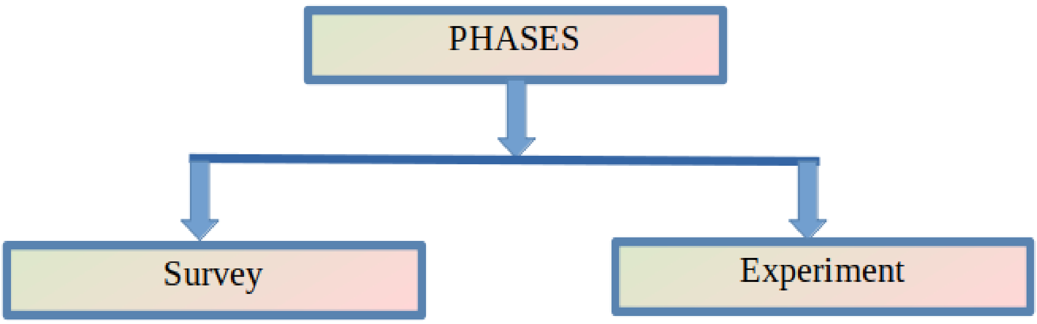
9. There is no significant difference between the pre-test and post-test mean scores of students' study habits in Mathematics of the experimental group students in standard XI.

Method of the Study

The present study has been conducted by administering both survey and experimental methods of research from which the two phases of the study are determined.

Figure 3

Diagrammatic Representation of the Phases of the Study



Descriptive Survey Method in Phase I

The prime objective of the study is to develop a Bridge Programme for enhancing achievement in Mathematics of standard XI students. The first phase of the study is essentially a survey with descriptive and exploratory purposes. The survey was conducted initially to identify the present status of plus one students' Mathematics learning with respect to the select factors, namely, attitude towards Mathematics learning, beliefs in mathematical abilities and study habits in

Mathematics and to seek their needs for learning Mathematics and good achievement in the subject. Hence this phase is considered as descriptive and exploratory survey of study.

This phase of study is actually intended to acquire relevant and exact data concerning the current level of Mathematics learning and, whatever conceivable, to reach substantial general conclusions from the fact found. In the present investigation, the level of students' Mathematics learning with respect to the attitude towards Mathematics, beliefs in mathematical abilities and study habits in Mathematics were gathered and analysed with the help of tools constructed by the investigator under the guidance of the supervising teacher. Also, the students' needs were sought by using a questionnaire. The detailed description of the tools are given separately.

Based on the findings from phase I, components of the Bridge Programme were determined and a frame work for the programme was prepared. Then the researcher prepared the Bridge Programme for enhancing achievement in Mathematics of standard XI students. Thus, the survey phase I culminated in the preparation of the Bridge Programme.

Experimental Method in Phase II

To validate the prepared Bridge Programme for enhancing achievement in Mathematics of standard XI students by ascertaining its effect on the achievement in Mathematics, quasi-experimental design under the Experimental research method was adopted. Among the quasi-experimental designs, the Pre- test Post- test Non-equivalent Group Design which would help to control threats to internal and external validity of the study was selected for the present study. This design was most suitable since two intact classes from the schools chosen were used and no randomization was done in the selection of the participants. The experimental design that enabled the researcher to test the hypotheses and reach valid conclusions is depicted symbolically in figure 4.

Figure 4

Symbolic Representation of the Experimental Design

Experimental Group	O_1	X	O_2	O_3

Control Group	O_4	C	O_5	O_6

Where, O_1, O_4 = pre tests

O_2, O_5 = post tests

O_3, O_6 = delayed post tests

X = exposure of the group to the experimental (treatment) variable

C = exposure of the group to the control condition (No treatment) and

-------- = dashed line indicates that groups are not equated.

Both groups received a pre-test (O_1 and O_4). One group received the experimental treatment (X), which was implementation of the Bridge Programme during the existing teaching and learning process. Other group was not received the experimental treatment (C) during the existing instructional process. Both the groups received a post-test ($O_{2\ \text{and}}$ O_5). Besides both the groups received a delayed post-test ($O_{3\ \text{and}}$ O_6) too. The dashed line in the representation shows that the experimental and control groups have not been equated by randomization hence the term non-equivalent. Control and manipulation of the variables is the basic idea of the experimental method.

This design is often used in classroom experiments when experimental and control groups are such naturally assembled groups as intact classes, which are normally non-equivalent and later these groups are equated by appropriate statistical techniques. In educational research conducted in a school setting it is not possible to assign students randomly to groups because schedules cannot be disturbed nor classes rearranged to conduct a research study due to administrative restrictions. In such situation the investigator must use that method which will provide as much control as possible under existing situation. Consequently, the design chosen for the investigation is the pre-test post-test non-equivalent group design. Quasi-experiments include assignments, but not random assignment of participants to groups. The experimental and control groups are formed not by assigning students randomly. One group of students was randomly taken as experimental group and the other as control group. That helped not to disrupt the existing school routine activities. More descriptions are presented as follows.

First pre-test (achievement test in Mathematics) was administered among both experimental and control groups to measure the dependent variable. The main objective of the pre testing was to examine the achievement level of the students before the treatment. This would help to eradicate the effect of existing differences in the level of achievement in Mathematics of the students before the treatment. Also, this would help in order to determine whether the groups were comparable prior to the implementation of the BPM. Pre testing, no doubt, would help to eliminate the effect of existing variations in the entry level.

In addition, Mathematics study attitude and belief scale, Mathematics study habits scale and a prerequisite test in basic Mathematics were administered in experimental group to test the initial levels (pre testing) and to prepare the student profile which is a requirement in the Bridge Programme. Format of student profile is given in Appendix B.

After that the experimental group was introduced with the Bridge Programme, which is the experimental treatment, together with the usual classroom instruction, whereas control group was not presented to the treatment, but the usual classroom instruction only given according to a schedule.

Soon after completing the implementation of the programme, post-test (achievement test in Mathematics) was conducted for the two groups that would help to examine the achievement levels of the groups after treatment. This would help to determine whether the two groups were different after the implementation of the Bridge Programme.

Besides Mathematics study attitude and belief scale, Mathematics study habits scale and test in basic Mathematics were also administered among the students of the experimental group (post testing).

Delayed post-test (achievement test in Mathematics) was administered to the experimental and control groups three weeks after the administration of the post-test. The same achievement test was used as delayed post-test and retention of students was checked. Thus, the experimental phase II culminated in the validation of the Bridge Programme.

Finally, a questionnaire for seeking students' feedback on BPM was administered among the experimental group students for collecting the feedback towards the developed BPM. The details of the tools administered are given separately.

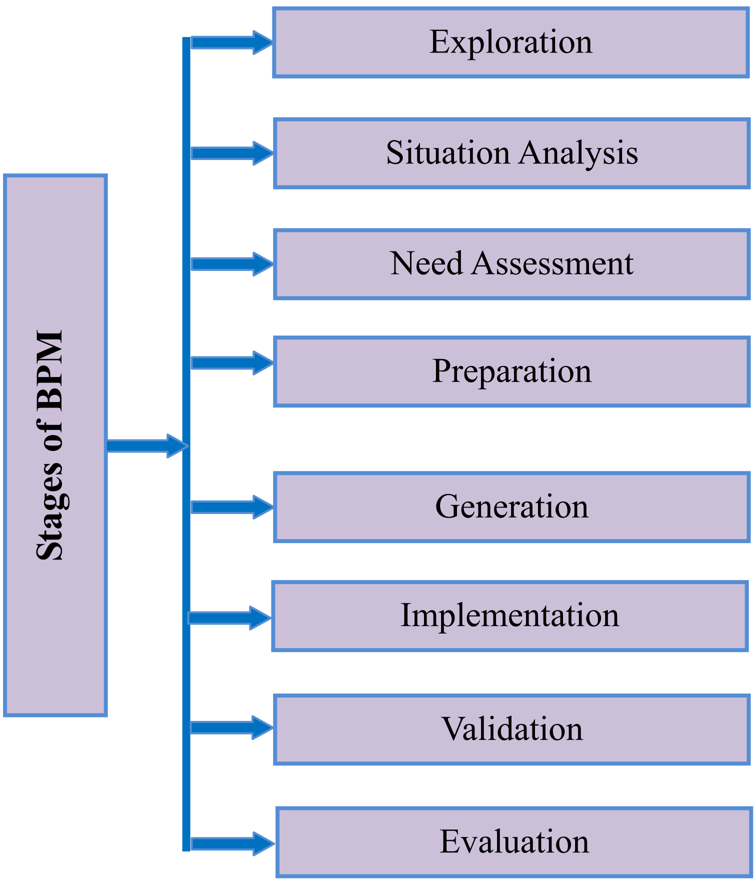
Briefly, the researcher adopted a combination of descriptive survey and experimental methods, by keeping in mind the objectives of the study and nature of the data required for the study. Survey (phase I) and experimentation (phase II) were adopted appropriately. In accordance with the objectives and hypotheses formulated, this method of study was found most appropriate in the present investigation.

Design of the BPM

The BPM is developed through eight stages which is diagrammatically depicted in figure 5.

Figure 5

Diagrammatic Representation of Stages of BPM



Exploration (Select Correlates)

The investigator tried to understand the factors responsible for learning and achievement in Mathematics. Review of related literature helped the investigator to explore various factors influencing learning and achievement in Mathematics. Besides there are so many sources of information to get factors of learning and achievement in Mathematics. They are teacher cluster meetings organized by the Department of HSE, courses, seminars and workshops conducted by Mathematics associations, PTA meetings, sharing by top achievers, mass media etc. These review provided that there are various personal, cognitive and non-cognitive, school related, home related and social factors affecting learning and achievement in Mathematics. Many of these factors are difficult to change and out of control of the educators. Out of these, the investigator was interested in students related factors such as attitude towards Mathematics, certain mathematical abilities cum prerequisite (basic) knowledge in the subject and study habits in Mathematics as deciding factors of mathematical learning and achievement. These factors were chosen so that they could be manipulated educationally within reasonable limits of time and effort.

Situation Analysis

The investigator referred the AMP developed by various HSS to get an overview of present scenario in Mathematics teaching and learning. Then the investigator conducted the survey using Mathematics study attitude and belief scale and Mathematics study habits scale to identify the levels of attitude towards Mathematics, beliefs in mathematical abilities and study habits in Mathematics. In fact, they helped to understand the present level of students' learning in Mathematics. These survey and the findings have largely helped the investigator in preparing the BPM.

Need Assessment

Next the investigator intended to assess the needs of students of plus one with regard to Mathematics learning and achievement in relation to the select correlates of Mathematics learning. A questionnaire prepared by the investigator under the guidance of supervising teacher was employed to seek the needs of students on Mathematics learning and achievement. The focus of enquiry was based on the following:

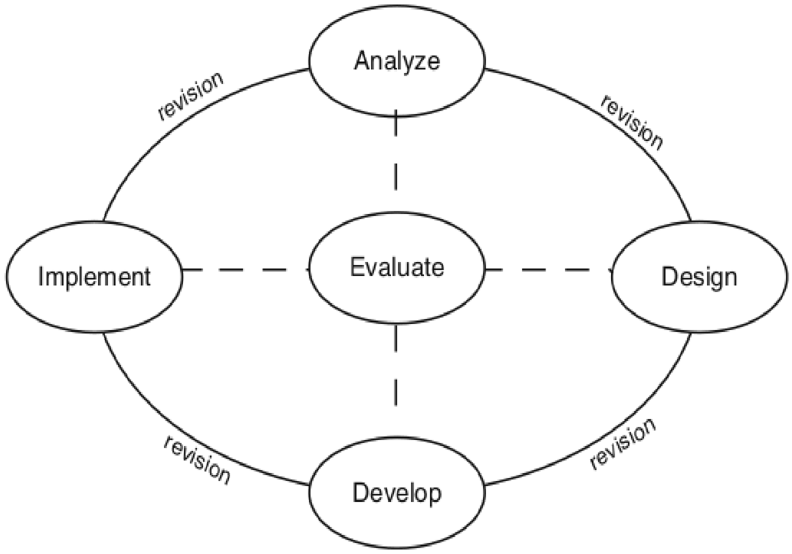
1) Need for special programmes to improve Mathematics learning and achievement
2) Students' participation in any such programmes conducted by any agency
3) Impact of special programmes on Mathematics learning and achievement
4) Development of favourable attitude towards Mathematics learning and achievement
5) Guidance on courses and careers related to Mathematics
6) Development of mathematical abilities
7) Expertise in basic Mathematics
8) Mathematics study habits
9) Preparations for Mathematics examinations
10) Desire to participate in special programmes

Preparation

After identifying the poorly practised dimensions and components and the need of special programmes, the investigator prepared the BPM, consisting of 11 plans (each plan has a common format of description of the plan, outcome, procedure, strategies and duration) and 21 strategies that are possible solutions based on diagnosis, guidance and training; scheduled to be implemented approximately for 30 days for enhancing achievement in Mathematics. The ways adopted in preparing the Bridge Programme were based on the guidelines and frameworks given by the instructional design models discussed in Chapter II especially following the principles of ADDIE model (Branch,2010) consisting the generic process of 5 phases.

Figure 6

ADDIE model



Analyze. Identify the probable causes for a performance gap. Determine the instructional goals, target audience and required resources. Analysis phase consists of audience (plus one students who follow science stream and having Mathematics as one of the optional subject), behavioural outcomes (to enhance achievement in Mathematics, increasing their attitude, beliefs in mathematical abilities, previous content knowledge and study habits in Mathematics), delivery options (using face to face group/individual interaction or online), duration (the time limit for the complete programme is of 30 days duration)

Design. Verify the desired performances and appropriate testing methods. Make a learning solution that aligns objectives and strategies with instructional goals. Design phase consists of purposes (the investigator focused on attitudinal, beliefs, abilities and study habits changes), resources and strategies to be utilised (diagnosis, guidance and training), activities and materials necessary for the development of the programme such as necessary pictures, paper cuttings, audio-video clippings etc., assessment methods (testing and feedback collecting)

Develop. Generate and validate the learning resources. Create learning resources, validate and revise drafts and conduct a pilot test. Development phase consists of objectives and measurement tools, detailed plan for implementing and documentation of the plans and strategies

Implement. Prepare the learning environment and engage the students. Execute the learning solution by preparing the learning space and engaging participants. Implementation phase consists of method, preparation of the students and administration of the tools.

Evaluate. Assess the quality of the instructional products and processes, both before and after implementation. Test the quality of learning resources and how well they accomplish instructional goals. Evaluation phase consists of testing and gathering feedback.

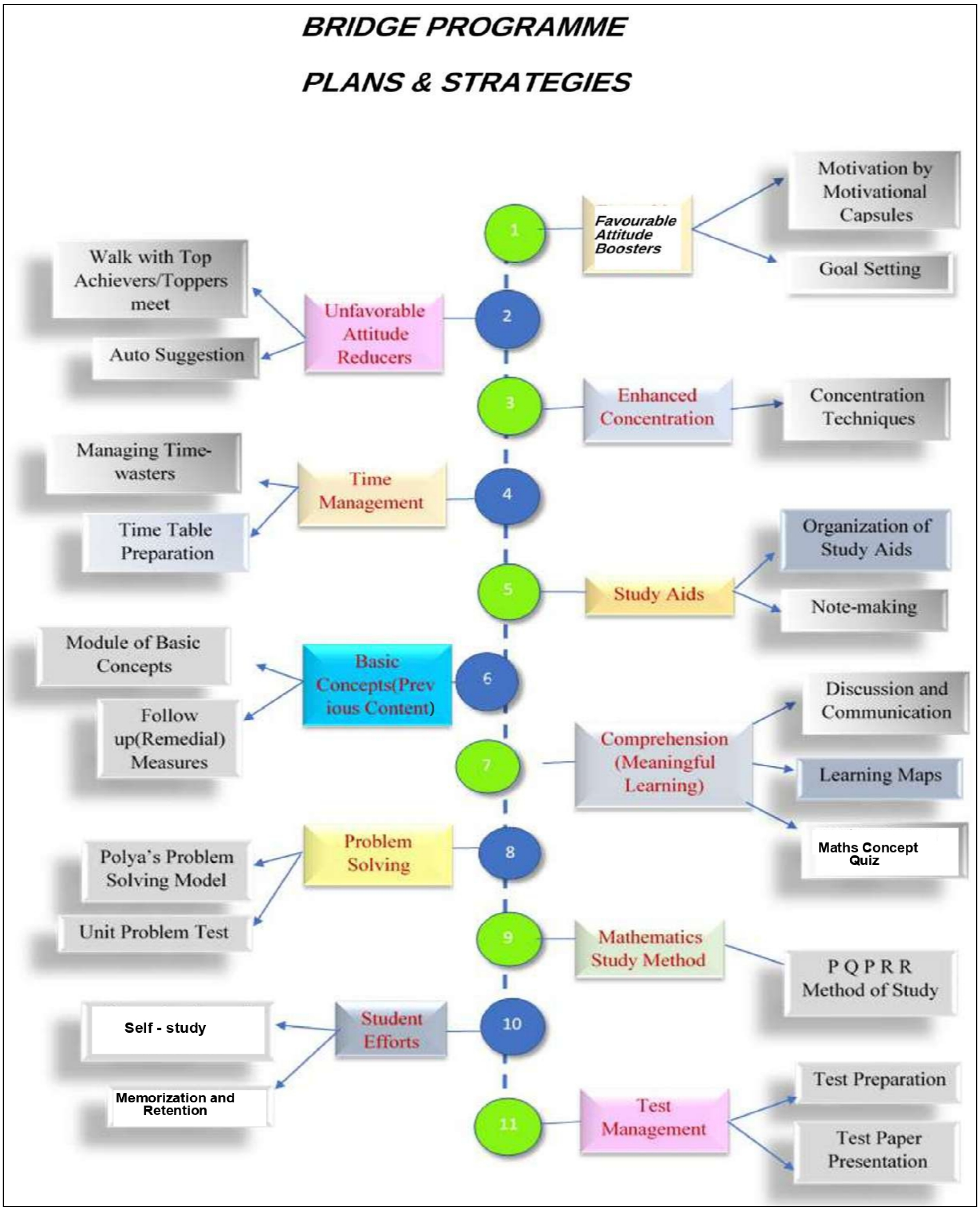
Generation (Evolution)

After the preparation, the plans and strategies were organised systematically for initial draft. Necessary changes were included based on the suggestions given by the supervising teacher. Suggestions and feedback were sought from the experienced and expert teachers to determine the content validity and face validity of the programme. On the basis of the suggestions provided by them the investigator modified the programme.

Before finalising the Bridge Programme, a try-out of the programme was conducted among a small group of ten students in St. Joseph's Boys' HSS, Kozhikode to see the suitability of the programme. The investigator made some changes in the materials on the basis of the feedback received during this pilot study. This programme consists of certain number of plans and strategies. A visual description is given in figure 7.

Figure 7

Bridge Programme for the Experiment Group



Implementation

The plans in the Bridge Programme in Mathematics are grouped as follows for implementation.

Figure 8

Division of Bridge Programme Plans

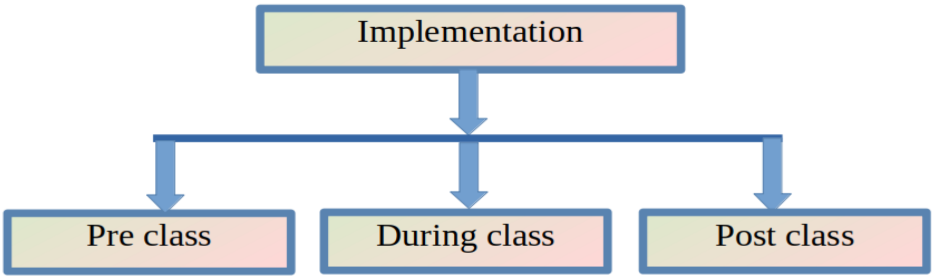
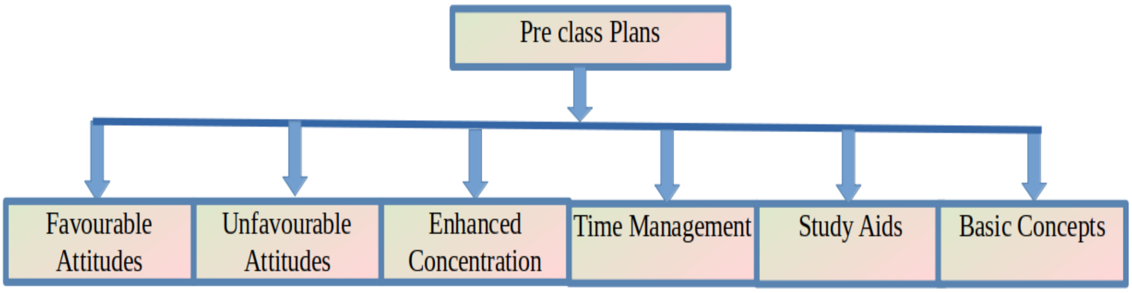


Figure 9

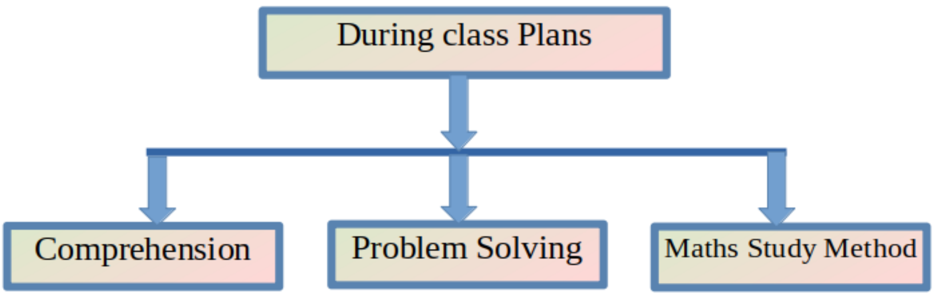
Pre Class Plans 1 to 6



These six plans are allotted before the classroom teaching-learning of the lesson chosen. The strategies 1 to 11 are administered at this step for first fifteen days.

Figure 10

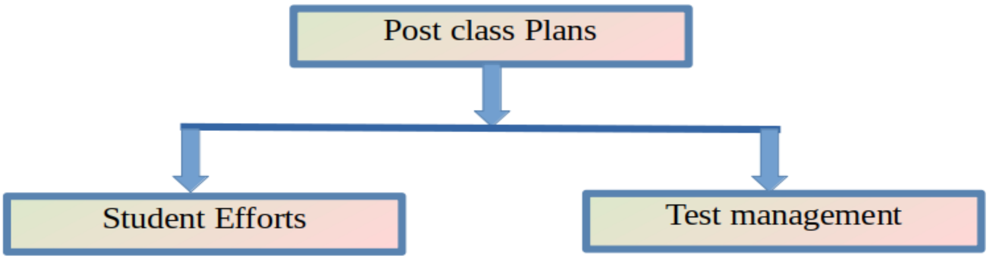
During Class Plans 7 to 9



These three plans are allotted during the classroom teaching-learning. The strategies 12 to 17 are administered at this step for next ten days.

Figure 11

Post Class Plans 10 to 11



These two plans are allotted after the classroom teaching-learning. The strategies 18 to 21 are administered at this step for last five days.

For conducting the experiment, the investigator contacted Principals of two schools selected for experiment and gave brief description of the Bridge Programme and handed over the copies to them. Both of them consented on the detailed explanations. Permission was granted after assurance that regular classes were not disturbed.

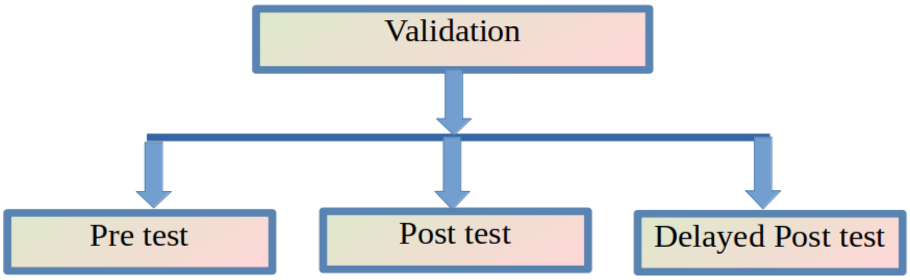
Also, a student profile for each student in the experimental group was prepared. The tools used in the survey are administered among the students in the experimental group at the beginning of the experiment. Prerequisite test in basic Mathematics for the unit Complex Numbers and Quadratic Equations was prepared and used by the investigator for testing the entry level requirements. It measured students' prerequisite knowledge in the topics related to the ones covered during the study. It was constructed using the blue print for achievement test in Mathematics. While attending this test, the students were required to work out the solutions step-by-step in a separate sheet so that they could be diagnosed, guided and trained. Using the data collected, the investigator prepared student profile for each student in the experimental group.

In SJBHSS, the investigator himself organised the experiment and in PGHSS, one of the HSST in Mathematics was entrusted the responsibility of the same. She was explained the sequence of stages and steps required to conduct each plan to avoid any type of confusions. The treatment was implemented for the academic year 2020-2021. The duration of the implementation was 30 days in February, 2021 and March, 2021. The treatment period was divided into 3 sessions as given above. Minimum of 30 hours had been allotted during these 30 days for the implementation of the Bridge Programme. The investigator and the co-researcher performed the roles of facilitators and mentors.

Validation

Figure 12

Diagrammatic Representation of Validation of the Programme



The effect of the implemented programme is to be tested in real school situation. The investigator administered pre-test to the students of experimental and control group with a view to measure their achievement in Mathematics. Also, the students in the experimental group were pre-tested using the constructed scales and the prerequisite achievement test in basic Mathematics too. At the end of the treatment period the students (in both the groups) were post tested using the achievement test. Also, after three weeks the post test was again administered among the two groups and the students' retention of achievement in Mathematics was tested. The data was analysed and interpreted by the investigator and the effect of the BPM was tested with respect to the factors attitude, beliefs, basic Mathematics, study habits and achievement in Mathematics.

Evaluation

After the implementation of the programme, a questionnaire was employed among the students of the experimental group to determine the degree of satisfaction with the BPM. The investigator and the co-researcher employed a questionnaire to get feedback of the participants on the BPM and the student's opinion about the programme had been collected through the feedback form.

Population and Sample

Population and sample selection have been described in detail for each phase. In the present study, population is the set of all students in standard XI studying in the schools affiliated to HSE, Kerala. Students of plus one at HSS level were chosen as the population since Mathematics result of plus two is one of the crucial results that determines the future of the students. Further the mathematical foundation imparted in plus one plays the prime role in the mathematical achievement in plus two. The researcher selected the sample which is a smaller representation of the population from the target population. Precisely, the target population or sampling frame is taken as all the students in standard XI at HSS from Kozhikode Revenue District.

In phase I, the investigator had used stratified random sampling technique (probability sampling method) which ensured representativeness of the target population and avoided bias in sampling. According to Garret (2012), when the population is composed of subgroups of different sizes stratified random sampling method is applicable. The sample comprised of 660 standard XI students opting Mathematics as one of the subjects from 39 schools in Kozhikode District. List of schools is given in Appendix C.

The following strata of the population were taken into consideration while selecting the sample.

i) Gender (boy/girl -1:1 ratio)

ii) Locality (urban/rural- 4:5 ratio)

iii) Type of the school (government/aided/unaided- 2:3:1 ratio)

Break-up of the sample is given in table 4.

Table 4

Break-up of the Sample for Survey (Phase I)

Gender	Boys (330)						Girls (330)					
Locality	Urban (144)			Rural (186)			Urban (144)			Rural (186)		
School Type	Govt.	Aided	Unaided	Govt.	Aided	Unaided	Govt.	Aided	Unaided	Govt.	Aided	Unaided
No. of Students	49	74	24	61	92	30	49	74	24	61	92	30

In phase II, the investigator selected two HSS from Kozhikode Educational District where the researcher and the co-researcher are permanent staff, with prior permission of the school management. List of schools is given in Appendix D.

Two intact classes of standard XI from each school were selected as the sample consisting of 231 students so that the sample included both boys (118) and girls (113). The investigator and the co-researcher conducted the experiment on these non-equivalent intact classroom groups. One class from each school was randomly selected as the experimental group and the other as the control group. There were 118 students in the experimental group and 113 students in the control group. In addition, these classes were appeared to be similar in terms of achievement, social, environmental and economic levels. Further details are given in table 5.

Table 5

Sample for Phase II

Serial Number	Name of the School	Group	Number of Students
1	SJBHSS	XI B	58
2	SJBHSS	XI C	60
3	PGHSS	XI A	60
4	PGHSS	XI C	53
Total			231

Description of the Tools Used

In the present study the investigator used the following tools for collecting necessary data:

1) Mathematics Study Attitude and Belief Scale
2) Mathematics Study Habits Scale
3) Questionnaire for the Assessment of Need of Bridge Programme
4) BPM for Standard XI Students
5) Achievement Test in Mathematics for Standard XI
6) Prerequisite Test in Basic Mathematics
7) Questionnaire for Seeking Students' Feedback on Bridge Programme

The tools were constructed by the investigator under the guidance of the supervising teacher. In the beginning of each tool a part requiring for personal details of the students was given to gather the demographic information such as their gender, locality, type of school and score or grade in Mathematics of standard X public examination. Needed instructions were given in the beginning itself. The tools are described one by one in the following sections.

Mathematics Study Attitude and Belief Scale

To assess the level of standard XI students' attitude towards Mathematics and their beliefs in mathematical abilities, the investigator under the guidance of the supervising teacher constructed, standardised and administered Mathematics study attitude and belief scale.

This tool contains two sub-scales. First one is based on the aspect of students' attitude towards Mathematics learning whose components are favourable and unfavourable attitudes towards Mathematics learning. Second one is based on the aspect of students' beliefs in mathematical abilities whose components were previous content knowledge, comprehension and problem solving. The tool had an initial pool of 40 statements containing 25 positive and 15 negative statements. Then it was given to six experts in the field of education (i.e., experienced HSS teachers and college teachers) for scrutiny and expert comments in terms of fluency, clarity and relevance of the items. The items which were agreed by them were retained or modified and the others (10 items) were deleted.

Table 6

Areas and Components of Mathematics Study Attitude and Belief Scale

Sl.No.	Areas	Components	No. of Items
1	Students' Attitude towards Mathematics Learning	1) Favorable Attitude	12
		2) Unfavorable Attitude	5
2	Students' Beliefs in Mathematical Abilities	3) Previous Content Knowledge	3
		4) Comprehension	4
		5) Problem Solving	6
Total	2	5	30

The attitudinal sub scale included 17 items; 11 positive (Items numbered 1,3,4,5,6,7,8,9,10,11 and 12) and 6 negatives (Items numbered 2,13,14,15,16 and 17). The belief sub-scale consisted of 13 items; 7 positive (Items numbered 2,3,4,7,8,12 and 13) and 6 negatives (Items numbered 1,5,6,9,10 and 11). The respondents were asked to indicate their choice on a five-point scale by marking the bubble corresponding to strongly agree to strongly disagree provided against each item.

The Likert's type of attitude and belief scales were scored on a five-point scale by giving weightages to strongly agree, agree, neither agree nor disagree, disagree and strongly disagree as 5,4,3,2 and 1 in the case of positive items and 1,2,3,4 and 5 in the case of negative items respectively.

- For attitude item no. 1,3,4,5,6,7,8,9,10,11 and 12 and for beliefs item no. 2,3,4,7,8,12 and 13 as given in appendix F were coded as follows: -

  Strongly agree = 5

  Agree = 4

  Neither agree nor disagree = 3

  Disagree = 2

  Strongly disagree = 1

And other items related to attitude, namely 2,13,14,15,16 and 17 and for beliefs item no. 1,5,6,9,10 and 11 in the same appendix were coded as follows: -

a. Strongly agree = 1
b. Agree = 2
c. Neither agree nor disagree = 3
d. Disagree = 4
e. Strongly disagree = 5

The total for each student on the sub-scales was obtained by adding the weightages on all the items in the respective sub-scales. The total score for a student stand for the score on attitude and beliefs. The range of the score for first sub-scale (i.e., attitudinal sub-scale) is 17 to 85 and that of the second sub-scale (i.e., belief sub-scale) is 13 to 65. The scoring was done in such a way that, higher the scores, the more favourable attitude and beliefs the students possessed.

The level of attitude and beliefs was determined by calculating the measures of central tendency and percentage analysis. Three levels are determined as high (3.68 - 5), moderate (2.34 - 3.67) and low (1 - 2.33). The different levels of attitude and beliefs were categorized as follows:

Table 7

Interpretation of the scores Regarding Mathematics Study Attitude and Belief

Attitude		Belief	
Range of Score	Level	Range of Score	Level
Below 40	Low	Below 31	Low
40 - 62	Moderate	31 - 47	Moderate
Above 62	High	Above 47	High

Low and moderate scores indicate an area for growth and practice.

Try Out

To get feedback on the tool, to check the clarity of instructions, items and language, to know whether there was any ambiguity in wording, the prepared tool was given to a small group of HSS students. Taking into consideration of their remarks, some items were rewritten and the preliminary draft was prepared. It is given in Appendix E.

Item Analysis

It helps to find out which items are most useful and which are problematic. Likert type of sum mated ratings to measure attitude is employed. The investigator conducted item analysis to include consistent items. Initially the tool was given to 370 students. Scoring of the tool was done and arranged in ascending order. The top 27% and the bottom 27% of the students were identified as criterion groups and mean scores obtained by these two groups were calculated for analysis. For each item t value was calculated. All the items were retained as the t values were greater than 1.75. The significant t test values show that average response on the high and low groups to all the 30 items differ significantly. The following table contains details of the item analysis.

Table 8

Mean, S D and t-values of the Items of Mathematics Study Attitude and Belief Scale

Item	Group	N	Mean	S. D.	t-value
1	Low	100	3.1800	.97835	11.099
	High	100	4.5700	.78180	
2	Low	100	2.6400	.92682	12.694
	High	100	4.2400	.85422	
3	Low	100	3.1700	.93263	16.197
	High	100	4.8100	.39428	
4	Low	100	2.0800	.83702	9.415
	High	100	3.4100	1.13791	
5	Low	100	3.3200	.94152	15.034
	High	100	4.8400	.36845	
6	Low	100	2.4300	.97706	12.962
	High	100	4.1100	.85156	
7	Low	100	2.8500	.94682	8.655
	High	100	3.9900	.91558	
8	Low	100	2.3700	1.10696	7.654
	High	100	3.5900	1.14676	
9	Low	100	2.5000	.91563	17.589
	High	100	4.5000	.67420	
10	Low	100	2.2700	1.02351	12.276
	High	100	3.8800	.81995	
11	Low	100	2.4200	1.13867	6.782
	High	100	3.4700	1.04886	
12	Low	100	2.3500	.92524	14.941
	High	100	4.1900	.81271	
13	Low	100	3.0000	.96400	13.665
	High	100	4.5800	.63850	
14	Low	100	2.6500	.98857	13.019
	High	100	4.3300	.82945	

Item	Group	N	Mean	S. D.	t-value
15	Low	100	2.4000	1.05409	16.837
	High	100	4.5200	.68873	
16	Low	100	3.1600	1.01225	13.520
	High	100	4.7000	.52223	
17	Low	100	2.8800	1.00785	14.130
	High	100	4.6200	.70754	
18	Low	100	2.8200	.99879	8.735
	High	100	4.0100	.92654	
19	Low	100	2.9900	.84680	12.291
	High	100	4.3400	.69949	
20	Low	100	2.8100	1.08892	6.423
	High	100	3.7300	.93046	
21	Low	100	3.7500	.92524	8.066
	High	100	4.6100	.52982	
22	Low	100	3.2100	1.02784	8.977
	High	100	4.3800	.80126	
23	Low	100	2.7000	.87039	8.178
	High	100	3.8100	1.04151	
24	Low	100	3.5200	.85847	9.462
	High	100	4.5600	.68638	
25	Low	100	4.2600	.98083	6.116
	High	100	4.8900	.31447	
26	Low	100	2.9300	.84393	9.123
	High	100	4.1600	1.05141	
27	Low	100	2.7300	.91954	13.629
	High	100	4.3400	.74155	
28	Low	100	2.0200	.81625	8.747
	High	100	3.1100	.94168	
29	Low	100	3.5100	1.02981	4.972
	High	100	4.1800	.86899	
30	Low	100	2.8400	.89578	11.681
	High	100	4.1300	.64597	

Reliability of the Tool

It refers to the accuracy of measurement and tries to see to what extent the test is reliable. It is the degree of consistency. The reliability of the scale was determined by calculating Cronbach's Alpha coefficient which was found to be 0.902 for first sub-scale and 0.815 for the second sub-scale. It showed that the scale constructed was satisfactorily reliable.

Validity of the Tool

The items in the tool seemed to measure attitude towards Mathematics learning and beliefs. In ascertaining the content validity of the tool, it is important to observe whether the content of the test is suitable for the purpose for which it is constructed. According to the experts who thoroughly examined the tool regarding objectives, content and instructions, items of the scale were directly related to the areas and components chosen. As all items were related to the areas and dimensions of attitude and beliefs under focus, it can be concluded that the scale used in the present study had high content validity. Each item was judged by experts and content validity was established. Total number of items were 17+13=30.

Criterion Related Validity has also been found out for the scale by using the scores obtained for the standardised tool developed by S.C. Gakhar and Rajni, Department of Education, Punjab University, Chandigarh in 2012: Attitude towards Mathematics Scale, as the criterion scores. By correlating the scores, the criterion validity was obtained. It was found to be 0.78.

Final form of the Tool

After conducting item analysis and establishing the reliability and validity, the investigator finalised the tool. The final form of the tool is given in Appendix F. The same tool was used for assessment of students' attitude and beliefs in both the phases of the study.

Mathematics Study Habits Scale

To assess the level of study habits in Mathematics of standard XI students, the investigator under the guidance of the supervising teacher constructed, standardised and administered Mathematics Study Habits Scale.

This tool is based on the aspect of students' study habits in Mathematics learning whose components are concentration, time management, organisation of study aids, study methods, students' efforts and test management. The tool had an initial pool of 50 statements containing 25 positive and 25 negative statements. Then it was given to six experts in the field of education for scrutiny and expert comments in terms of fluency, clarity, appropriateness and relevance of the items. The items which were agreed by them were retained or modified and the others (12 items) were deleted. Thus, the total number of items was 38.

Table 9

Area and Components of Mathematics Study Habits Scale

Sl. No.	Area	Components	No. of Items
1	Study Habits in Mathematics Learning	1) Concentration	3
		2) Time Management	4
		3) Organization of Study Aids	6
		4) Study Methods	7
		5) Students' Efforts	5
		6) Test Management	13
Total		6	38

The respondents were asked to indicate their choice on a five-point scale by marking the bubble corresponding to always, often, sometimes, seldom and never provided against each item.

The Likert's type of study habits scale was scored on a five-point scale by giving weightages to always, often, sometimes, seldom and never as 5,4,3,2 and 1 in the case of positive items and 1,2,3,4 and 5 in the case of negative items respectively.

For students' study habits in Mathematics item no. 1, 4, 6, 8, 9, 11, 12, 14, 16, 17, 18, 19, 21, 23, 24, 25, 26, 27, 32 and 35, as given in appendix H, were coded as follows: -

- Always = 5
- Often = 4
- Sometimes = 3
- Seldom = 2
- Never = 1

And other items 2,3,5,7,10,13,15,20,22,28,29,30,31,33, 34,36 and 37 were coded as follows: -

- Always = 1
- Often = 2
- Sometimes = 3
- Seldom = 4
- Never = 5

The total for each student on the scale was obtained by adding the weightages on all the items. The total score for a student stand for the score on study habits. The range of the score is 38 to 190. The scoring was done in such a way that, higher the scores, the better the students possessed the study habits in Mathematics.

The level of study habits was determined by calculating the measures of central tendency and percentage analysis. Three levels were determined as good (3.68 – 5), moderate/satisfactory (2.34 – 3.67) and poor (1 - 2.33). The different levels of study habits were categorized and table 10 shows the interpretation of the score obtained by a student on the scale.

Table 10

Interpretation of the Scores Regarding Mathematics Study Habits

Sl. No.	Range of Scores	Level
1	Below 87	Poor
2	87 -135	Moderate/satisfactory
3	Above 135	Good

Moderate/satisfactory or poor scores indicate an area for improvement and training.

Try Out

To get feedback, clarity of instructions and language and to know whether there was any ambiguity, the prepared tool was given to a small group of HSS students. Taking into consideration of their remarks, some items were rewritten and the preliminary draft was prepared. The preliminary draft of the tool is given in Appendix G.

Item Analysis

For the purpose of item analysis, the draft tool was administered among 370 standard XI students. The responses were scored by the investigator and arranged in ascending order. The top 27% and the bottom 27% of the students were identified as criterion groups and mean scores obtained by these two groups were calculated for analysis. For each item t value was calculated. 37 items were retained (except item 30) as the t values were greater than 1.75. The significant t test values show that average response on the high and low groups to all the 37 items differ significantly. The following table contains details of the item analysis.

Table 11

Mean, S D and t-values of the Items of Mathematics Study Habits Scale

Items	Group	N	Mean	S. D.	t-values
1	Low	100	3.5900	1.15553	7.602
	High	100	4.6200	.70754	
2	Low	100	3.2200	1.10627	10.852
	High	100	4.6500	.71598	
3	Low	100	2.8500	1.29782	8.871
	High	100	4.3100	1.01200	
4	Low	100	2.4100	1.33405	8.244
	High	100	3.8800	1.18305	
5	Low	100	2.7600	1.17310	7.760
	High	100	4.0300	1.14111	
6	Low	100	2.6900	1.16943	6.780
	High	100	3.8400	1.22862	
7	Low	100	2.4900	1.15027	10.994
	High	100	4.1600	.99209	
8	Low	100	3.6200	1.23730	7.067
	High	100	4.6500	.77035	
9	Low	100	3.2000	1.32574	7.950
	High	100	4.4500	.84537	
10	Low	100	2.8300	1.11966	9.222
	High	100	4.3800	1.25352	
11	Low	100	3.6800	1.22169	8.622
	High	100	4.8400	.56354	
12	Low	100	1.9800	1.02474	8.051
	High	100	3.2800	1.24787	
13	Low	100	3.6100	1.36252	6.807
	High	100	4.6900	.81271	
14	Low	100	2.2000	1.13707	8.008
	High	100	3.4800	1.12349	
15	Low	100	3.1800	1.22582	13.048
	High	100	4.8700	.41815	

Items	Group	N	Mean	S. D.	t-values
16	Low	100	3.0100	1.23497	11.009
	High	100	4.5800	.71322	
17	Low	100	2.4900	1.24312	10.709
	High	100	4.1400	.91032	
18	Low	100	2.9400	1.10846	13.344
	High	100	4.6400	.62797	
19	Low	100	2.9000	1.12367	9.188
	High	100	4.2500	.94682	
20	Low	100	2.6900	1.08892	7.864
	High	100	3.9000	1.08711	
21	Low	100	3.0500	1.14922	12.277
	High	100	4.6800	.66485	
22	Low	100	3.2100	1.19168	6.179
	High	100	4.2600	1.21123	
23	Low	100	2.3600	1.15049	7.423
	High	100	3.5800	1.17362	
24	Low	100	3.1400	1.06382	8.503
	High	100	4.3100	.87265	
25	Low	100	2.4500	.95743	9.555
	High	100	3.7200	.92201	
26	Low	100	2.9300	1.10330	11.111
	High	100	4.4500	.80873	
27	Low	100	2.6100	1.13614	9.801
	High	100	4.1000	1.01005	
28	Low	100	2.5900	1.37139	8.158
	High	100	4.0200	1.09157	
29	Low	100	3.3500	1.50000	5.744
	High	100	4.3800	.98247	
30	Low	100	2.9900	1.34461	.051
	High	100	3.0000	1.42134	

Items	Group	N	Mean	S. D.	t-values
31	Low	100	2.5100	1.32188	2.165
	High	100	2.9400	1.48269	
32	Low	100	2.9100	1.17288	9.160
	High	100	4.3700	1.07923	
33	Low	100	3.6000	1.23091	7.919
	High	100	4.7000	.64354	
34	Low	100	2.5700	1.24117	9.203
	High	100	4.0700	1.05653	
35	Low	100	2.1600	1.19528	6.727
	High	100	3.2600	1.11573	
36	Low	100	3.5600	1.18339	8.612
	High	100	4.7400	.69078	
37	Low	100	2.7800	1.29162	8.674
	High	100	4.1800	.96797	
38	Low	100	2.8100	1.08892	7.118
	High	100	3.8600	.99514	

Thus, the tool had 37 items; 20 positively worded (Items numbered 1, 4, 6, 8, 9, 11, 12, 14, 16, 17, 18, 19, 21, 23, 24, 25, 26, 27, 32 and 35) and 17 negatively worded (Items numbered 2, 3, 5, 7, 10, 13, 15, 20, 22, 28, 29, 30, 31, 33, 34, 36 and 37).

Reliability of the Tool

The reliability of the tool was determined by calculating Cronbach's Alpha coefficient which was found to be 0.883 and it showed that the tool had high reliability.

Validity of the Tool

The tool was examined by the experts. A positive opinion was expressed by them. Thus, the content validity of the tool was established. Total number of items were 38.

Criterion Related Validity has also been found out for the scale by using the scores obtained for the standardised tool developed by B. V. Patel: Study Habits Inventory for Secondary School Students (VI to XII i.e., 12 to 18 years), published by Agra Psychological Research Cell, Tiwari Kothi, Belanganj, Agra, as the criterion scores. By correlating the scores, the criterion validity was obtained. It was found to be 0.72.

Final Form of the Tool

After conducting item analysis and establishing the reliability and validity, the investigator finalised the tool. The final form of the tool is given in Appendix H. The same tool was used for assessment of study habits in both the phases of the study.

Questionnaire for the Assessment of Need of Bridge Programme

A questionnaire was constructed under the guidance of the supervising teacher by the investigator to identify the needs of the students and to collect the opinions of students on the diagnosis, guidance and training (bridge) programme to be prepared and validated for enhancing achievement in Mathematics. The items were selected on the basis of the discussion given in Method and Design of the Study -Need Assessment. It contained 10 Yes or No questions. The tool is given in Appendix I.

BPM for Standard XI Students

Plan 1- Favourable Attitude

The investigator focuses on Higher Secondary School students' favourable attitude towards Mathematics learning and achievement. It is important to develop feelings such as motivation, interest, confidence, hard work, constant effort to pursue and tension-free learning which are taken as the dispositions of the students to learn the subject effectively and attain good scores and grades. Unless the students have developed proper attitude towards Mathematics learning, it is very difficult for them to learn the subject and they will slowly become poor achievers in the subject. Many studies also reveal that the students can achieve high levels of success by changing their attitude that promotes learning and achievement in Mathematics.

Outcome.

☞ The students will be able to develop favourable and positive attitude towards Mathematics learning and achievement.

Procedure.

¤ Strength, weakness and problem diagnosis of positive and favourable attitude of standard XI students using student profile.

¤ Guidance on student attitude towards Mathematics learning and achievement so that performance gap be resolved. According to Branch (2010) the performance gap lies between actual performance and desired performance.

¤ Training using the following strategies called Favourable Attitude Boosters

Motivation by Motivational Capsules. Motivational capsules are critical for learning and are favourable attitude boosters. They are important strategies in the learning process and as the name suggests, are what move the pupils. The problem is that many students are not motivated to learn. It is true that an unmotivated student cannot learn. No doubt, proper motivation in the form of speech, talk, reading etc. promote better learning environments. Description of the strategy is given in Appendix J.

Goal Setting. Goals are good for motivation. Goal setting is another favourable attitude booster towards planning for the learning and achievement in Mathematics. Without a clear target, one will never hit the mark. If the students don't know what to accomplish in Mathematics learning and achievement, he/she can't create a plan to get there. Setting goals is the vehicle that will drive you to your desired destination. Understanding the importance of goals and the techniques involved in setting achievable goals paves the way for high achievement in Mathematics. Description of the strategy is given in Appendix J.

Duration. Three days (Minimum three sessions of sixty minutes each day)

Plan 2- Unfavourable Attitude

The unfavourable attitudes of Higher Secondary School students such as anxiety, stress, apprehension, panic, idleness, boredom of Mathematics learning, no doubt, will badly affect learning and achievement in Mathematics. Even the memories of learning and examinations in the subject upset and puzzle some students. It is evident that students having negative feelings towards Mathematics find it difficult to learn and achieve well. Hence it is mandatory to change the "I cannot'' belief to "I can" belief.

Outcome.

☞ The students will be able to reduce unfavourable and negative attitude towards Mathematics learning and achievement.

Procedure.

¤ Strength, weakness and problem diagnosis of negative and unfavourable attitude of standard XI students using student profile.

¤ Guidance on reducing negative attitude towards Mathematics learning and achievement

- Training using the following strategies called unfavourable attitude reducers

  Walk with Top Achievers/ Toppers Meet. It means 'meet and talk' with toppers in Mathematics learning and achievement i.e., face-to-face interactions with them. It will provide a lot of information on the points regarding the study approaches they follow and the benefits of such techniques. Description of strategy is given in Appendix J.

  Auto Suggestion. It is a form of self-induced suggestion in which students guide their own thoughts, feelings or behaviour. The technique of self-talk and auto suggestion will help the students to eliminate unfavourable attitude or negative thoughts. These are powerful and positive sentences that they constantly repeat in mind and heart till they get embedded in the subconscious mind. Students are encouraged to use positive affirmations repeatedly. This is the easiest way to reprogramme the subconscious mind. Description of strategy is given in Appendix J.

Duration. Two days (Minimum two sessions of sixty minutes each day)

Plan 3- Enhanced Concentration

One of the barriers to Mathematics learning is the lack of focused attention and concentration during studies. The ability to direct all effort and attention on one thing at a time without thinking of anything else is one's power to concentrate. Students need to study with complete concentration. Their studies are properly finished only when they are done with full concentration and determination. If the mind keeps revolving over different matters, the students can't achieve the set goals. At higher secondary stage some students are capable of concentrating easily and for long time, whereas some others find it difficult to concentrate at all. The difference between a good student and a weak student is determined by one's power of concentration. In fact, Mathematics learning demands whole-hearted concentration which some HSS students may not be easily able to give. It is important to acquire this skill of concentration through systematic and constant training.

Outcome.

☞ The students will be able to enhance their concentration.

Procedure.

- ¤ Strength, weakness and problem diagnosis in student concentration using student profile
- ¤ Guidance on attention distractions facing by the present adolescent H S S students and development of efficient concentration.
- ¤ Training using the strategies

Concentration Techniques. It is one of the most important and indispensable skills a student needs for successful Mathematics learning. Concentration is the ability to focus the attention on one single thought or subject, excluding everything else from the field of awareness. It means control of the attention. Description of strategy is given in Appendix J.

Duration. Two days (Minimum two sessions of sixty minutes each day).

Plan 4- Time Management

One of the important attributes of a good learner in Mathematics is the ability to make good use of time. It is important to schedule one's time for optimal achievement. Time management is very essential and it means setting all the subjects to be studied and learning to be done according to their importance. It is to be noted that scheduling of time does not mean dividing the time and allocating it to each subject, but setting the time according to priorities by arranging what is to be learned. Then students can adjust more time for hard subjects like Mathematics and less time for easier subjects. Also, good scores are secured on the basis of the percentage of time allocated to study. Study at the same time each day. A regular schedule can help to frame this as “study time” and consider studying a regular activity. It is important to study Mathematics every day.

Outcome.

☞ The students will be able to maintain proper and effective time schedules and to plan good time table.

Procedure.

- ¤ Strength, weakness and problem diagnosis in proper and effective time management of Mathematics learning using student profile
- ¤ Guidance to follow effective time schedules and allotting proper time for Mathematics learning.
- ¤ Training using the strategies

Managing Time-Wasters. There are many things that can waste a lot of time. Students at HSS level nowadays face various internal and external distractions which are major time-wasters. Make sure that the students are not wasting time on distractions (such as social media, for example). By minimizing distractions and removing time-wasters, students are able to accomplish more and achieve high. Description of strategy is given in Appendix J.

Time Table Preparation. As a student, making a study time table will provide an effective time management strategy. It means a prearranged plan of study and other activities. A study time table is something that helps the students to stay on track with the studies and help them in balancing the study time well. A good time table is the basis for proper study habit. It helps to manage the daily time to get the maximum out of each day. It ensures smoothness and order. Description of strategy is given in Appendix J.

Duration. Two days (Minimum two sessions of sixty minutes each day)

Plan 5- Study Aids

Another aspect that has a big influence towards Mathematics learning is organization of the study aids in Mathematics. It is helpful in maximizing the learning and achievement in Mathematics. HSS students learn efficiently when they are able to use available resources. Keeping oneself organized will save one's valuable time and energy and allow them to learn the subject systematically.

Outcome.

☞The students will be able to be organized by study aids.

Procedure.

- Strength, weakness and problem diagnosis in organizing study aids using student profile.
- Guidance on organizing study aids such as quiet and comfortable study place, text and note books, supporting materials (both digital and non-digital).
- Training using the strategies

Organisation of Study Aids. Good organization of the study aids is the key to good study and getting organized so that students can study effectively is an important strategy in learning Mathematics. For the study time to be effective it is recommended that one should find a suitable place to learn. The students should then make sure that they have easy access to the tools and various resources needed for studying. Description of strategy is given in Appendix J.

Note-making. Note- making is right at the heart of Mathematics learning and achievement. Self-written notes containing important points and ideas after realizing the lessons are very important. It is a process of reviewing, connecting and synthesizing concepts and problems from classes and self-learning. Different studies have shown that those who prepare notes are more likely to achieve in examinations than those who are not. Learning with self-prepared notes is, no doubt, very much helpful in learning the subject Mathematics. Description of strategy is given in Appendix J.

Duration. Three days (Minimum three sessions of sixty minutes each day)

Plan 6- Basic Concepts

Many studies reveal that lack of basic concepts becomes a potential cause of difficulty in learning higher concepts. It is known that poor achievement is caused due to lack of understanding of the mathematical concepts at the school level. Actually, Mathematics is the most easily learned subject if the basic concepts (previous content) are understood thoroughly. If all basic concepts of Mathematics are clear, then pupils can utilize that knowledge for higher levels too. Students are expected to be well-versed in all the basic concepts from the units Arithmetic, Algebra, Geometry, Coordinate Geometry, Trigonometry, Statistics and Probability, which ever required for the new chapter. For the present unit, i.e., Complex Numbers and Quadratic Equations (NCERT, Mathematics Textbook for Class XI, Chapter 5) the basic concepts required are linear equations in one and two variables and quadratic equations in one variable. The students need to be aware of the prerequisites and previous knowledge related to it in detail. Once the fundamental concepts get clear, it is easy to understand applications of the subject. Hence a prerequisite test was prepared and administered for the students in the experimental group. The students are expected to give the solutions in the worksheet provided which is to be used later for various analysis (score wise as well as error wise)

Outcome.

☞ The students will be able to revise previous mathematical concepts, facts, principles, equations, process, abilities and skills.

Procedure.

- Strength, weakness and problem diagnosis of the students in terms of prerequisites required using student profile. This will help to determine what are known to the learner already so that the researcher can figure out how to rectify the learning gap.
- Guidance on reflecting previous knowledge, finding the root causes of misconceptions and errors, and removing weaknesses with the help of error analysis.
- Training using the strategies

Module of Basic Concepts. It is important to know the basic concepts in Mathematics so that students can lay a strong foundation in Mathematics learning and achievement. Strengthening basic understanding of the subject dealing with acquisition of basic information upon which more complex learning relies is more important. Description of strategy is given in Appendix J.

Follow up (Remedial) Measures. The strategies used to remove problems and weakness of the students in learning Mathematics are known as remedial measures. They are designed to close the gap between what a student knows and what he/she is expected to know. In Mathematics each concept is the foundation for new learning and when a student has not mastered one concept, they are unable to move on to the next concept. Here remedial measures help to get the students back on track. When errors are identified and corrected, students make significant progress in Mathematics. Description of strategy is given in Appendix J.

Duration. Three days (Minimum three sessions of sixty minutes each day)

Plan 7 - Comprehension

Comprehension is the ability to grasp the meaning of the material (Gronlund, 1985). Also, it includes factual knowledge, conceptual understanding, procedural knowledge and meta cognition in Mathematics. The students should be motivated to learn Mathematics in a meaningful way. Emphasis should be given on teaching and learning for meaning and understanding in Mathematics. They have positive effects on student learning and achievement. It is very important to understand and study the meanings of symbols, equations, definitions, statements, etc. to be memorized in Mathematics. Some students follow rote learning with little attention paid to understanding of mathematical concepts. This way of study i.e., cramming without proper understanding, at any cost, is to be avoided. The content learnt without comprehending it is generally forgotten. The Education Commission (1964-66) pointed out that in the teaching of Mathematics emphasis should be more on the understanding of basic principles than on the mechanical teaching of Mathematical computations. The NEP, 2020 also demands the emphasis on conceptual understanding rather than rote learning and learning-for- exams (NEP, 2020, p.5). Briefly the importance of concept formation (comprehension) in Mathematics is highly solicited because good achievement can only be attained if the ideas on the subject are well understood.

Outcome.

☞ The students will be able to understand the concepts in Mathematics with meaning than rote learning.

Procedure.

- Strength, weakness and problem diagnosis in comprehension or meaningful learning using student profile.
- Guidance on meaningful learning (conceptual understanding).
- Training using the strategies

Discussion on Specifications of Maths Content and Communication of Learning Objectives. Pupils learn effectively when they acquire key information i.e., specifications of the content and objectives which are interconnected and synthesized and are able to study well. Importance of the content analysis and instructional goals in Mathematics learning is discussed among the students with utmost care. Description of strategy is given in Appendix J.

Learning Maps. Learning map is a graphical tool that can be used to organize and highlight the concepts and examples that the students should get from the unit. It is a study map that incorporates all the important concepts of each part to be learned i.e., an outline in which the study areas are categorized and then prioritized and correlated. It helps the students stay on the unit and make it easier for them to learn and highlights the most important information students need to learn. Actually, it provides students with guideposts for following the sequence of instruction. Description of strategy is given in Appendix J.

Maths Concept Quiz. Concept quiz is a small test administered to know the students' knowledge or it is a short duration test used to know the students' knowledge and understanding in Mathematics topic studied. On completing a topic in a unit, the concepts are mastered by making use a set of questions related with theory and worked out examples in the topic concerned. It is very useful to the children retain information. Learning the topics and then taking a quiz is much more effective, by forcing the brain to retrieve facts that it becomes embedded for use in the future. As quizzes help to embed information, this provides a firm foundation for the next stage of learning. Further, quizzes are beneficial in identifying the gaps in learning and highlight any areas that need more revision. Description of strategy is given in Appendix J.

Duration. Four days (Minimum four sessions of sixty minutes each day)

Plan 8- Problem Solving

Problem solving is the cornerstone of school Mathematics. It is strongly believed that the most efficient way for learning Mathematics concepts is through problem solving. The ability of handling the problem and getting the solution is termed as problem solving ability. It means the students ability to connect all their mathematical knowledge of concepts and procedures to solve the problems in the unit learned. Many research studies revealed that problem solving ability had significant effect on the academic achievement in the various subjects especially Mathematics. It is the best predictor of learning and achievement in Mathematics. Problems in the topic should be meaningful and to the need of the students. Solving these problems makes the students self-confident and more efficient in Mathematics learning and achievement.

Outcome.

☞The students will be able to develop problem solving ability systematically.

Procedure.

- Strength, weakness and problem diagnosis in problem solving of standard XI students using student profile.

- Guidance on cultivating a culture of problem solving and solving text book exercise questions systematically.
- Training using the strategies

Polya's Problem Solving Model. It provides a simple clear strategy for tackling problem-solving situations. Polya (1945) created his famous four-step process for problem solving which is used all over to aid people in problem solving. He thought that any problem was solved easier with an action plan. It was found that the Polya's problem solving process can contribute significantly to the learning and achievement in Mathematics. Description of strategy is given in Appendix J.

Unit Problem Test. This test is designed as summative assessment. The prime motive is to assess what students have learned after the completion of the unit. Further, it is conducted to prepare the students for an upcoming standardized test in the unit learned and to evaluate the teaching- learning process. This is a process of measuring students' performance in problem solving and providing necessary corrections. Students are encouraged to participate actively in the comprehensive problem assessment in the unit. Description of strategy is given in Appendix J.

Duration. Four days (Minimum four sessions of sixty minutes each day)

Plan 9- Mathematics Study Method

Learning and achievement in Mathematics is dependent on one's ability to study efficiently. Many students fall behind in the subject because they do not study the subject in the proper way. We are going to discuss how to learn effectively and score high marks in order to achieve our academic goals. It is true that anybody can score high marks by practising the scientific learning methods. It is important to study the topics personally which are dealt on that day in the class. Mathematics learning should be made as studying an active process by incorporating reading, writing, taking notes, making reviews and memorizing.

Outcome.

☞ The students will be able to develop a proper method of Mathematics learning.

Procedure.

- Strength, weakness and problem diagnosis in the method of learning the subject Mathematics using student profile.
- Guidance on developing an individual method of learning Mathematics content.
- Training using the strategy

PQPRR Method of Study. This strategy that the investigator has found to work best focusses on how to study a Mathematics topic. It is, in fact, that everyone studies differently and there is no one right way to study for Maths topics. It is investigator's intent with this tip of study to help the students do the best and hopefully this study habit will help them to study efficiently and not waste time. In order to learn Mathematics students must be actively involved in the learning process. So, this method can be broken down into five stages- Preview, Question, Practice, Retrieve/ Rehearse, Review. Description of strategy is given in Appendix J.

Duration. Two days (Minimum two sessions of sixty minutes each day)

Plan 10- Student Efforts

The subject Mathematics needs practice, extra time for practice. Now a days HSS students have no time to learn at home. Most of the time, they are engaged in non-academic tasks. They want to achieve higher grades without doing hard work and practices in the subject. Students should be convinced that the chances of success in Mathematics learning are higher if studied systematically. Without investing proper efforts, it is difficult to achieve the desired goals. They should know how to put various efforts in Mathematics learning personally at home. They should also decide the areas where more attention and efforts are required. Pupils need to follow such type of practices regularly. In short, quality time and effort should be given in their academic activities at home.

Outcome.

☞The students will be able to develop the habit of self-learning

Procedure.

- Strength, weakness and problem diagnosis in student efforts such as drilling, help-seeking, revision etc. using student profile.
- Guidance on the importance of the habits like daily study, time-bound repetition and revision
- Training using the strategies

Self-study. Self-study is an essential and crucial part of a students' learning. Self-study is a learning method where students direct their own study- outside the classroom and without direct supervision. It is the manifestation of student's constant and steady effort. The students are directed to learn by self that is widely lacking among HSS students now a days. Being self- taught helps the students in many ways; self-study helps in better comprehension of the subject matter; students are better focused and they are well revised with the subject. All these factors contribute to score better marks in the subject. Description of strategy is given in Appendix J.

Memorization and Retention. Memorization and retention play an essential role in the learning of Mathematics. It is the ability to recover what students have learned when they need it. They can be trained and develop their memorizing abilities. The emphasis should be on remembering what one has learned each time. Surely, memorization and retention will raise the standard of Mathematics learning and achievement. Description of strategy is given in Appendix J.

Duration. Two days (Minimum two sessions of sixty minutes each day)

Plan 11-Test Management

This final plan is an attempt in helping the standard XI students to score better marks in the coming examinations than that in the previous ones. It is a fact that tests are part of learning. The tests are conducted to find out what a person has learned from the lessons taught and what they can write from that topic. A student who has prepared very well in advance will be able to cope with examinations as well. Actually, exams are meant to bring out the best in one.

The attitude towards the exam as well as the knowledge in the subject determine the success or failure in the exam. It is found that even the best students in HSS section by default do not perform well in Mathematics exam. Some students are unable to recollect the things studied, particularly in the examination hall. This is because they do not know some of the important things to look out for and some tricks to use when facing exams. With the understanding of these basic facts and techniques, the attitude of the students towards the exam itself changes and they are able to achieve higher scores and grades.

Outcome.

☞The students will be able to develop test management skills.

Procedure.

¤ Strength, weakness and problem diagnosis in test management by standard XI students using student profile.

- Guidance on preforming excellently in unit, term, model and board examinations.
- Training using the strategies

Test Preparation. It is important to attend this strategy in order to maximize the test score. Students are directed to set up a study plan, stick to it and practice for Mathematics test paper. Begin the preparation several days before the test. All the topics in Mathematics need to be studied repeatedly from the beginning to the end before the examination. Those students who have studied well and earlier can complete this final revision quickly and effectively at this stage. No doubt, today's preparation determines tomorrow's achievement. Description of strategy is given in Appendix J.

Test Paper Presentation. Along with writing the right and appropriate answers, the presentation also matters a lot in any board exam. Actually, scoring marks is all about the presentations. Those tips in this strategy will help to organize the paper in the best way that may add some spark to the answers and impress the examiner. Pupils' answers should be so visually appealing to the examiner so that he/she need not put any extra effort to go through the answer script. Students should remember to follow certain guidelines while writing their exam to avoid any loss of marks due to inappropriate presentation of answers. No doubt, there is a positive relation between test paper presentation and achievement in Mathematics. All that is needed for good achievement is hundred percent focus and zero percent tension. Description of strategy is given in Appendix J.

Duration. Three days (Minimum three sessions of sixty minutes each day)

Achievement Test in Mathematics

Any test that measures the attainments or accomplishments of an individual after a period of training or learning is called an achievement test (Downie, 1961). For the present study, achievement test is designed with a definite purpose. The purpose of the test is to check the effect of the prepared Bridge Programme in terms of achievement of students in Mathematics. The effect of the Bridge Programme was checked by means of achievement test as pre-test (to examine the achievement level of the students before the treatment), post-test (to examine the achievement level of the students after the treatment) and delayed post-test (to examine the retention ability of the students). Since no specific test in the topic selected was available, this test was constructed and standardized by the investigator under the guidance of the supervising teacher. The procedures followed and the techniques used in the standardization of the achievement test in Mathematics for standard XI are discussed below.

Planning of the Test

It is the first and important step in the preparation of an achievement test. This test is intended to assess the achievement in Mathematics of standard XI students. It was constructed based on Revised Bloom's Taxonomy (RBT) of learning objectives of the cognitive domain (Anderson & Krathwohl, 2001). The objectives considered were Remember, Understand, Apply, Analyse, Evaluate and Create. Further details are provided in table 12.

Table 12

Structure of the Cognitive Process Dimension of RBT

Category/ processes	Alternative terms
1. Remember	**Retrieve relevant knowledge from long-term memory**
1.1. *Recognising*	identifying- (e.g. Recognize the dates of important events in Indian history)
1.2. *Recalling*	retrieving - (e.g. Recall the major exports of India)
2. Understand	**Construct meaning from instructional messages, including oral, written and graphic information**
2.1. *Interpreting*	clarifying, paraphrasing, representing, translating (e.g. Write an equation [using B for the number of boys and G for the number of girls] that corresponds to the statement 'There are twice as many boys as girls in this class')
2.2. *Exemplifying*	illustrating, instantiating (e.g. Locate an inorganic compound and tell why it is inorganic)
2.3. *Classifying*	categorizing, subsuming (e.g. Classify the given transactions to be recorded in Purchase returns book and Sales returns book)
2.4. Summarising	abstracting, generalizing (e.g. Students are asked to read an untitled passage and then write an appropriate title.)

2.5. *Inferring*	concluding, extrapolating, interpolating, predicting (e.g. a student may be given three physics problems, two involving one principle and another involving a different principle and ask to state the underlying principle or concept the student is using to arrive at the correct answer.)
2.6. *Comparing*	contrasting, mapping, matching (e.g. Compare historical events to contemporary situations)
2.7. *Explaining*	constructing models (e.g. the students who have studied Ohm's law are asked to explain what happens to the rate of the current when a second battery is added to a circuit.)
3. Apply	**Carry out or use a procedure in a given situation**
3.1. *Executing*	Carrying out (e.g. Prepare Trading and Profit and loss Account from the Trial Balance given and find out the net profit.)
3.2. *Implementing*	using (e.g. Select the appropriate given situation where Newton's Second Law can be used)
4. Analyse	**Break material into its constituent parts and determines how the parts relate to one another and to an overall structure or purpose**
4.1. *Differentiating*	discriminating, distinguishing, focusing, selecting (e.g. distinguish between relevant and irrelevant numbers in a mathematical word problem)
4.2. *Organising*	finding coherence, integrating, outlining, parsing, structuring (e.g. the students are asked to write graphic hierarchies best corresponds to the organisation of a presented passage.)
4.3. *Attributing*	deconstructing (e.g. determine the point of view of the author of an essay in terms of his or her ethical perspective)
5. Evaluate	**Make judgements based on criteria and standards**
5.1. *Checking*	coordinating, detecting, monitoring, testing (e.g. after reading a report of a chemistry experiment, determine whether or not the conclusion follows from the results of the experiment.)
5.2. *Critiquing*	judging (e.g. Judge which of the two methods is the best way to solve a given problem)
6. Create	**Put elements together to form a coherent or functional whole; reorganize elements into a new pattern or structure**
6.1. *Generating*	hypothesizing (e.g. suggest as many ways as you can to assure that everyone has adequate medical insurance)
6.2. *Planning*	designing (e.g. design social intervention programmes for overcoming excessive consumerism)
6.3. *Producing*	constructing (e.g. the students are asked to write a short story based on some specifications)

(Source: Class – XI Mathematics Teacher Text, 2014, pp.44- 46)

The investigator should be familiarised with the current syllabus (teacher text) and text book of plus one Mathematics. The test covers the content area of the syllabus prescribed by SCERT for the unit Complex Numbers and Quadratic Equations of standard XI of HSE, Kerala State. The syllabus and learning outcomes related to the said unit were analysed carefully. Text book, reference materials, question banks, question papers, source book, Edumate, hand books and other standardised tests of Mathematics were utilised as source materials for framing test items. Due weightage to the objectives and content area of the proposed test was chosen in accordance with the guidelines given by the department. It was decided to include objective type items only so as to avoid subjectivity. The investigator decided to construct multiple choice items with four options so that the participants could answer and the investigator could score easily. The design and blue-print of the test are given below. The weightage assigned for various objectives has been presented in table 13.

Table 13

Weightage to Objectives

Sl. No	Objectives	No. of Items	Scores	Percentage
1	Remember	4	4	10.00%
2	Understand	12	12	30.00%
3	Apply	8	8	20.00%
4	Analyse	6	6	15.00%
5	Evaluate	6	6	15.00%
6	Create	4	4	10.00%
	Total	40	40	100.00%

The objectives selected can be verified only through some content. The weightage assigned to content has been presented in table 14.

Table 14

Weightage to Content (Unit: Complex Numbers and Quadratic Equations)

Sl. No.	Content	Number of Items	Score	Percentage
1	Complex Numbers	4	4	10.00%
2	Algebra of Complex Numbers	16	16	40.00%
3	The Modulus and Conjugate of a Complex Number	4	4	10.00%
4	Argand Plane and Polar Representation of Complex Numbers	10	10	25.00%
5	Quadratic Equations	6	6	15.00%
	Total	40	40	100.00%

It was decided that the test as a whole may be of average difficulty. The weightage assigned for the difficulty level are given in table 15.

Table 15

Weightage to Difficulty Level

Sl. No	Difficulty Level	Score	Percentage
1	Easy	8	20.00%
2	Average	24	60.00%
3	Difficult	8	20.00%
	Total	40	100.00%

The investigator opted objective type items only and hence blue print is a two-dimensional chart indicating the content area and the number of questions under each objective. The blue-print of the achievement test is given in table 16.

Table 16

Blue Print of the Achievement Test in Mathematics

Sl. No.	Content	Learning Objectives						Total
		Remember	Understand	Apply	Analyse	Evaluate	Create	
1	Complex Numbers	1	3	-	-	-	-	4
2	Algebra of Complex Numbers	1	5	3	4	3	-	16
3	The Modulus and Conjugate of a Complex Number	1	-	1	1	1	-	4
4	Argand Plane and Polar Representation of Complex Numbers	1	2	2	1	1	3	10
5	Quadratic Equations	-	2	2	-	1	1	6
	Total	4	12	8	6	6	4	40

Preparation of the Test

The initial draft of the test contained 40 multiple choice questions. Items were written down and assembled in a logical sequence. Thus, the draft version containing 40 items was pooled. The scoring key also was prepared. While preparing the test items, suggestions given by the supervising teacher, HSS teachers in Mathematics and subject experts were taken into consideration. In addition, the question paper and answer key were given to scrutiny to expert and experienced teachers in Mathematics in view of item difficulty, language accuracy and clarity. They evaluated all the items. The draft test was set up in a Google form with necessary instructions. Each test item has four alternatives A, B, C and D. The students had to click on the correct option. The draft form, response sheet and scoring key are given in Appendix K.

Pilot Study and Try Out of the Test

The initial draft was administered among a small group of students studying in standard XI from two different schools for the pilot testing. On the basis of student's reaction necessary changes were made in the items to set preliminary form of the test. This test was conducted on a sample of 100 standard XI students, selected randomly. The response sheets were collected and scored (a correct answer was given 1 score and a wrong answer 0). After getting total scores of the test, item analysis was done to obtain best items of the test.

Item Analysis

Item analysis involves estimating of the Difficulty Index (D I) and Discrimination Power (D P) of each test item. It helped the investigator to detect the strength and weakness of the test items. The investigator intended to set a test of 30 items for final test. The draft of 40 items has been tried out on a representative sample of 100 students. Their answer sheets were arranged in the descending order of the total scores obtained. The scores obtained by the top 27 and bottom 27 were taken as the upper group and lower group respectively. In order to select items for the final test, the difficulty index and discrimination power of the test items have been estimated.

The following formulae were used for calculating D I and D P:

D I= U+L/2N and D P= U-L/N;

Where U is the number of correct responses in the upper group, L is the number of correct responses in the lower group and N is the number of students in each group. The details of item analysis are given in the table 17.

Table 17

Data and Results of Item Analysis

Qn. No.	U	L	D I	D P	Status	Qn. No.	U	L	D I	D P	Status
1	26	13	0.72	0.48		21	25	16	0.75	0.33	
2	27	9	0.67	0.66	Selected	22	19	5	0.44	0.51	Selected
3	27	15	0.78	0.44		23	15	7	0.40	0.29	
4	26	3	0.53	0.85	Selected	24	23	8	0.57	0.55	Selected
5	21	7	0.51	0.51	Selected	25	26	4	0.55	0.81	Selected
6	26	11	0.68	0.55		26	26	7	0.61	0.70	Selected
7	26	9	0.64	0.62	Selected	27	24	3	0.5	0.77	Selected
8	25	4	0.53	0.77	Selected	28	24	4	0.51	0.74	Selected
9	26	10	0.66	0.59		29	27	6	0.61	0.78	Selected
10	26	11	0.68	0.55		30	26	5	0.57	0.78	Selected
11	24	3	0.5	0.77	Selected	31	11	8	0.35	0.11	
12	24	7	0.57	0.62	Selected	32	24	2	0.48	0.81	Selected
13	22	6	0.51	0.59	Selected	33	26	7	0.61	0.70	Selected
14	26	6	0.59	0.74	Selected	34	25	5	0.56	0.74	Selected
15	24	5	0.53	0.70	Selected	35	22	7	0.53	0.55	Selected
16	23	6	0.53	0.62	Selected	36	25	8	0.61	0.62	Selected
17	24	9	0.61	0.55	Selected	37	23	6	0.53	0.62	Selected
18	26	10	0.67	0.59		38	27	4	0.57	0.85	Selected
19	11	3	0.25	0.29		39	20	4	0.44	0.59	Selected
20	19	7	0.48	0.44	Selected	40	20	9	0.53	0.40	Selected

Note: U = The number of correct responses in the upper group

L = The number of correct responses in the lower group

D I = Difficulty Index

D P = Discriminating Power

Final Form of the Test

From the total of 40 items of the draft test, 30 items were selected for the final test having D I between 0.3 and 0.7 i.e., 0.3 < D I < 0.7 and D P more than 0.4 i.e., P > 0.4. Thirty questions were accordingly chosen for the final test.

The test being an objective type, the scoring scheme of the test is '1' score for each correct answer and '0' score for each incorrect answer. The achievement score of the test is the sum total on all the items of the test. The score range extended from 0 to 30. The final version, response sheet and scoring key are given in Appendix L.

Reliability of the Test

It is defined as the degree of consistency with which the test measures what it does measure. The reliability of the test was estimated by applying the Cronbach's Alpha test. A reliability coefficient of 0.70 or higher is considered good and acceptable in most social science research situations. The reliability index for the present test was determined as 0.79 and it showed that the items were consistent and reliable. The same test was used for pre-testing, post-testing and delayed post-testing.

Validity of the Test

It is defined as the accuracy with which the test measures what it supposed to measure. The face validity and content validity of the test were ensured in the present achievement test. For that expert judgement was taken into consideration. Six Mathematics teachers confirmed the face validity of the test through careful observation of the test. In addition, they agreed the content validity of the test through careful analysis of objectives and content. The investigator explained the main purpose of the achievement test, content involved in the test, objectives to be tested and asked the experts to evaluate various items in the test for the validity against weightage to objectives, content, difficulty level and type of questions. They agreed that the items in the test provided adequate coverage about the content. They also solved the questions so that the scoring key could be verified. The experts agreed with the investigator in the scoring key. In this way content validity of the test was ensured.

Criterion Related Validity has also been found out for the test by using the scores of term I Mathematics test as the criterion scores. By correlating the obtained test scores with the above scores, criterion validity was obtained. It was found to be 0.88. The finalised form of the test is given in Appendix L.

Prerequisite Test in Basic Mathematics

This test is intended to assess the prerequisite knowledge in Mathematics of standard XI students. The test covered the content area of the Basic Mathematics required for the chapter Complex Numbers and Quadratic Equations of standard XI of HSE, Kerala. The design and blue print of the test were determined in accordance with that of the achievement test discussed above. They are provided in Appendix M.

The draft contained 40 questions from Arithmetic, Algebra, Geometry, Co-ordinate Geometry and Trigonometry. The pool of questions, response sheet and scoring key are given in Appendix N.

As in the case of the achievement test in Mathematics given above, pilot study, try out and item analysis were done. The details are given in Appendix O.

Finally, the test contained 30 questions. The final form is given in Appendix P.

The Criterion Related Validity of the test was established by correlating the marks of the students in the standardized test developed by Pradeep M. Patel, Centre of Advanced Study in Education, Faculty of Education and Psychology, The M.S. University of Baroda, Vadodara in 2007: Prerequisite Test and Achievement Test for Quadratic Equations. It was found to be 0.72. Also, the reliability coefficient for the test was determined by Cronbach's Alpha test as 0.78 and it showed that the items were consistent and reliable.

Questionnaire for Seeking Students' Feedback on Bridge Programme

A questionnaire was prepared by the investigator under the guidance of the supervising teacher to know the feedback of the experimental group students regarding the Bridge Programme i.e., to know what they thought about and felt about the BPM. Further, it would help the investigator to test the efficacy of the Bridge Programme. It contained 14 items.

It included aspects like purpose, content, objectives, procedure, strategies, materials and difficulty level and the statements were based on these aspects of the BPM. The students were supposed to respond to the items in terms of two options - Yes or No by giving tick mark in one appropriate box which reflected their evaluation about the programme. The tool is given in Appendix Q.

Data Collection

After finalising the tools, the next step was to collect data from the selected sample. The investigator first of all obtained permission from Principals of the selected Higher Secondary Schools for conducting the survey (phase I) and administering the Bridge Programme (phase II).

For the survey phase I, the tools 1,2 and 3 were administered among the selected 660 students and the data were collected from the sample. The tools for the survey were employed using Google forms (online mode) due to COVID- 19 pandemic situation during the period July 21 to 25, 2020. Needed instructions were also given to the students by the investigator before administering the tools. Enough time was allotted to complete the responses. They were asked to respond genuinely to all the items given in the tools. The students were ensured about the confidentiality of the information collected from them. The responses of the students were scored and the data were collected.

In phase II, copy of the Bridge Programme in Mathematics and schedule was given in advance to Principals of the selected schools. As per the schedule planned earlier, pre-testing, implementation of the programme, post-testing, delayed post-testing and feedback seeking were conducted through online and offline as far as possible. While administering the tools, proper instructions were given by the investigator. Only after being sure that students had followed the instructions properly, the tools were distributed. The investigator kept proper attention over the class during the administration of the tools. Besides that, the students of the experimental group were allowed to contact the investigator and the partner through phone, WhatsApp, e- mail and Google meet in the event of requiring any clarification regarding the BPM.

After collecting the response sheets from the students, the investigator scored them according to the scoring procedures and tabulated in excel format. The tabulated data were analysed using the Statistics Product and Service Solution SPSS/ SAS 9.4 as per the objectives of the study and were interpreted accordingly.

Statistical Techniques Employed

The statistical techniques help the researcher to analyse the data qualitatively as well as quantitatively and interpret meaningfully on the basis of the analysed data. For the present study, the statistical techniques (both descriptive and inferential) to be applied in analysing the data collected through the research tools are described as follows.

Descriptive Statistics

- They are statistical procedures used to summarize, organize, and simplify data. The descriptive statistics such as mean (measure of central tendency), variance and standard deviation (measures of dispersion) were calculated to describe the distribution of scores.

- To assess the levels of attitude, beliefs in mathematical abilities and study habits in Mathematics, percentage analysis was used and also, pie charts were used to represent them diagrammatically.
- To identify the needs, percentage analysis was employed. Here the item wise analysis of the students' responses was done with the help of frequency and percentage.
- Qualitative analysis of participants' feedback was done to study the impact of the BPM on the participants and to judge the effectiveness of the programme with respect to feedbacks of the students. The analysis of the students' reactions with respect to each and every statement was done with the help of frequency and percentage.

Inferential Statistics

- To test different hypotheses, the inferential statistics such as t tests were employed i.e., validation of the Bridge Programme in Mathematics ascertaining the effect of the BPM had been done by calculating t value between pre-test, post-test and delayed post-test mean scores. The t tests were applied to determine the significant difference between the means of experimental and control groups. Thus, the independent sample t test and paired sample t test techniques were used to test the hypotheses by finding out significant difference in experimental and control group means.
- Since the groups to be compared were non-equivalent and intact, the statistical technique ANCOVA (Analysis of Co-variance) was used to check the genuineness of the results. Analysis of covariance represents an

extension of the analysis of variance (ANOVA) that tests the significance of the difference between means of final experimental data by taking into account the correlation between the dependent variable and one or more co variants or pertinent controlled variable, by adjusting initial mean differences in the group i.e., it is used to test whether there is significant difference between the group means in view of the inherent variability within the separate groups. It is not easy to control practically the extraneous or confounding variables physically, but its influence can be controlled statistically by using ANCOVA.

- The importance of research finding was assessed by calculating the effect size using the statistics Cohen's d or Partial Eta Squared value. It is knowledgeable to find the effect size along with the significance. In present study the effect size was found to study how much is the effect of the Bridge Programme on achievement in Mathematics.
- Further, the mean gain scores were compared by t-test to study the effectiveness of the Bridge Programme in terms of gain scores of achievements i.e., gain score = post test score – pre test score for each individual student. Differences credited to the implementation of the BPM are then determined by comparing the mean gain scores of the experimental and control groups.

The numerical results found were discussed and interpreted to arrive at conclusions in the succeeding chapters.

CHAPTER 4

DATA ANALYSIS AND INTERPRETATIONS

- *Analysis of Survey Based Data*
- *Analysis of Experiment Based Data*
- *Analysis of Students' Feedback Based Data*

The study started by exploring the level of plus one students' attitude towards Mathematics learning, beliefs in mathematical abilities and study habits in Mathematics and identifying the need for a Programme which can enhance their achievement in Mathematics. The data collection for this phase of study was conducted from 660 students studying in standard XI, using tools given in the Appendices F, H and I to know their attitude, beliefs, study habits and opinion regarding a Programme which can be used along with their classroom learning. After that the Bridge Programme in Mathematics was prepared and then 231 students were randomized into experimental and control groups as explained in the methodology. Out of these 231 students, 118 were included in the experimental group and the rest 113 were in the control group. Then a test to assess baseline understanding of Mathematics was done prior to the intervention in both groups which was named as achievement test in Mathematics and then after 30 days of intervention, to see the post intervention effect and then again after 3 weeks after post intervention test to see the delayed effect of the Programme using an achievement test given in appendix L. Along with this, a test to assess the change in basic Mathematics score, attitude, beliefs and study habits of students in the experiment group was done using a Mathematics question paper given in appendix P; two questionnaires having three sections as given in appendix F and H, respectively. The effect of the interventions between the groups was examined using independent samples t test in SAS 9.4. In addition, the effect of the Programme was cross checked using paired sample t test in SAS 9.4. After this effect assessment, feedback about the Programme was also taken from the students in the experiment group as well using a questionnaire in Appendix Q.

This chapter deals with analysis of the data collected, drawing relevant results and interpretations leading to necessary conclusions rationally.

Analysis of Survey Based Data

In the first phase of the study, data were collected through survey. This included data of attitude, beliefs, study habits and students' opinions. These data were analyzed initially on the basis of the objective 1 of the study (to explore the level of standard XI students' attitude towards Mathematics learning and achievement, beliefs in mathematical abilities and study habits in Mathematics) and objective 2 of the study (To identify standard XI students' needs and requirements with respect to Mathematics learning and achievement) and are presented in the following sections.

Level of Standard XI Students' Attitude towards Mathematics

The descriptive statistics mean and standard deviation of overall sample, gender, locality and type of school related with attitude of students towards Mathematics learning are presented in table 18.

Table 18

Mean and Standard Deviation of Attitude for Overall Sample, Gender, Locality and Type of School

Sample		Attitude	
		Mean	Standard Deviation
Total Sample		58.6091	11.0967
Gender	Male	57.8939	11.32811
	Female	59.3242	10.83032
Locality	Urban	57.551	10.81693
	Rural	59.459	11.2592
Type of school	Govt.	58.8182	11.38948
	Aided	59.4578	10.82578
	Unaided	55.5741	10.8956

From the table 18, it follows that the respondents held only a moderate level of attitude towards Mathematics learning.

The percentage distribution of the students' attitude towards Mathematics score is depicted in table 19 and figure 13.

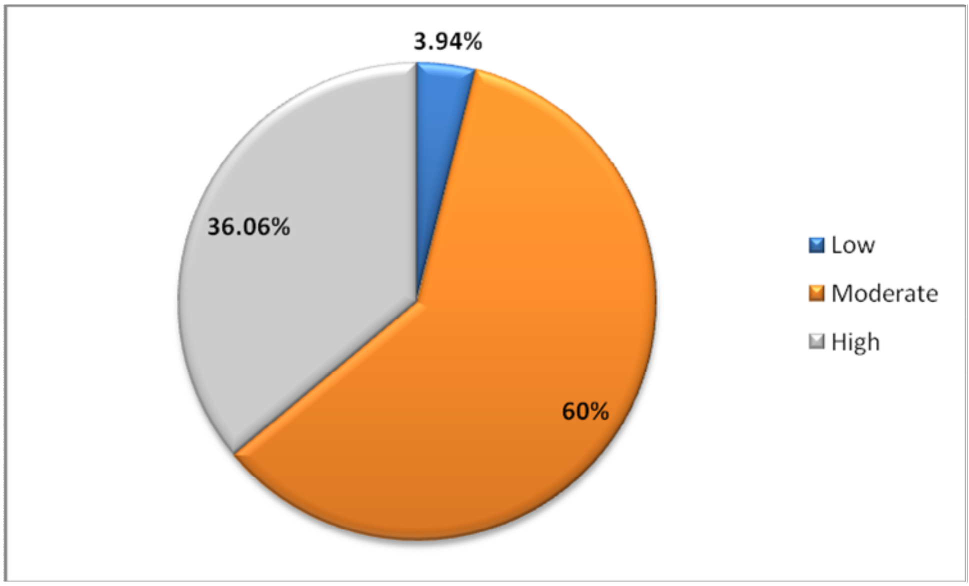
Table 19

Percentage Scores of Students' Attitude towards Mathematics in Low, Moderate and High Categories

Sl. No.	Category	Range of Scores	No. of Students (N)	Percentage (%)
1	Low	Below 40	26	3.94
2	Moderate	40-62	396	60
3	High	Above 62	238	36.06
Total			660	100

Figure 13

Diagrammatic Representation of Percentage Score of Attitude towards Mathematics



The table 19 and figure 13 reveal that there are variations in the attitude of students towards Mathematics learning. 36.06% of the students had high level of attitude and 60% were placed under the moderate level; 3.94% of students had low level of attitude towards Mathematics. It follows that majority of the students had low and moderate levels of attitude towards Mathematics.

Level of Standard XI Students' Beliefs in Mathematical Abilities

The descriptive statistics mean and standard deviation of overall sample, gender, locality and type of school related with students' beliefs in mathematical abilities are presented in table 20.

Table 20

Mean and Standard Deviation of Beliefs for Overall Sample, Gender, Locality and Type of School

Sample		Beliefs	
		Mean	Standard Deviation
Total Sample		46.8576	6.81654
Gender	Male	46.0242	7.01925
	Female	47.6909	6.5122
Locality	Urban	46.068	6.8046
	Rural	47.4918	6.76888
Type of School	Govt.	46.8682	7.08886
	Aided	47.2711	6.48205
	Unaided	45.5648	7.15029

From the above 20, it follows that the respondents exhibit a moderate level of beliefs in mathematical abilities.

The percentage distribution of students' beliefs score is depicted in table 21 and figure 14.

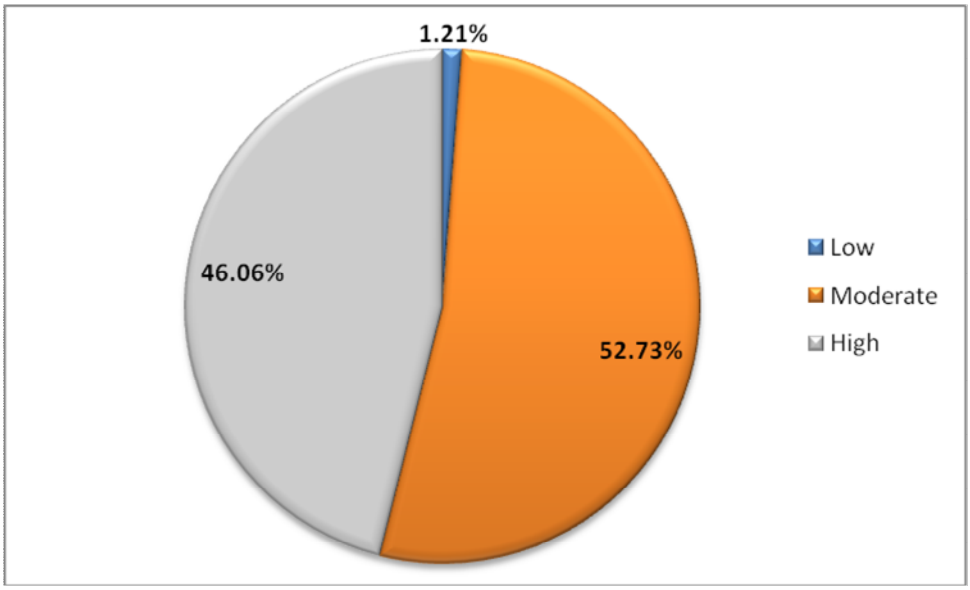
Table 21

Percentage Scores of Students' Beliefs in Mathematical Abilities in Low, Moderate and High Categories

Sl. No	Category	Range of Scores	No. of Students(N)	Percentage (%)
1	Low	Below 31	8	1.21
2	Moderate	31- 47	348	52.73
3	High	Above 47	304	46.06
	Total		660	100

Figure 14

Diagrammatic Representation of Percentage Score of Beliefs in Mathematical Abilities



The table 21 and figure 14 reveal that there are variations in the students' beliefs in mathematical abilities. 46.06% of the students had high level of beliefs and 52.73% were placed under the moderate level; only 1.21% of students had low level of beliefs in mathematical abilities. It follows that majority of the students had low and moderate levels of beliefs in mathematical abilities.

Level of Standard XI Students' Study Habits in Mathematics

The descriptive statistics mean and standard deviation of overall sample, gender, locality and type of school related with study habits in Mathematics are presented in table 22.

Table 22

Mean and Standard Deviation of Study Habits in Mathematics for Overall Sample, Gender, Locality and Type of School

Sample		Study Habits	
		Mean	Standard Deviation
Total Sample		129.8788	19.51640
Gender	Male	126.1212	19.90915
	Female	133.6364	18.39125
Locality	Urban	127.8741	20.31966
	Rural	131.4891	18.71923
Type	Govt.	131.4955	20.84789
	Aided	130.6536	18.49089
	Unaided	124.2037	18.94298

From the table 22, it follows that the respondents had only a moderate level of study habits in Mathematics.

The percentage distribution of students' study habits score is depicted in table 23 and figure 15.

Table 23

Percentage Scores of Students' Study Habits in Mathematics in Poor, Moderate and Good Categories

Sl. No	Category	Range of Scores	No. of Students(N)	Percentage (%)
1	Poor	Below 87	6	0.91
2	Moderate	87-135	413	62.58
3	Good	Above 135	241	36.51
Total			660	100

Figure 15

Diagrammatic Representation of Percentage Score of Study Habits in Mathematics

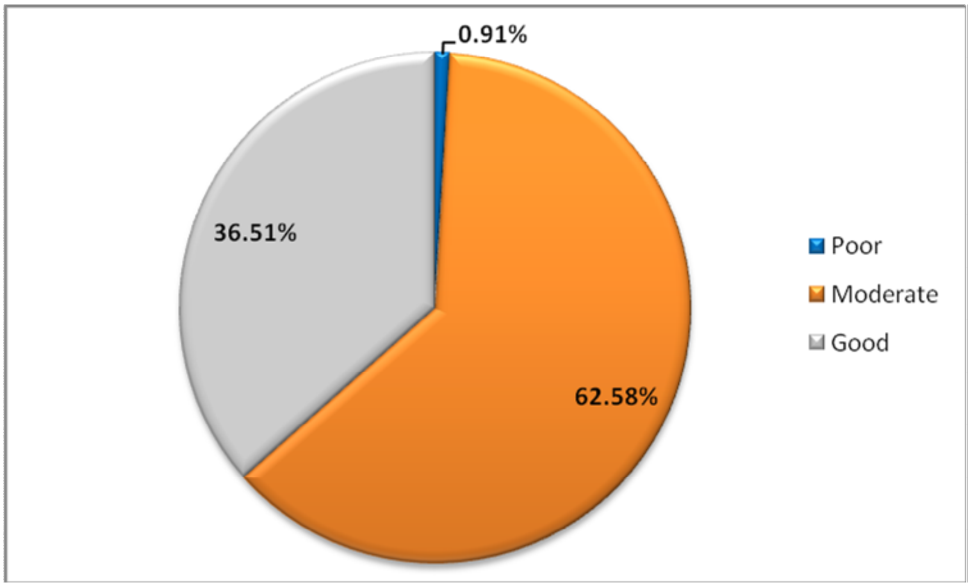


Table 23 and figure 15 reveal that there are variations in the students' study habits in Mathematics. 36.51% of the students had good level of study habits and 62.58% were placed under the moderate level; only 0.91% of students had poor level of study habits in Mathematics. It follows that majority of the students had poor and moderate levels of study habits in Mathematics.

Thus, low/poor and moderate levels of students' attitude, beliefs and study habits in Mathematics indicate that there is space for students' guidance and training programmes like BPM.

Standard XI Students' Need for a Programme

There were 660 students included in the study to check the need and requirements of students related to any additional assistance, training or a Programme in Mathematics.

Table 24

Opinion of Students Regarding a Programme in Mathematics

Sl. No.	Items	Category	n	%
1	Need for special programmes	No	181	27.42
		Yes	479	72.58
2	Earlier participation in such programmes	No	383	58.03
		Yes	277	41.97
3	Impact of diagnosis, guidance and training programmes	No	91	13.79
		Yes	569	86.21
4	Development of positive attitude	No	78	11.82
		Yes	582	88.18
5	Correcting shortcomings in attitude	No	76	11.52
		Yes	584	88.48
6	Practice in basic concepts	No	60	9.09
		Yes	600	90.91
7	Developing concept formation and problem solving	No	95	14.39
		Yes	565	85.61
8	Training in study habits in Mathematics	No	61	9.24
		Yes	599	90.76
9	Preparation for Mathematics examinations	No	44	6.67
		Yes	616	93.33
10	Preference of additional programmes	No	151	22.88
		Yes	509	77.12

While surveying the need of students with respect to their Mathematics learning and achievement, many respondents said that they needed special programmes, whereas only a few of them had participated in any programmes in Mathematics ever. There were a good number of the students felt that diagnosis, guidance and additional training programmes in Mathematics would have impact on

Mathematics learning and achievement and these special programmes would develop a positive attitude towards the subject. Also, almost same number of students thought that it was useful to get guidance on correcting the shortcomings in attitude towards Mathematics. They were asked about training prior to new learning in their 11^{th} standard by practicing in basic Mathematics and most of them agreed to it too. Concept formation and problem solving in Mathematics were also emphasized in the survey and it was found that most of them believed in it. It can be seen from the table that only a very few of the total respondents thought that there was no benefit of getting training in good study habits in the subject, although most of them considered training in preparation for Mathematics examinations to be useful, whereas, many of the respondents liked to participate in a training Programme with regular Mathematics classes in the school.

Only those opinions were accepted as valid opinions which have been endorsed by more than fifty per cent of the sample. All students agreed that the additional programmes such as Bridge Programme was important in enhancing achievement in Mathematics of standard XI students.

During this study, the topic-related literature given by various authors from books, websites, journal papers and research studies was also reviewed to arrive at logical conclusions through analysis and interpretation of relevant ideas, data, and details therefrom. The findings from the survey were used to propose a plan for the development of Bridge Programme for enhancing learning and achievement in Mathematics of Standard XI students.

It was the effort of the researcher to measure the level of students' attitude, beliefs, study habits and opinions so that the findings of the survey would be a basis to propose plans and strategies for enhancing the achievement in Mathematics through developing Bridge Programme. Thus, situation analysis and need assessment clearly indicated that students were in need of additional teaching and learning programmes. Hence the investigator initiated a Programme called Bridge Programme in Mathematics to fulfill the objective 3 (To prepare a Bridge Programme based on students' attitude towards Mathematics learning and achievement, beliefs in mathematical abilities cum pre-requisite / basic knowledge in the subject and study habits in Mathematics for enhancing achievement in Mathematics of standard XI students). The Bridge Programme was the intervention in this study after identifying the needs of the students. This Programme was supposed to be implemented along with the classroom teaching among the students in the experimental group. This Programme consisting of 11 plans and 21 strategies has its own role to play. Its effectiveness is tested and established in the following section.

Analysis of Experiment Based Data

In this section the quantitative data collected during the experiment were analyzed and interpreted to find the effect of the prepared Bridge Programme on the basis of the objectives 4 (to study the effect of the Bridge Programme in terms of achievement in Mathematics of standard XI students), 5 (to study the effect of the Bridge Programme on retention of achievement in Mathematics of standard XI students) and 6 (to test whether the Bridge Programme is effective to change standard XI students' attitude towards Mathematics learning and achievement, beliefs in mathematical abilities cum pre-requisite / basic knowledge in the subject and study habits in Mathematics in the desired direction).

Effectiveness of the Bridge Programme in Enhancing Student's Achievement in Mathematics

To assess the effectiveness of the Bridge Programme in enhancing Mathematics achievement of students, a Mathematics achievement test was conducted as given in appendix L, before, after the Programme and again after three weeks and then it was checked as per the scoring key given in the same appendix. These scores were then added up to form a single test score of each student at the above three time points and then compared.

Keeping in mind the objective 4 (to study the effect of the Bridge Programme in terms of achievement in Mathematics of standard XI students) of the study, the researcher framed the null hypotheses 1,2,3 and 4.

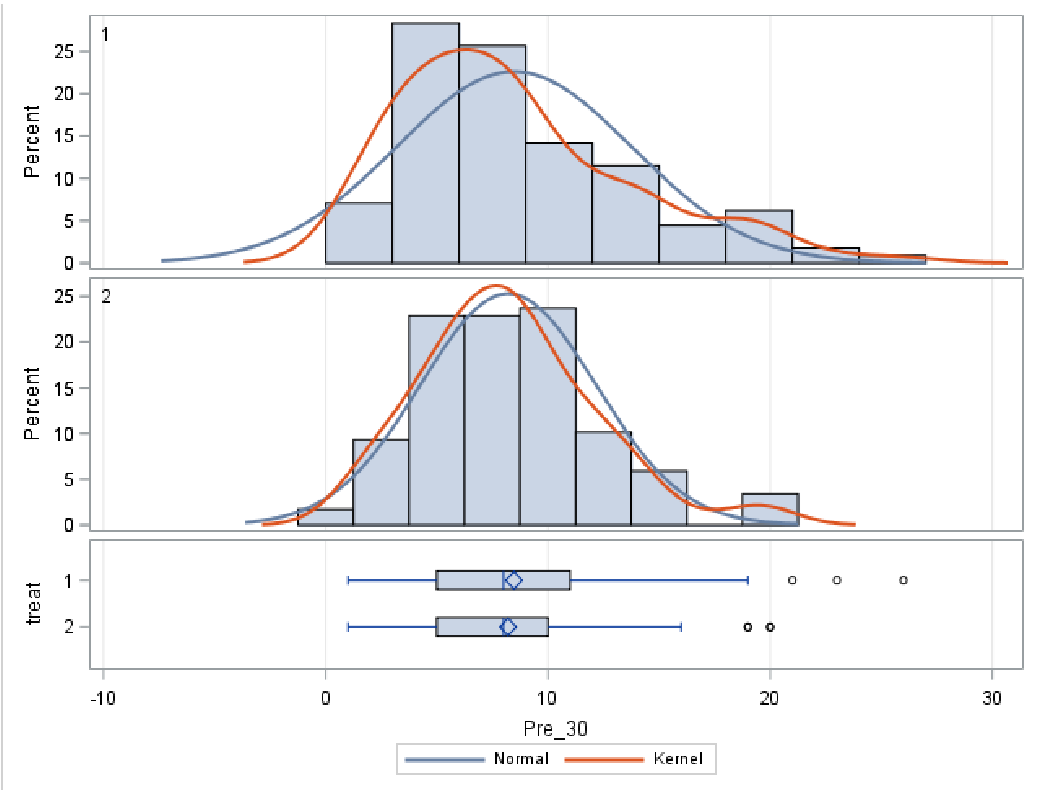
Testing of Hypothesis 1:

> There is no significant difference between the pretest mean scores of achievements in Mathematics of the experimental and control group students in standard XI.

The technique used for testing this hypothesis was two group independent sample t-test. Before calculating the t-value, the necessary conditions were ensured. The data followed a normal or near normal distribution. The sample size was more than 30. The variances of the groups were nearly equal (homogeneity of variance) and so on.

Figure 16

Distribution of Baseline Mathematics Scores of Students in Experimental and Control Groups before the Intervention



The graphs show the distribution of the test scores of control group (as labeled 1) and experimental group (as labeled 2). The distribution of the obtained scores as shown in orange is fit against the expected normal to check for the assumptions of normality. Their equality of variance is tested using Leven's variance test.

Table 25

Variance Test Results for Baseline Mathematics Scores of Students in Experimental and Control Group

Test	Num DF	Den DF	F value	p value
Leven's Variance Test	117	112	0.43	0.6649

The table 26 shows the relevant results of pretest in Mathematics achievement of control and experimental group students.

Table 26

Baseline Mathematics Achievement Test Scores of Students in Control and Experiment Groups

Groups	N	Mean	S D	t value	p value
Control	113	8.47	5.29	0.43	0.6669
Experiment	118	8.2	3.94		

The pre intervention scores of experimental and control groups were compared first using their individual distribution as given in the figure and then their variance was compared using Leven's test which has its results in the table and the difference was found to be insignificantly different, after this their means were compared as given in the table 26 , to check the baseline differences, if any, using two group independent sample t test. To do this, the hypothesis H_{01} was formed and tested and the difference between the mean scores was found to be statistically not different from each other, resulted in the failure of rejection of the null hypothesis.

H_{01}: There is no significant difference between the means in the baseline achievement test scores of students from experiment and control groups.

Because there was no significant difference on the pretest means, it was assumed that the two groups started out with equivalent means. Thus, this analysis helped the researcher to form two parallel equivalent groups in their achievement before going for further analysis and interpretations.

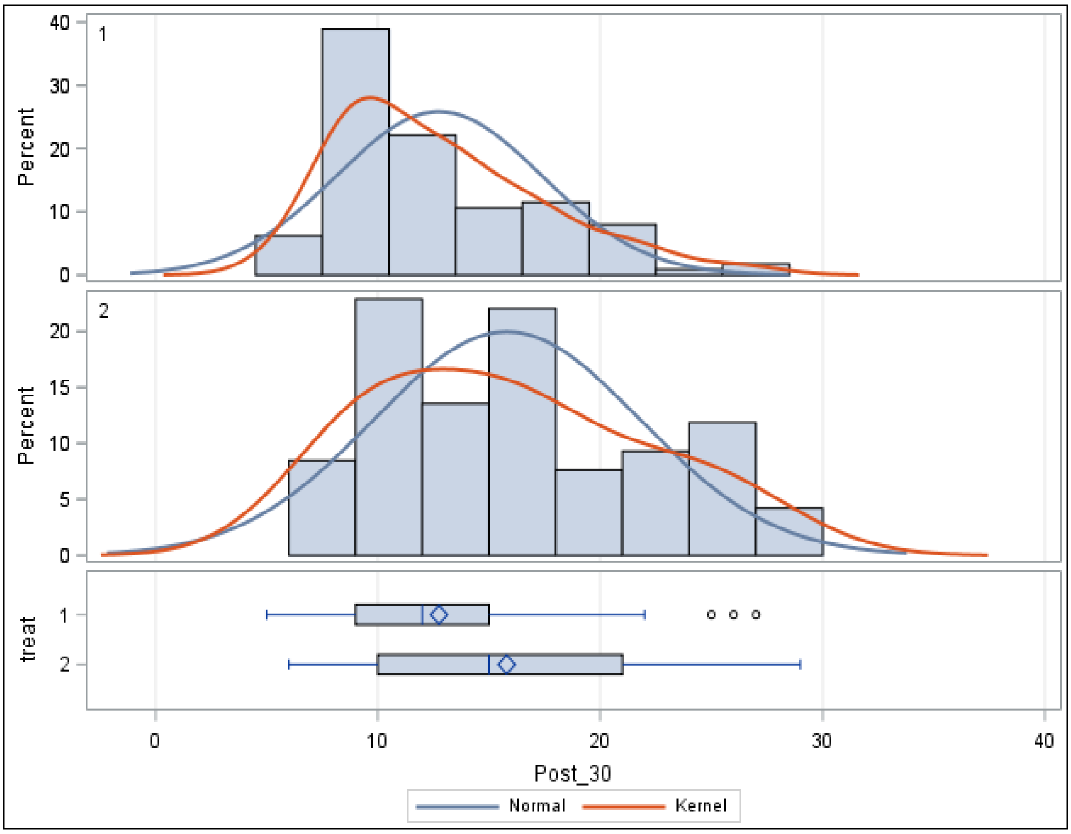
Testing of Hypothesis 2:

There is no significant difference between the posttest mean scores of achievements in Mathematics of the experimental and control group students in standard XI.

Before calculating the t value, the necessary conditions were ensured.

Figure 17

Distribution of Mathematics Achievement Test Scores of Students in Experimental and Control Group after Intervention



The graphs show the distribution of the test scores of control group (as labeled 1) and experimental group (as labeled 2). The distribution of the obtained scores as shown in orange is fit against the expected normal to check for the assumptions of normality. Their equality of variance is tested using Leven's variance test.

Table 27

Variance Test Results for Post Mathematics Achievement Test Scores of Students in Experimental and Control Group

Test	Num DF	Den DF	F value	p value
Leven's Variance Test	117	112	1.68	0.063

Table 28 presents the relevant results of the posttest in Mathematics achievement for control and experimental group students.

Table 28

Post Intervention Mathematics Achievement Test Scores of Students in Control and Experiment Groups

Groups	N	Mean	S D	t value	p value
Control	113	12.75	4.63	4.31	0.00
Experiment	118	15.8	5.99		

After the implementation of the Programme among the students in the experiment group for 30 days, the test was conducted with the experiment and control group and then their post intervention scores were obtained and compared, as results are illustrated in the table 28 ; the mean score obtained by students in experiment and control group was 15.8 and 12.75 respectively. The obtained mean difference of 3.044 units was found to be significant resulted in the rejection of H_{O2}, using independent sample t test and their distribution and variance were also checked before that which were found to be not statistically different.

H_{o2}: There is no significant difference between the means of the post intervention Mathematics achievement test scores of students from experiment and control groups.

It means that there was significant difference in the mean achievement scores of the experiment group and control group students. That is in the post test, students experiencing teaching-learning with BPM have higher score on achievement in Mathematics compared to that of students not experiencing BPM.

Both the experimental and control groups had received same mathematical learning experiences from regular classes. But the experimental group received additional inputs through the BPM for enhancing achievement in Mathematics. The experimental and control groups were significantly different in achievement on posttest after the Programme was implemented to the experimental group. The students of the experimental group who were given the treatment of the Programme showed better achievement in Mathematics than the control group students.

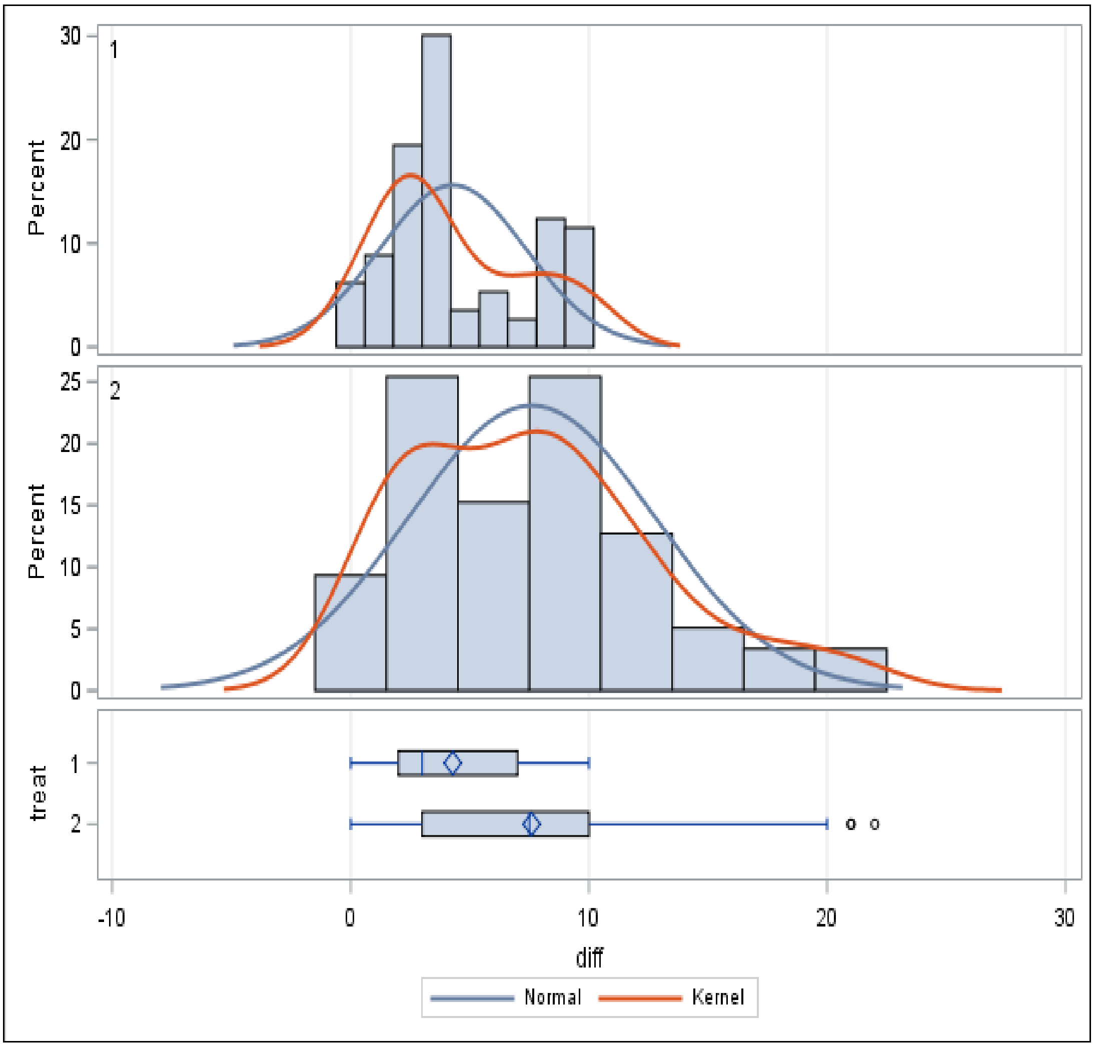
In addition, the effect size was calculated for the variable achievement in Mathematics. Cohen's d was calculated for the variable, as the standard deviations for this variable of the experimental and control groups are homogeneous. The calculated value was 0.57, lying between 0.51 and 1, which implies that there is medium or moderate effect. Thus, by Cohen's d the Bridge Programme prepared by the investigator has a moderate effect on achievement in Mathematics of standard XI students.

Testing of Hypothesis 3:

> There is no significant difference between the means of gain scores of achievements in Mathematics of the experimental and control group students in standard XI.

Figure 18

Distribution of Gain Scores of Students in Experimental and Control Group after the Intervention



The graph labeled 1 shows the distribution of gain scores in control group and the graph labeled 2 shows the distribution of gain scores in experimental group. The distribution of the obtained scores as shown in orange is fit against the expected normal to check for the assumptions of normality. The table 29 shows the relevant results of gain scores in Mathematics achievement of control and experimental group students.

Table 29

Gain Scores of Achievements in Mathematics of Students in Control and Experimental Groups

Differences	N	Mean	S D	t value	P value
Control Group	113	4.28	3.07	5.93	0.00
Experiment Group	118	7.59	5.19		

The differences are given in the table 29 and the below given hypothesis was tested using the two independent sample t-test and the difference between the mean gain was seen to be higher in the experimental group and the difference in the gained scores of two groups was found to be statistically significant resulting in the rejection of null hypothesis.

H_{o3}: There is no significant difference in the gained scores of experimental and control groups after the Bridge Programme.

Due to the Bridge Programme, there is increase in gain score of the experimental group as the experimental group after the intervention of the Programme showed an increase in achievement in Mathematics. The mean difference of 3.31 was found to be in favor of experimental group. This significant change in the scores of the experimental group can be attributed to the implementation of the Bridge Programme to the experimental group. The results were further analyzed by applying the ANCOVA too.

Testing of Hypothesis 4

There is no significant effect of the Bridge Programme on achievement in Mathematics after controlling pre-experimental status in terms of pretest scores of achievements in Mathematics.

For comparing the effect of teaching-learning together with the BPM and without using the BPM in enhancing achievement in Mathematics, ANCOVA with initial level of achievement in Mathematics (pretest) as co variate was employed. The following table shows the details of the ANCOVA conducted.

Table 30

Summary of ANCOVA of Gain Score on Achievement in Mathematics by Groups with Pretest Score of Achievement in Mathematics as Co variate

Source	Type III Sum of Squares	DF	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	3266.849[a]	2	1633.425	96.175	.000	.458
Intercept	3563.293	1	3563.293	209.804	.000	.479
Pre test	2731.852	1	2731.852	160.850	.000	.414
Groups	606.050	1	606.050	35.684	.000	.135
Error	3872.328	228	16.984			
Total	54425.000	231				
Corrected Total	7139.177	230				

a. R Squared = .458 (Adjusted R Squared = .453)

From the table 30, it follows that, after adjusting for pretest scores, there is statistically significant difference in mean achievement in Mathematics ($F=35.684$, $p=0.00$) between the experimental and control groups, resulting in the rejection of null hypothesis.

H_{04}: There is no significant effect of the Bridge Programme on achievement in Mathematics after controlling pre-experimental status in terms of pretest scores of achievements in Mathematics.

The analysis of results according to ANCOVA have also confirmed the findings. Hence the experiment has significant effect on gain score on achievement in Mathematics.

The partial Eta squared value (0.135) indicates the effect size and it can be seen that for achievement in Mathematics the effect size is small.

This means that teaching-learning with BPM made significant improvement in Mathematics achievement of students in the experimental group.

Keeping in mind the objective 5 of the study (to study the effect of the Bridge Programme on retention of achievement in Mathematics of standard XI students), the researcher framed the null hypothesis 5.

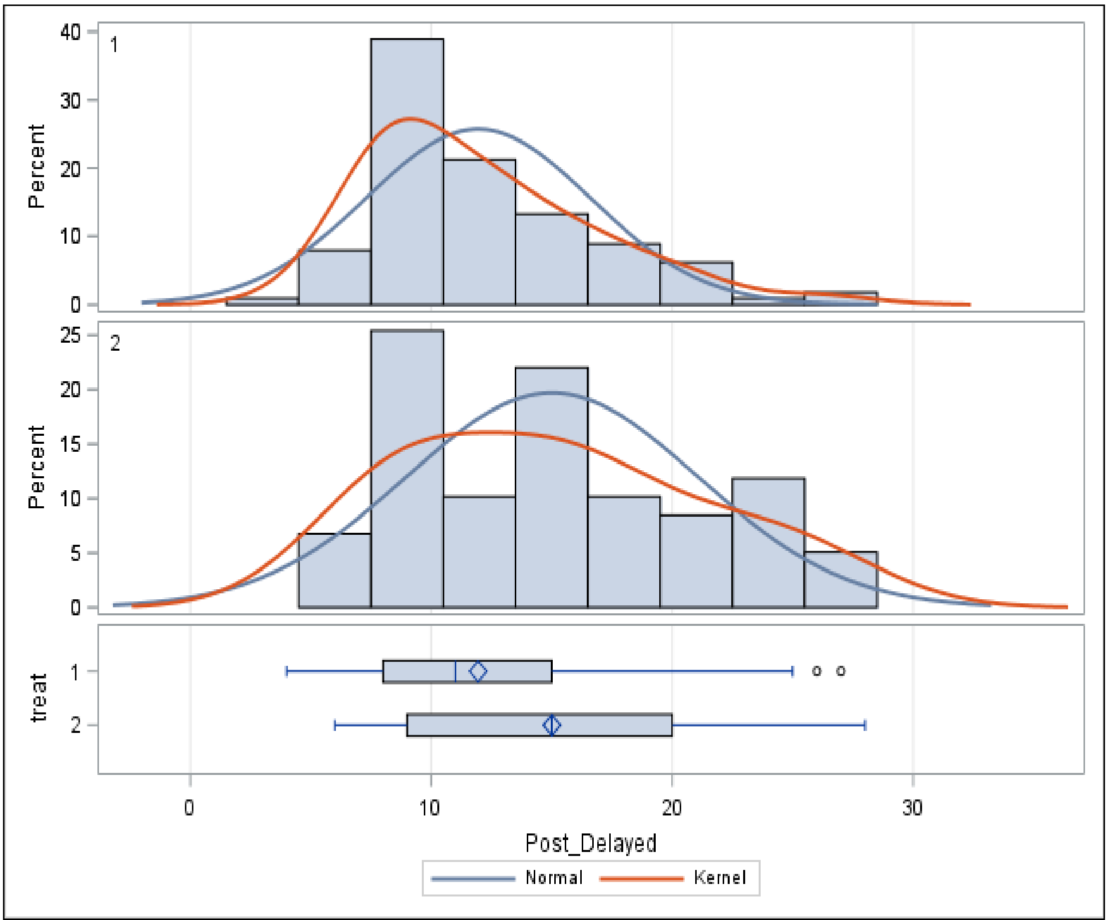
Testing of Hypothesis 5:

> There is no significant difference between the delayed posttest mean scores of achievements in Mathematics of the experimental and control group students in standard XI.

Before calculating the t value, the necessary conditions were ensured.

Figure 19

Distribution of Post Delayed Mathematics Achievement Test Scores of Students in Experimental and Control Group



The figure 19 shows the distribution of the test scores of control group (as labeled 1) and experimental group (as labeled 2). The distribution of the obtained scores as shown in orange is fit against the expected normal to check for the assumptions of normality. Their equality of variance is tested using Leven's variance test and is given in table 31.

Table 31

Variance Test Results for Delayed Mathematics Achievement Test Scores of students in Experimental and Control Group

Test	Num DF	Den DF	F value	p value
Leven's Variance Test	117	112	1.7	0.059

The table 32 shows the relevant results of post delayed achievement test in Mathematics of control and experimental groups.

Table 32

Delayed Intervention Mathematics Achievement Test Scores of Students in Control and Experiment Groups

Group	N	Mean	S D	t value	p value
Control	113	11.95	4.66	4.31	0.00
Experiment	118	15.01	6.08		

The achievement test was conducted after 21 days among the experiment and control group students to check the post delayed effect among them. The scores obtained from this test were compared with their pre intervention scores for normality and variance, the figure 19 and table 31 dole out that the scores were normally distributed and had equal variance, apart from this, the means were compared using two independent sample t-test as given in the table 32. The table illustrates the mean test score of control group was found to be 11.95 and mean post delayed score of experimental groups was 15.01, the difference between the two was found to be statistically significant; using independent sample t test; resulted in the rejection of the null hypothesis.

H_{05}: There is no significant difference between the means in the post delayed achievement test sores of students from experiment and control groups.

For comparing the delayed effect of teaching-learning together with the BPM and without using the BPM on enhancing achievement in Mathematics, ANCOVA with initial level of achievement in Mathematics (pretest) as covariate was also employed. The table 33 shows the details of the ANCOVA conducted.

Table 33

Summary of ANCOVA of Gain Score on Delayed Post Test Achievement in Mathematics by Groups with Pretest Score of Achievement in Mathematics as Covariate

Source	Type III Sum of Squares	DF	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	3407.546[a]	2	1703.773	100.011	.000	.467
Intercept	2777.231	1	2777.231	163.023	.000	.417
Pre test	2866.496	1	2866.496	168.262	.000	.425
Groups	614.295	1	614.295	36.059	.000	.137
Error	3884.177	228	17.036			
Total	49459.000	231				
Corrected Total	7291.723	230				

a. R Squared =.467 (Adjusted R Squared =.463)

This means that the Programme had a post delayed effect on student's achievement too, namely, there was significant difference in the mean achievement scores of the students in the experiment group after a particular period of time too.

Effectiveness of the Bridge Programme in Changing Student's Attitude, Beliefs, Basic Mathematics and Study Habits towards Mathematics

To cross check the effectiveness of the implemented Bridge Programme in Mathematics, the students in the experimental group were inquired regarding their attitude towards Mathematics learning, their beliefs in mathematical abilities cum basic Mathematics knowledge and study habits in the subject as the BPM was given to the experimental group only. These characteristics were assessed both pre and post intervention to examine the change and their results are discussed below in this section.

Keeping in mind the objective 6 of the study (to test whether the Bridge Programme is effective to improve standard XI students' attitude towards Mathematics learning and achievement, beliefs in mathematical abilities cum pre-requisite / basic knowledge in the subject and study habits in Mathematics in the desired direction), the researcher framed the null hypotheses, 6, 7, 8 and 9.

Effectiveness of the Bridge Programme in Improving Student's Attitude towards Mathematics learning:

Testing of Hypothesis 6:

There is no significant difference between the pretest and posttest mean scores of students' attitude towards Mathematics of the experimental group students in standard XI.

Table 34

Attitude of Students in the Experimental Group towards Mathematics Learning

Characteristic	Time of test	No. of items	Mean	S D	t value	p value
Attitude	Pre	17	56.09	10.61	0.65	0.514
Attitude	Post	17	56.86	8.92		

The results, as given in the table 34, show that there was no statistically significant difference in the attitude of the students after the Programme resulting in the failure of rejection of the null hypothesis.

H_{o6}: There is no significant difference in the attitude of students in the experimental group before and after the Programme.

This means that the Bridge Programme in Mathematics had exerted no significant effect on the students' attitude towards Mathematics learning.

Effectiveness of the Bridge Programme in Improving Student's Beliefs in their Mathematical Abilities:

Testing of Hypothesis 7:

There is no significant difference between the pretest and posttest mean scores of students' beliefs in mathematical abilities of the experimental group students in standard XI.

Table 35

Student's Beliefs in their Mathematical Abilities

Characteristic	Time of test	No. of items	Mean	S D	t value	p value
Belief	Pre	13	38.54	8.92	7.47	0.00
Belief	Post	13	45.48	6.14		

The results, as given in the table 35, show that there was statistically significant difference in the beliefs of the students after the Programme as their post intervention scores were significantly higher than their previous scores which resulted in the rejection of the null hypothesis.

H_{o7}: There is no significant difference in the beliefs of students in the experimental group before and after the Programme.

This meant that students' beliefs in their mathematical abilities improved significantly.

Effectiveness of the Bridge Programme in Improving Student's Basic Mathematics Scores

Testing of Hypothesis 8:

There is no significant difference between the pretest and posttest mean scores of basic Mathematics (prerequisite knowledge in the subject) of the experimental group students in standard XI.

Table 36

Basic Concepts in Mathematics of Students in the Experimental Group

Characteristic	Time of test	No. of items	Mean	S D	t value	p value
Basic Mathematics	Pre	30	13.17	7.20	16.7	0.00
Basic Mathematics	Post	30	18.86	7.29		

The results, as given in the table 36, show that there was statistically significant difference in their basic Mathematics score as their post intervention scores were significantly higher than their previous scores which resulted in the rejection of the null hypothesis.

H_{08}: There is no significant difference in the scores of basic Mathematics of students in the experimental group before and after the Programme.

This meant that by the Bridge Programme in Mathematics students' basic Mathematics scores improved significantly.

Effectiveness of the Bridge Programme in Improving Student's Study Habits* in *Mathematics

Testing of Hypothesis 9:

There is no significant difference between the pretest and posttest mean scores of students' study habits in Mathematics of the experimental group students in standard XI.

Table 37

Study Habits in Mathematics of Students in the Experimental Group

Characteristic	Time of test	No. of items	Mean	S D	t value	p value
Study habits	Pre	37	121.9	13.62	3.61	0.00
Study habits	Post	37	128.8	16.84		

The results, as given in the table 37, show that there was statistically significant difference in the study habits in Mathematics as their post intervention scores were significantly higher than their previous scores which resulted in the rejection of the null hypothesis.

H_{o9}: There is no significant difference in student's Mathematics study habits in the experimental group before and after the Programme.

This meant that by the Bridge Programme in Mathematics students' study habits in Mathematics improved significantly.

The investigator thus cross checked the results on the effectiveness of the Bridge Programme in enhancing achievement in Mathematics due to the BPM itself in helping students to reach the needed level of attitude, beliefs, basic concepts and study habits. Even though the level of attitude towards Mathematics learning remained the same, the levels of all the other three factors involved in the BPM had been remarkably improved.

Analysis of Students' Feedback Based Data

The data obtained through feedback of students on the Bridge Programme in Mathematics based on the objective 7 (to study the efficacy of the Bridge Programme in terms of students' feedback regarding the prepared and implemented Bridge Programme) are presented in table 38.

Table 38

Feedback of Students about the Bridge Programme

Sl. No.	Feedback	Category	N	%
1	Use of the Programme	No	0	0.00
		Yes	118	100.00
2	Use of plans and strategies in the Programme	No	27	22.88
		Yes	91	77.12
3	Difference in attitude	No	38	32.20
		Yes	80	67.80
4	Appropriateness of procedures	No	31	26.27
		Yes	87	73.73
5	Ease of use	No	19	16.10
		Yes	99	83.90
6	Improvement in abilities	No	18	15.25
		Yes	100	84.75
7	Development of study habits	No	15	12.71
		Yes	103	87.29
8	Help in learning	No	0	0.00
		Yes	118	100.00
9	Difficulty in practice	No	97	82.20
		Yes	21	17.80
10	Relevancy of materials	No	26	22.03
		Yes	92	77.97
11	Tension free learning	No	35	29.66
		Yes	83	70.34
12	Use of guidelines	No	22	18.64
		Yes	96	81.36
13	Use of online and offline materials	No	15	12.71
		Yes	103	87.29
14	Useful for future	No	23	19.49
		Yes	95	80.51

The students in the experimental group were asked to give the feedback about the Bridge Programme in Mathematics which they went through for 30 days, the table alludes to their responses, where it was found that everyone agreed for the Programme meeting the needs of standard XI students and more than 2/3rd found the plans and strategies to be beneficial for enhancing their achievement, but some of the participants found them to be difficult to practice.

There were a number of students who found a difference in their attitude towards Mathematics after 30 days of intervention and a good number of the total respondents felt the procedure of the Programme to be appropriate, whereas majority of the total students had opined that their mathematical abilities improved while participating. A good number of students in experimental group found the intervention to be helpful in developing good study habits in the subject learning and all of them believed that it was helpful in enhancing their learning and achievement in Mathematics, albeit a small number of the students felt the Programme plans to be difficult to practice and continue.

Majority of the students in this group found that the provided material to be relevant and there were a good number of the students who felt that the subject learning was stress free. The guidelines given in the Programme regarding Mathematics examinations were found to be beneficial by majority of the students and the students of this group found the online and offline materials to be useful. In a similar manner most of the students held the opinion that the plans and strategies provided in the Bridge Programme in Mathematics to be beneficial for the future too.

CHAPTER 5

SUMMARY, FINDINGS & CONCLUSIONS

- *Summary of the Study*
- *Findings of the Study*
- *Tenability of the Hypotheses*
- *Conclusions of the Study*

Academic achievement in Mathematics is an important and significant topic in the field of education. A study in the area of learning and achievement in Mathematics is of paramount importance all over the world and all the educators are very much concerned with enhancement of mathematical achievement of students. This chapter presents the summary, findings and conclusions derived in the course of the study which primarily aimed at developing a Bridge Programme for enhancing achievement in Mathematics of standard XI students.

Summary of the Study

Mathematics is an important subject and integral part of the school curriculum, especially at Higher Secondary level. It is essential for everyday life and for studying other core subjects. However, the majority of the students detest Mathematics. It is due to various reasons, including learner's educational, cognitive, emotional and psychomotor problems as well as problematic subject content and learning environment. It is a felt need for the students, teachers, parents, administrators and educators to enhance the learning and achievement of standard XI students at HSS level. Hence, through the present study, the investigator has intended to provide answers to the following questions.

- What are the factors contributing and promoting learning and achievement in Mathematics of standard XI students?
- Why do the students in standard XI feel so many problems and difficulties in better learning and achievement in Mathematics?
- How do the students in standard XI perceive their attitude, beliefs and study habits towards Mathematics learning and achievement?
- How can quality of Mathematics learning and hence achievement in Mathematics of standard XI students be improved?

- What is the effect of the Bridge Programme in enhancing achievement in Mathematics of standard XI students?
- How does the Bridge Programme based on attitude, beliefs in mathematical abilities cum prerequisite knowledge and study habits in Mathematics help to enhance learning and achievement in Mathematics of standard XI students?
- How do the students in standard XI receiving Bridge Programme in Mathematics retain their learning and achievement?
- How do they react to the teaching-learning together with the Bridge Programme in Mathematics?

Actually, learning and achievement in Mathematics are affected, not only by the intellectual factors, but also by the psychological factors. The students of standard XI struggle with Mathematics learning. So, the study started by exploring the level of plus one students' attitude towards Mathematics learning, beliefs in mathematical abilities and study habits in Mathematics and identifying the need for a programme which can enhance their learning and achievement in Mathematics. The needed programme is based on the students' attitude towards Mathematics learning, beliefs in mathematical abilities, expertise in basic mathematical concepts and study habits in Mathematics. Thus, the BPM is mainly dependent on these correlates of learning and achievement in Mathematics. The prepared programme was tested for its effectiveness.

Restatement of the Problem

Realizing the importance of the need for the hour the present study has been undertaken to develop the Bridge Programme for enhancing learning and achievement in Mathematics of standard XI students. So, the study was entitled as DEVELOPMENT OF A BRIDGE PROGRAMME FOR ENHANCING ACHIEVEMENT IN MATHEMATICS OF STANDARD XI STUDENTS.

Variables of the Study

The following were the variables selected for the study.

- The independent variables were the teaching-learning strategies at two levels, together with and without the Bridge Programme in Mathematics.
- The dependent variable was achievement in Mathematics of standard XI students in terms of scores on standardized achievement test.
- The control variables were
  - Pupils' age
  - Unit of instruction
  - Prior achievement and knowledge level of students
  - Locality of school
  - Type of school
  - Teacher characteristics

Objectives of the Study

The major objectives of the present study were

1) To prepare a Bridge Programme in Mathematics; and
2) To study its effectiveness in enhancing achievement in Mathematics of standard XI students.

To attain these two major objectives seven specific objectives were formulated by the investigator.

1) To explore the level of standard XI students' attitude towards Mathematics learning and achievement, beliefs in mathematical abilities and study habits in Mathematics.
2) To identify standard XI students' needs and requirements with respect to Mathematics learning and achievement.

3) To prepare a Bridge Programme based on students' attitude towards Mathematics learning and achievement, beliefs in mathematical abilities cum pre-requisite (basic) knowledge in the subject and study habits in Mathematics for enhancing achievement in Mathematics of standard XI students.
4) To study the effectiveness of the Bridge Programme in terms of achievement in Mathematics of standard XI students.
5) To study the effectiveness of the Bridge Programme on retention of achievement in Mathematics of standard XI students.
6) To test whether the Bridge Programme is effective to improve standard XI students' attitude towards Mathematics learning and achievement, beliefs in mathematical abilities cum pre-requisite (basic) knowledge in the subject and study habits in Mathematics in the desired direction.
7) To study the efficacy of the Bridge Programme in terms of students' feedback regarding the prepared and implemented Bridge Programme.

Hypotheses of the Study

Previous studies have proved that the academic achievement can be enhanced by special programmes in various subjects. Accordingly, the assumption of the present study is that there will be significant increase in Mathematics achievement of standard XI students by the implementation of the Bridge Programme. Hence the study tests the main hypothesis that the Bridge Programme would exert a significant effect on the achievement in Mathematics of standard XI students. So, the null hypothesis (H_o) states that teaching-learning together with the Bridge Programme would exert no significant effect on the academic achievement in Mathematics of standard XI students.

This main hypothesis was split into nine sub-hypotheses that would be presented as follows.

1. There is no significant difference between the pre-test mean scores of achievements in Mathematics of the experimental and control group students in standard XI.

2. There is no significant difference between the post-test mean scores of achievements in Mathematics of the experimental and control group students in standard XI.
3. There is no significant difference between the means of gain scores of achievements in Mathematics of the experimental and control group students in standard XI.
4. There is no significant effect of the Bridge Programme on achievement in Mathematics after controlling pre-experimental status in terms of pre-test scores of achievements in Mathematics.
5. There is no significant difference between the delayed post-test mean scores of achievements in Mathematics of the experimental and control group students in standard XI.
6. There is no significant difference between the pre-test and post-test mean scores of students' attitude towards Mathematics of the experimental group students in standard XI.
7. There is no significant difference between the pre-test and post-test mean scores of students' beliefs in mathematical abilities of the experimental group students in standard XI.
8. There is no significant difference between the pre-test and post-test mean scores of basic Mathematics (pre-requisite knowledge in the subject) of the experimental group students in standard XI.
9. There is no significant difference between the pre-test and post-test mean scores of students' study habits in Mathematics of the experimental group students in standard XI.

Methodology

Design of the Study

The present study was carried out primarily to develop the Bridge Programme for enhancing achievement in Mathematics of standard XI students. To achieve the objectives of the study the investigator adopted both survey and experimental methods of research. Hence the study proceeded through two phases such as survey and experimentation. Through the survey (phase I) situation analysis and need assessment were carried out. Following the findings of survey, the Bridge Programme was prepared and its effectiveness was established through the experimentation (phase II). The quasi- experimental design with pre-test post-test non-equivalent groups was adopted for the study.

Sample

The sample for the survey consisted of 660 HSS students from 39 schools in Kozhikode Revenue District. Two hundred and thirty-one HSS students belonging to four intact classes of two schools in Kozhikode Educational District constituted the sample for the experiment. There were 118 students in the experimental group and 113 students in the control group.

Tools

Data were collected by the administration of the appropriate tools.

1. Mathematics Study Attitude and Belief Scale to assess the students' attitude towards Mathematics learning and beliefs in mathematical abilities during both phases of the study.
2. Mathematics Study Habits Scale to elicit information from students regarding their study habits in Mathematics initially and during experimental phase.

3. Questionnaire for the Assessment of Need of Bridge Programme to collect their opinions about the special programmes.
4. BPM for Standard XI Students
5. Achievement Test in Mathematics for standard XI students to use as pre-test, post-test and delayed post-test for determining the achievement levels in Mathematics of the students from the experimental and control groups before and after the treatment.
6. Prerequisite Test in Basic Mathematics to identify students' level in pre-requisite knowledge in the subject.
7. Finally, Questionnaire for Seeking Students' Feedback on Bridge Programme to evaluate the developed Bridge Programme in Mathematics.

Thus, the scales, opinionnaire, BPM, tests and questionnaire made the present study effective and comprehensive.

Statistical Techniques

Both descriptive and inferential statistical techniques were used for the analysis of data.

1. Preliminary descriptive statistics like mean and standard deviation
2. Percentage analysis
3. Test of significance of difference between mean scores (t- test)- independent samples t test and paired sample t test. The former is used to compare the mean scores of two different groups; and the latter is used when to compare the mean scores for the same group on two different occasions.
4. ANCOVA
5. Estimation of effect size by Cohen's d or Partial Eta Squared value

Analysis

The data collected from both survey and experiment were analysed with the help of statistical and non-statistical measures. Mainly, this included comparison of means of pre-test scores, post-test scores, gain scores and post delayed test scores. The techniques of t test to get a formal result of the comparative effectiveness of the treatment and ANCOVA to provide more precise result were used in the study. The percentage analysis was employed in phase I to identify the students' levels of attitude towards Mathematics, beliefs in mathematical abilities and study habits in Mathematics. Also, the percentage analysis was used to determine the opinions and feedbacks of the students.

Findings of the Study

The important findings that emerged from the study in accordance with the objectives are summarized below.

Findings based on Survey

The objectives 1 and 2 were fulfilled by the survey conducted in phase I. The literature review helped the investigator to find out the correlates of achievement in Mathematics and select factors. Also, the scrutiny of academic master plans had revealed that students as well as teachers were facing many problems and difficulties in Mathematics learning and achievement. So, there raised the need to assess the level of select factors in Mathematics learning and achievement.

A survey to assess the level of plus one students' attitude towards Mathematics learning, beliefs in mathematical abilities and study habits in Mathematics was conducted. From the analysis, it was shown that majority of the students selected had low/poor and moderate levels of:

- positive attitude towards Mathematics learning and achievement (3.94% low and 60% moderate). [Vide table 19]

- beliefs in mathematical abilities (1.21% low and 52.73% moderate). [Vide table 21]
- study habits in Mathematics (0.91% poor and 62.58% moderate). [Vide table 23]

Thus, the results of the survey revealed that standard XI students' attitude towards Mathematics, beliefs in mathematical abilities and study habits in Mathematics were at low/poor and moderate levels only.

From the need analysis in the survey, it was revealed that

- majority of the students (72.58%) were in need of the additional programmes such as Bridge Programme for enhancing achievement in Mathematics. [Vide table 24]

Really, the students were in need of enhancement programmes so that favourable attitude and proper beliefs must be fostered. Also, good study habits should be cultivated.

- Hence, a Bridge Programme in Mathematics based on the select student-related factors was designed and validated by the investigator.

The Bridge Programme in Mathematics (BPM)

In order to fulfil the objective no. 3, the Bridge Programme in Mathematics was designed. The prepared programme was based on the learner's attitude, abilities, basic concepts and study habits in Mathematics and the procedure based on diagnosis, guidance and training. Also, ADDIE model was selected as a framework to outline different stages of preparation and validation. The researcher prepared the BPM by selecting the following Mathematics learning and achievement enhancement plans and strategies.

Favourable Attitude Boosters

i) Motivation by Motivational Capsules.

- Motivation is the prime factor in initiating a child to study. Pupils learn effectively when they are motivated. A motivated learner learns and achieves much more than an indifferent learner in Mathematics.
- Power of achievement motive is immense. Mathematics is necessary for various courses, competitive tests and careers. Students were made aware of why and how Mathematics learning and excellent achievements could help them in future (e g: winning the competitive examinations, getting into prestige institutions, finding good jobs and so on). The students were motivated to pursue a career in Mathematics.
- There is external as well as internal motivators. Intrinsic motivation (satisfaction and self-development) had better long-term benefits for learning and achievement in Mathematics of plus one students at HSS level.
- It is critical to get and hold the learners' interest in learning Mathematics. Initiatives had been taken to retain their interest in Mathematics. This could be done by stating the various purposes, relevance and usefulness of the subject. Students should be encouraged to keep a passion in learning more and more.
- Students were promoted to take membership in Mathematics club and participate actively in various club activities such as reading history of Mathematics, biographies of Mathematicians, seminar presentations, power point presentations etc.
- Students' confidence level should be enhanced. The ability to determine to learn the subject was much more important. Students had to believe that they could learn Mathematics and achieve better.

ii) Goal Setting.

- The students were directed to set short-term and long-term goals in Mathematics learning and achievement. Students were expected to plan for them and work towards achieving them.
- For the selected students in the class XI (experimental group), the attainable goal was to succeed with the best grade (minimum of C plus or 50% in Mathematics) and all efforts should be directed to that.
- High level courses and opportunities in the field of Mathematics were aimed.

Unfavourable Attitude Reducers

iii) Walk with Top Achievers/Toppers Meet.

- Success stories of top achievers in Mathematics, public and competitive examinations were very beneficial. Hence such common programmes were arranged by the investigator by himself for students.
- Students were directed to follow those students who got A plus grade in Mathematics i.e., watch them carefully and learn the plus points as to know how they study; how they overcome study related problems.
- It was also a good idea to meet people regularly who could help them for achieving the study goals.

iv) Auto Suggestion.

- Students were directed to start paying attention to the self-talk with more encouraging positive words instead of negative self-talk.
- Actually, the learner oneself gives suggestions to the subconscious mind by keeping the conscious mind totally active. The principle of auto suggestion is to keep continuously reminding the subconscious mind and keep reminding

it about what one wants to do and store it there so that it gradually begins working. It keeps one to get rid of all worries and tensions.

- If the student continuously keeps reminding the subconscious mind about the negative attitude and instructs it ‘I am capable of giving them up’, then the student can gradually move away from those habits.
- One has to say over and over again that ‘I need to study Maths well’, ‘I can study Mathematics’ or ‘I determine to study Mathematics’ and at the same time one has to have good faith, hope and enthusiasm in the mind that it can happen i.e., say with full emotion and visualize that one has achieved it. Focus the entire attention on the meaning of what is being said during this exercise. In order to make auto suggestion work, it must trigger feelings. The more meaningful auto suggestion is, the more effective it is.

Enhanced Concentration

v) Concentration Techniques.

- As a beginning, it was simple to practise deep breathing and relaxation techniques.
- To practise it, sit in a comfortable position with one’s hands on the stomach. Inhale deeply and slowly. Let the stomach expand as much as possible. Hold breath for five seconds. Then exhale slowly through pursed lips, as if whistling. Repeat the cycle three or four times. The technique of breathing is very simple; as one inhales, know that he/she is breathing in. As one exhales, know that he/she is breathing out.
- Another best way to improve the power of concentration is meditation. In meditation the rays of the mind are focused at a fixed point. It is difficult to concentrate in such a way but as one keeps practising, it becomes easy.

Time Management

vi) Managing Time- wasters.

- The students were promoted to prepare the list of time-wasters.
- Some of the internal factors are day dreaming, idleness, procrastination, inertia, laziness etc.
- Some of the external factors are problem friendships i.e., too much socializing and distracting friendships, idle talk, prolonged television watching, addiction to TV, Radio, Internet, uncontrolled hobby, too much craze for sports and games, unplanned use of mobile, computer and internet, online games, texting, Facebook, Twitter, Instagram, WhatsApp, and such social media.
- Students were helped to take firm decision to abstain from all these kinds of time -wasters.

vii) Time Table Preparation.

- Students were directed firstly to check the present schedules and how they currently spend time.
- The students were encouraged to frame a suitable time table keeping the guidelines for an efficient time table. For example, give due place and emphasis to various subjects and activities according to their relative importance and difficulty.
- It was customary to allocate four hours in working days and eight hours in holidays personally for learning.
- Study time must further be divided into the study of various school subjects. Encourage the students to set aside a fixed time for daily study at home or study Mathematics in the prime time.

- It was good to check the implementation of the time table daily before going to bed.
- Personal preferences need to be taken into account and it is worth experimenting with a number of different approaches to discover what works best for the individual.

Study Aids

viii) Organization of study aids.

- Firstly, arrange a comfortable place for study where study table, chair, and almirah are available. If the student chooses this same study place every day, learning will occur smoothly.
- Also keep all the study materials in the convenient locations. Remember to have a place for everything and everything in its place.
- Students were encouraged to collect the following five important things which are very beneficial for Mathematics learning and achievement: Syllabus (using source book), Textbook (NCERT), Reference books (M L Khanna, R D Sharma) and solution guides, Question Bank (Edumate Questions, Previous Year Question Papers; minimum five years, both March and Improvement) and Digital Resources like Samagra portal (Internet) and auxiliary materials.
- As a common procedure the text and other books may be marked by highlighting the points.
- Students are trained to prepare ‘marked copy of the text’.

ix) Note Making.

- It was paramount to prepare notes by oneself for effective learning and students were directed to maintain a Mathematics notebook.

- The notes students prepare by combining the notes written in the class and later with organized study aids given in previous strategy make the learning and achievement in Mathematics easy.
- Assign main title, various titles and subtitles carefully while preparing notes. Also include necessary diagrams, graphs, concepts, theory and examples.

Basic Concepts (Previous Content Knowledge)

x) Module of Basic Concepts.

- Necessary concepts learned in previous years should be revised before starting the new chapter, since previous knowledge determines the achievement.
- Hence a comprehensive syllabus of the prerequisites was provided to the students in advance for self-preparation. It included topics such as, Real numbers, number line, algebraic operations, various properties, squares and square roots, identities, laws of exponents, solution of linear equations in one variable and two variables, quadratic equations and their solutions, Pythagoras theorem, plotting points in a plane, distance formula, slope of a line, trigonometric ratios and trigonometric values of certain angles.
- Training classes using detailed study notes including worked out examples were also conducted, if necessary.
- Certain practice questions were also provided.
- It was essential to revise all concepts which were connected to the new chapter as far as possible.

xi) Follow up (Remedial) Measures.

- Initially a pre-requisite test in basic Mathematics had been administered.
- Based on the module and analysis of the pre-requisite test, follow up measures were provided to improve their pre-requisite knowledge.

- Remedial sessions, group or individual, if needed, were conducted without fail on the basis of the above module which the students revised by self and the test had been conducted because prior drilling in the fundamentals was very beneficial.
- Causes of errors were located and proper instructions were given to overcome these types of errors. For this, the detailed answer sheets of the test in basic Mathematics attended by the students could be used.
- Students were encouraged to do the task again and again as they really benefit from it in future too.

Comprehension (Meaningful Learning)

xii) Discussion on Specifications of Maths Content and Communication of Learning Objectives.

- For meaningful learning, the following two points i.e., the 'what' and 'why' of learning the lesson were discussed giving due importance. The students were pushed through the lower levels of remember and understand new information, to being able to apply it, analyse it, evaluate its impact and ultimately to solve unique problems by creating solutions that would not have been possible without the new knowledge (Revised Bloom's Taxonomy).
- Informing the details of the content and desired learning objectives to students is, no doubt, very beneficial.
- Familiarise all the prescribed specifications related with textual content and all the desired learning objectives related with it using the source book for Higher Secondary Mathematics (standard XI).

xiii) Learning Maps.

- The students must be well-versed with the concepts and worked out examples in the chosen area of study. For that purpose, learning maps help students be on the topic and make it easier for them to study.
- It consisted of a starting map which included the core idea, often the name of the unit and subtopics in the introduction of the unit and an ending map which included important details to be used in the summary discussion when the unit was completed. Thus, it depicted all things to be learned in the chapter.

xiv) Maths Concept Quiz.

- A short Quiz based on the concepts and examples learnt was conducted.
- The students were expected to prepare well in advance and participate in this quiz programme.
- Arrange feedback sessions in group or individual, if needed. Remedial instructions were provided as and when needed.

Problem Solving

xv) Polya's Problem Solving Model.

- Mathematical problem solving consists of

  1) Understanding the problem

  2) Devising a plan

  3) Carrying out the plan

  4) Looking back
- First phase relates with the analysis of the problem which is the foundation to successful problem solving. This is actually the 'getting started' phase. The

activities in this step are to formulate what is known, what is asked, whether the information is sufficient and restate the original problem in an operational manner. Once the problem is clearly understood, one can list all the components and data that are involved.

- The second phase involves ‘working on the problem’. Here main focus is to plan, explore and choose a strategy that would lead to the solution of the problem. Then they come up with a way to solve the problem.
- The third phase involves ‘digging deeper’. It is the implementation or execution of the proposed plan of actions that have been created in the previous step.
- The fourth phase is the concluding step. It is the verification or evaluation of the work done from the first phase to the third phase and the obtained solution. In problem solving it is good to check and interpret, namely, check to see whether all information is used and the answer makes sense.
- The students were directed to follow the proposed model to solve the mathematical problems.

xvi) Unit Problem Test.

- The students were expected to prepare well in advance and participate in the comprehensive unit problem test.
- Usually, a worked-out example is accompanied by step-by-step procedure for completing it. Pay special attention to the mathematical procedures for completing the solutions provided there.
- A unit test based on the problems (worked out examples as well as exercise questions) given in the chapter was conducted.
- Arrange feedback sessions in group or individual, if needed. Take some time to review it and work on the problems that were done incorrectly.

- There may be three type of errors as careless mistakes, conceptual errors and procedural or computational errors. Students were helped to learn from mistakes committed.

Mathematic Study Method

xvii) PQPRR Method of Study.

- It was good to carry out an effective Mathematics study strategy.
- P= Preview: this is done to get an overall picture of the lesson learned in the class. While previewing, the students may note headings, sub headings, important sentences in each paragraph, charts, diagrams, their captions and the matters given in the boxes. This will give a good starting.
- Q= Question: collect and read questions as far as possible from the text, reference books and note book based on the topic. It will increase the efficiency of learning and make them to be focussed.
- P= Practise: study and write the answers to the above questions formed i.e., stands for the habit of writing after studying the content. When studying Mathematics, you need paper and pen in hand to practise the question answering. Learn and write formulas, equations and definitions over and over again.
- R= Retrieve or rehearse or recollect: after practising, close the book and keep in mind the main points of what you have learned i.e., meditate over the learned things. Here pupils look at how they can remember what they have learned.
- R= Review: check the retrieved topics by examining the text and note books and repeat if needed.
- The real study of Mathematics occurs when these five learning processes happen in order.

Student Efforts

xviii) Self Study.

- Mainly, drilling and help-seeking are two means for applying this strategy of self-study.
- The subject Mathematics needs more drilling the topics learned and the timely completion of home works or assignments given by the teachers. The students were insisted to do the home works by self without fail.
- Help-seeking is much beneficial to the students. Ask the classmates or teachers what one does not understand. Do not hesitate to ask the teacher or clever companions or good performers in the subject the things one does not grasp clearly. Never leave difficulties unanswered, as this will put one in greater difficulty later. When clearance of doubt occurs, the study can proceed in a positive way.

xix) Memorization and Retention.

- For memorising and retaining the topics learned in Mathematics, the best way suggested is repetition, practice and revision of the lesson in proper time intervals.
- A topic learned once must be gone through again before it may be erased from memory. It is a good practice to revise the topic taught in the class within twelve hours or the same day itself. After that, if you study again within twenty-four hours, it will be very well memorized.
- It was highly recommended weekly, monthly, term and annual revision schedules. It is when the topics learned are repeated many times that they enter into long-term memory.
- Revision and repetition are fruitful only when they are done sincerely with genuine interest and attention.

Test Management

xx) Test Preparation.

- It was a good practice to re-examine the answer sheets of the previously written tests and evaluate the shortcomings and prepare sincerely.
- Students were expected to look upon previous year question papers critically and carefully to get an idea of the important portions of the syllabus and how questions were worded. It was also helpful to get acquainted with a lot of question patterns. Further it was useful to know the style, number and scores of the questions so that students could attend the exam with full confidence.
- The best way to face a test is to take a practice test. Students must do mock tests using previous question papers, as many years ahead as possible.
- By now, the students are able to collect the examiners' favourites. Students carefully guessed some questions that were likely to come up in the exam and were prepared to give them the most appropriate answers. Using these important questions, prepare note cards with one question per card and the solution on the back of the card. These were very useful for immediate revision before the examination.

xxi) Test Paper Presentation.

- During fifteen minutes cool off time, students were directed to read the entire question paper carefully and plan the order of preference for the questions to be answered and the answer could be thought out in advance. This additional time was provided for students to read the questions properly and draft a plan in their mind about how they would solve the paper correctly without getting panicked. So, students must utilise these 15 minutes very carefully to make a strategy for writing their exam smoothly and correctly.

- The questions which are known very well should be answered in serial order.
- Quality of content is certainly of prime importance in the answers. Along with it, the presentation style needs attention.
- While answering problem type questions in Mathematics, students should remember to write systematically the relevant data, related theory and necessary steps. This will help them to get a partial score even if the final answer was wrong.
- Students should be aware of conceptual, application, computational and careless errors.
- The answers are supported with appropriate graphs, diagrams, figures etc., whenever necessary.
- Finally, the written answers were scrutinized and rechecked.

Using this BPM, standard XI students at HSS level could enhance their learning and achievement in Mathematics. So, the researcher was in favour of the Bridge Programme in Mathematics which would be most beneficial to those students at HSS level.

Findings based on Experiment

The objectives 4,5 and 6 were fulfilled by the experiment conducted. The main purpose in this phase was to find out whether the hypotheses framed by the researcher were valid or not. The experimentation was employed to determine the significance of the effectiveness of the prepared programme.

- The comparison of students' pre-test achievement scores in Mathematics in the experimental and control groups showed that there was no significant difference between their pre-test scores ($t = 0.43$, $p = 0.6669$)[Vide table 26]. The difference between the two mean scores of the achievement in

Mathematics from experimental and control group students in pre-test was found to be not significant.

- The post-test achievement scores in Mathematics of students in the experimental and control groups were found to be significantly different (t = 4.31, p = 0.00). The performance of the students in the experimental group in the post-test (mean = 15.8) was better than that of the students in the control group (mean =12.75). [Vide table 28]. In addition, by Cohen's d (0.57) it was found that the BPM prepared by the investigator had a moderate effect on achievement in Mathematics among the students.
- The gain scores in Mathematics achievement of the experimental and control groups under analysis (t = 5.93, p = 0.00) showed significant difference between their mean gain scores (7.59 and 4.28). These results emphasized the superiority of the experimental group over the control group. [Vide table 29]. The gain score in achievement of experimental group was more than the control group. Thus, there was significant difference in the gain scores of students' achievement in Mathematics.
- From the analysis of covariance after adjusting for pre-test scores, there was statistically significant difference in mean achievement in Mathematics (F = 35.684, p = 0.00) between the experimental and control groups. In addition, the partial Eta Squared value (0.135) indicated the effect size and it could be seen that for achievement in Mathematics the effect size was small. [Vide table 30]. These results revealed that the experimental group was superior to the control group in Mathematics achievement. The prepared BPM for enhancing achievement in Mathematics of standard XI students proved better to the experimental group. It indicated that the experimental group students who were exposed to the BPM were benefited by the treatment. Thus, the

Bridge Programme in Mathematics used in the experimental group favoured the students than the control group students who were not exposed to the intervention.

- The post delayed test achievement scores in Mathematics of students in the experimental and control groups were found to be significantly different ($t = 4.31$, $p = 0.00$) [Vide table 32]. The analysis of covariance after adjusting for pre-test scores, there was statistically significant difference in the post delayed mean achievement in Mathematics ($F = 36.059$, $p = 0.00$) between the experimental and control groups. Also, the partial Eta Squared value (0.137) indicated the effect size was small. [Vide table 33]. This means that the teaching-learning with the BPM had a significant post delayed effect on student's achievement too. Therefore, it was found that the treatment given to the experimental group by conducting the BPM prepared by the researcher was highly effective in enhancing the achievement in Mathematics. Hence the developed Bridge Programme in Mathematics proved better to the experimental group students.

Performance in achievement test in Mathematics highlighted that teaching-learning integrated with the developed BPM enhanced the achievement in Mathematics of the students of the experimental group to some extent. This was cross checked by analysing the data collected using the tools 1 and 2. Also, mean of test in basic Mathematics indicated undesirable and poor performance of the students for prerequisite knowledge of what they have already learned.

- The comparison of total score on attitude towards Mathematics learning of the students in the experimental group revealed that the BPM had exerted no significant effect on the students' attitude towards Mathematics learning ($t = 0.65$, $p = 0.514$). [Vide table 34]

- The comparison of total score on beliefs in mathematical abilities of the students in the experimental group revealed that the BPM had an impact on improving the beliefs in mathematical abilities of students (t=7.47, p=0.00). [Vide table 35]. There was significant improvement in beliefs in mathematical abilities.
- The comparison of total score on basic Mathematics (prerequisite knowledge in Mathematics) of the students in the experimental group showed that there was significant effect on improving their basic Mathematics concepts (t =16.7, p = 0.00). [Vide table 36]. The analysis of test in basic concepts showed that the students in experimental group were good at basic concepts. So, the implementation of the BPM had helped the experimental group students in standard XI with respect to improvement in basic Mathematics.
- The comparison of total score on study habits in Mathematics of the students in the experimental group revealed that the BPM had significant effect on improving the study habits of the students (t = 3.61, p = 0.00). [Vide table 37]

Accordingly, there were remarkable improvements in beliefs in mathematical abilities, basic Mathematics and study habits in Mathematics, even though the attitude towards Mathematics remained the same. These findings presented definite support to the effectiveness of the Bridge Programme in enhancing achievement in Mathematics of standard XI students. Thus, there is significant difference in Mathematics achievement of students who participated in the teaching-learning process using the BPM in comparison with the achievement of students who did not participate in it.

Findings based on Students' Feedback

In order to fulfil the objective 7, the analysis of feedback expressed by the students in the experimental group was conducted. That also supported the major finding of the study, namely, effectiveness of the Bridge Programme with respect to students' achievement in Mathematics.

- The students expressed positive and favourable opinions towards teaching-learning together with the BPM (100%).
- The plans and strategies presented through the programme were found relevant and effective to enable the students for enhancing achievement in the subject (77.12%).
- Most of the students were in favour of the BPM and they liked it to follow in future too (80.51%). [Vide table 38]

Analysis of the feedback of the students indicated that they were benefited by the Bridge Programme in enhancing achievement in Mathematics. The students expressed favourable opinions towards teaching-learning together with the BPM.

Tenability of the Hypotheses

The tenability of the hypotheses set for the study was examined in the light of the analysis and interpretations presented in chapter IV. The results showed that out of nine hypotheses, seven were rejected as follows:

1. The null hypothesis 2 was rejected, since $t = 4.31$, $p = 0.00$. There was significant difference between the post-test mean scores of achievements in Mathematics of the experimental and control group students in standard XI.
2. The null hypothesis 3 was rejected, since $t = 5.93$, $p = 0.00$. There was significant difference between the means of gain scores of achievements in Mathematics of the experimental and control group students in standard XI.
3. The null hypothesis 4 was rejected, since $F = 35.684$, $p = 0.00$. There was significant effect of the Bridge Programme on achievement in Mathematics after controlling pre-experimental status in terms of pre-test scores of achievements in Mathematics.

4. The null hypothesis 5 was rejected, since $t = 4.31$, $p = 0.00$. There was significant difference between the delayed post-test mean scores of achievements in Mathematics of the experimental and control group students in standard XI.
5. The null hypothesis 7 was rejected, since $t = 7.47$, $p = 0.00$. There was significant difference between the pre-test and post-test mean scores of beliefs in mathematical abilities of the experimental group students in standard XI.
6. The null hypothesis 8 was rejected, since $t = 16.7$, $p = 0.00$. There was significant difference between the pre-test and post-test mean scores of basic Mathematics (pre-requisite knowledge in the subject) of the experimental group students in standard XI.
7. The null hypothesis 9 was rejected, since $t = 3.61$, $p = 0.00$. There was significant difference between the pre-test and post-test mean scores of study habits in Mathematics of the experimental group students in standard XI.

The study failed to reject the following two null hypotheses. Hence, they were retained as follows:

1. The null hypothesis 1 was failed to reject, since $t = 0.43$, $p = 0.6669$. It was retained. There was no significant difference between the pre-test mean scores of achievements in Mathematics of the experimental and control group students in standard XI.
2. The null hypothesis 6 was failed to reject, since $t = 0.65$, $p = 0.514$. It was also retained. There was no significant difference between the pre-test and post-test mean score of attitudes towards Mathematics of the experimental group students in standard XI.

Thus, the above discussions show that eight out of nine hypotheses have been proved in the right direction which increase the credibility of the research findings.

Conclusions of the Study

Based on the indicated findings and hypotheses testing, the following conclusions were drawn.

1) More than 50% of the students in standard XI mostly display a low/poor and moderate levels of attitude towards Mathematics, beliefs in mathematical abilities and study habits in Mathematics. Low/poor and moderate levels of students' attitude, beliefs and study habits in Mathematics indicate that there is space for guidance and training programmes.
2) The students in standard XI are in need of special programmes such as Bridge Programme in Mathematics.
3) The developed BPM comprising of eleven Mathematics learning and achievement enhancement plans and twenty-one strategies is employed during Mathematics teaching-learning of standard XI students at HSS level for enhancing achievement in Mathematics.
4) The students in standard XI are equivalent with respect to their achievement in Mathematics before the treatment using the BPM.
5) The teaching-learning together with the BPM is superior to the teaching-learning without using the BPM with respect to the achievement in Mathematics of standard XI students. The Bridge Programme in Mathematics helped the students in standard XI to improve their academic performance in Mathematics. Hence, the developed BPM is effective for enhancing achievement in Mathematics of standard XI students.

6) The developed BPM is effective not only in relation to mathematical achievement of standard XI students but also in relation to retention of the achievement in Mathematics. The retention of students' learning was superior when the teaching-learning was conducted using BPM.

7) Students' attitude towards Mathematics was not significantly changed. May be, it was due to the short period of time assigned for the implementation of the programme. The investigator is of the opinion that it would be possible, if more time is allotted for implementation and thus students can be quickly pushed towards a positive and significant direction. In fact, the investigator could have attempted for a longer period using the BPM to establish its effect on attitudinal changes of the students.

8) It is a fact that one of the major reasons of mathematical backwardness is a lack of command over basic Mathematics. The fundamental mathematical abilities can be mastered easily through the BPM. The students were helped to overcome the difficulties of basic Mathematics before learning new lessons in standard XI. As students' grasp of fundamental Mathematics was improved, their further mathematical achievement was enhanced.

9) The standard XI students' beliefs in mathematical abilities especially on concept formation and problem-solving in Mathematics can be enhanced through the BPM.

10) The BPM is efficient to foster good study habits in Mathematics among the standard XI students.

11) On the basis of the students' feedback, the BPM is a sufficient and effective programme for enhancing achievement in Mathematics.

In the present study, it has been concluded on the basis of the findings that Mathematics teaching-learning together with the Bridge Programme is found to be more effective than the routine ways of teaching-learning in producing enhanced achievement in Mathematics of standard XI students. On cross checking, it was found that the BPM has transformed the students' beliefs in mathematical abilities, basic concepts in Mathematics and study habits in Mathematics that in turn has helped in better achievement in Mathematics, even though there was no significant change found in the students' attitude towards Mathematics. Thus, those students who were exposed to the experimental condition (Bridge Programme in Mathematics) developed better achievement in Mathematics than their counter parts in the control group along with the development of certain other positive psychological and mathematical abilities.

All these findings and conclusions of the present study go along with earlier research findings and conclusions (Adeeb, 2020; Kurukkan, 2018; Godse, 2016; Patel, 2012; Pillai, 2009; Vyas, 1983). In addition, these conclusions are consistent with those of the conclusions obtained by the researcher Patel (2007) who developed a programme for enhancing achievement of the students of class X in Mathematics.

The present study will also have educational implications and recommendations for students, teachers, parents and educators. Also, there are suggestions for further research. These are given in the following chapter.

CHAPTER 6

IMPLICATIONS, RECOMMENDATIONS & SUGGESTIONS

- *Educational Implications of the Study*
- *Recommendations of the Study*
- *Suggestions for Further Research*

The present study reveals that the academic achievements in Mathematics of standard XI students can be enhanced using the teaching-learning process together with the Bridge Programme in Mathematics. This chapter discusses the educational implications of the study which probably help to improve Mathematics teaching-learning process of standard XI students at HSS level. This chapter also provides certain recommendations in the form of educational practices and the follow up research studies that can be pursued by the persons concerned and Mathematics teachers in particular.

Educational Implications of the Study

The quality of Mathematics teaching- learning and achievement in Mathematics is always a significant concern for students, teachers, parents as well as educators in general. In our education system, there are very few special efforts taken in schools to enrich Mathematics learning and achievement. Remedial and support programmes such as Bridge Programmes are, undoubtedly, the need of the time to safeguard the quality of education, in particular that of school education. Bridge programmes are very helpful in the sense that they make up various flaws and difficulties in fundamentals and basics of the subject and nurture students' attitude, beliefs and habits in a positive direction. The present study, focussing on the development of a Bridge Programme, has proved relevant and useful in resolving the learning loss and learning gaps of students in standard XI due to so many reasons. The Bridge Programme becomes all the more significant as it helped the students to overcome the learning loss and learning gaps produced by the COVID-19 pandemic situation.

The survey in phase I has revealed that many students' attitude, beliefs and study habits in Mathematics were at low/poor and moderate levels only and they were in need of enrichment programmes like BPM. So, the educators might consider the possibility of planning effective and efficient programmes along with usual classroom teaching-learning process. Any academic reforms that intend to bring about changes in Mathematics learning and achievement of students can make use of the present study- the developed Bridge Programme in Mathematics.

As it was found in the findings, the strategy of teaching-learning together with the Bridge Programme was so effective in enhancing the mathematical learning and achievement of standard XI students at HSS level. The educational and practical implication of the study signifies most in this context that the instructional strategy together with the BPM ensures better achievement in Mathematics compared to the routine method of teaching-learning strategies. This implies that there is a need for the educators to implement the BPM plans and strategies, because this will result into higher Mathematics achievements of the students in class XI. The findings will give an insight to all to recognize the different ideas of the programme to allow favourable environment to nurture students' mathematical achievement.

The major difficulty identified by Mathematics teachers of standard XI at HSS level was the lack of basic psychological and mathematical competencies among the students especially that of basic concepts in the subject. This study provides understanding for the causes of low achievement so that the educators can try to minimize such causes and will be able to give proper guidance and training. Thus, the developed BPM can be employed as an effective programme specially for optimizing the needed competencies.

It is a general belief that Mathematics is a difficult subject, but the fact is that any student of an average intelligence can learn this subject easily. It is also assumed that excellent learning and achievement of Mathematics demands special ability and intelligence, and therefore, most of the learners think to avoid the trouble of learning this subject thinking that they are not competent enough to learn Mathematics. Any student can study well by developing positive attitude towards Mathematics, beliefs in mathematical abilities with expertise in basic Mathematics and proper study habits. The study provides plans and strategies to the students of standard XI for enhancing their achievement in Mathematics through the developed BPM. The experiment in phase II has proved that the teaching-learning strategy together with the BPM ensures better achievement in Mathematics compared to the routine method of teaching-learning strategies.

Further, it will fill the previous research gaps of learning and achievement in Mathematics of standard XI students at HSS level by introducing effective guidelines and measures such as BPM plans and strategies for enhancing achievement in Mathematics. Hence, the researcher strongly advocates the implementation of the BPM with deliberate intention as it can provide positive results in the mathematical achievement of the students of plus one at HSS level which is a crucial stage for students as far as higher studies are concerned. In fact, wastage in education can be minimised if each student undergoes the Bridge Programme in Mathematics.

Recommendations of the Study

The present study has proved the effectiveness of the Bridge Programme for enhancing achievement in Mathematics of standard XI students. No doubt, it will immensely contribute for the betterment of Mathematics education as the findings will be beneficial for the students, teachers, parents, school administrators and educators in general with information which will help to formulate strategies for enhancing the teaching-learning process in Mathematics at HSS level.

- By adopting the plans and strategies in the BPM, the standard XI students can understand the important correlates of mathematical achievement such as attitude, beliefs, basic concepts and study habits in Mathematics.
- The standard XI students can be motivated for enhancing achievement in Mathematics with the help of BPM which contains plans and strategies for cultivating students' beliefs in mathematical abilities, basic knowledge and study habits in Mathematics and favourable attitude towards Mathematics to certain extent.
- As the learners in standard XI at HSS level face a lot of issues, especially in attitude, beliefs, basic concepts and study habits in Mathematics, they must be properly diagnosed, guided and trained to be excellent in their studies in Mathematics. In this context BPM arises as a bridge for their rescue.
- For students in standard XI to be successful in their studies, they can use plans and strategies in the BPM that are effective in improving their learning and achievement in Mathematics by paving a strong foundation of learning both psychologically and mathematically. It is not on the number of hours that makes studying effective but, the strategies employed in order to learn and assimilate the lessons taught in the classroom and studied at home.
- The findings of the study will be of great help to Mathematics teachers in such a way that the teachers themselves can be more innovative in their approaches of instruction and understand the individual differences of the students. School teachers can help the students by encouraging them to develop favourable attitude towards the subject, strong beliefs in mathematical abilities and to cultivate better study habits. Additionally, it is found that remedial instruction, especially in basic Mathematics, can assist

students who are having difficulty in learning. Truly, the BPM will be useful for teachers in daily teaching- learning process.

- Mathematics teachers can use the programme to make the standard XI students at HSS level active participants in the learning process. It is necessary that a Mathematics teacher is responsible not only to transact the content matter of the subject effectively, but also to diagnose, guide and train the students acquiring 'learning to learn' capabilities.
- Teacher mentorship and encouragement are significant determinants of mathematical achievement of the students. Teachers should make themselves mentors for learning and not information providers in the classroom. For an example, the teacher who tests the previous knowledge of the students and imparts it to those who lack it before starting a new lesson contributes much for the success of Mathematics learning and achievement. Similarly, the unit test after the completion of each unit is beneficial in fixing the concepts in mind and so on.
- Parents are the first teachers of children, so right from home they should try to create the home environment which nurtures better attitude, beliefs and study habits in their children. They must create a home environment favourable to their children's learning and achievement in Mathematics.
- The administrators may design their activities in the light of the findings of the study. The Heads of the schools may see that the students and teachers make the maximum use of what they have acquired from the BPM in Mathematics teaching- learning process in school and home. It is better to arrange orientation programmes, seminars and workshops for students as well as teachers based on the plans and strategies mentioned in the BPM for better results in Mathematics.

- The educators can incorporate the Bridge Programme in Mathematics with the usual teaching-learning process in Mathematics as the instructional practices together with the BPM is found to be more effective in enhancing the achievement in Mathematics of standard XI students.
- Due to COVID-19 pandemic crisis, almost all the areas of human life were severely affected and education scenario was not an exemption, especially school education and Mathematics teaching-learning. Now it is the best time to include a set of inputs in educational process like Bridge Programme plans and strategies. It is advocated that a long-term Bridge Programme in Mathematics would be desirable to include consciously, deliberately and systematically as part of the curriculum by the policy makers requiring all teachers and students to apply the BPM at all levels of education.

Based on these observations, the investigator suggests that the BPM be introduced for standard XI students as it heavily supports Mathematics teaching-learning at HSS level. The BPM plans and strategies or the essence of the programme may be incorporated as additional resources into the regular class room instruction for maintaining quality in Mathematics education for the standard XI students. The researcher recommends that the developed BPM plans and strategies be accepted and implemented for enhancing learning and achievement in Mathematics. The impact is that students' abilities and learning achievement of Mathematics can be enhanced.

Suggestions for Further Research

The present study proved that even a short-term Bridge Programme was beneficial to enhance achievement in Mathematics of standard XI students. The investigator while conducting the present study identified a few allied problems and would like to suggest the following areas for further research.

1) It was remarked that the implementation of the BPM in the present study was confined only to 30 days duration, 11 plans and 21 strategies. The same type of programme can be implemented for longer periods, choosing more plans and strategies to produce outstanding results.
2) Same programme can be administered among a large and wider representative sample of the population, especially during experimentation phase, by selecting more schools and HSS teachers in Mathematics as Co-researchers.
3) More select correlates of Mathematics learning in relation to achievement in Mathematics of HSS students such as mathematical aptitude, self-efficacy, locus of control can be included in the preparation of the Programme and the validation of the Programme can be done.
4) A study can be conducted on interaction effect of gender (male and female), locality (urban and rural), school type (government, aided and unaided) and the Bridge Programme treatment on achievement in Mathematics among students of plus one in Kerala.
5) An Intervention programme can be developed for the progress of pupils among mathematically backward students at Higher Secondary level i.e., preparation of a programme for improving the achievement of underachievers and its experimental validation may be taken up.
6) Similar studies may be undertaken for other subjects of HSS curriculum.
7) The study can also be extended to Secondary School classes, Upper Primary School classes and Lower Primary School classes by suitably modifying the Bridge Programme. i.e., similar programmes can be developed to enhance learning, performance and achievement in Mathematics of students at any school levels. Such types of studies at all levels will aid in boosting the mathematical achievement of pupils.

8) The present study can be extended by increasing the number of dependent variables such as total performance in Mathematics of HSS students and problem solving in Mathematics.

9) The present study was conducted among standard XI students following Kerala State Board Syllabus. The study can be conducted among CBSE and ISC syllabus students of standard XI.

To sum up, the researcher has undertaken the present study and developed the Bridge Programme with a view to enhancing achievement in Mathematics of standard XI students. The preparation of such a programme gradually evolved in the HSS Mathematics class rooms of the researcher taking years of observations and experiments. It is found that the learning and achievement of HSS students are badly affected as the basis in all areas of Mathematics learning and achievement is not properly administered to the students of standard XI. These observations are proved scientifically by undertaking the present study. Hence, the researcher concludes that the Bridge Programme in Mathematics developed as a part of the research study or any such scientifically designed innovative programmes will enhance the learning and achievement in Mathematics of standard XI students.

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APPENDICES

Appendix A

FAROOK TRAINING COLLEGE

FAROOK COLLEGE P.O. 673632

List of Schools whose Academic Master Plans are Referred

1) St. Joseph's Boys' HSS, Kozhikode

2) Providence Girls' HSS, Kozhikode

3) St. Joseph's Anglo-Indian Girls' HSS, Kozhikode

4) Himayathul Islam HSS, Kozhikode

5) Savio HSS, Devagiri

6) Government Model HSS, Kozhikode

7) Government Girls' HSS, Nadakkavu

8) GHSS, Karaparamba

9) Government HSS, Medical College Campus, Chevayoor

10) Government HSS, East Hill

Appendix B

FAROOK TRAINING COLLEGE

FAROOK COLLEGE P.O. 673632

Format of Student Profile

Name of the Student:... School:.............................

1. Favourable Attitude: -
   Items 1 to 12 of Attitude and Belief Scale; part 2 (maximum Score: 60)
   Student score: ....
2. Unfavourable Attitude: -
   Items 13 to 17 of Attitude and Belief Scale; part 2 (maximum score: 25)
   Student score: ....
3. Concentration: -
   Items 1 to 3 of Study Habits Scale (maximum score: 15)
   Student score: ....
4. Time Management: -
   Items 4 to 7 of Study Habits Scale (maximum score: 20)
   Student score: ....
5. Study Aids: -
   Items 8 to 13 of Study Habits Scale (maximum score: 30)
   Student score: ....
6. Basic Concept: -
   Items 1 to 3 of Attitude and Belief Scale; part 3 (maximum score: 15)
   Student score: .... &
   Test in Basic Mathematics (maximum score: 30)
   Student score: ....
7. Comprehension: -
   Items 4 to 7 of Attitude and Belief Scale; part 3 (maximum score: 20)
   Student score: ....
8. Problem Solving: -
   Items 8 to 13 of Attitude and Belief Scale; part 3 (maximum score: 30)
   Student score: ....
9. Mathematics Study Method: -
   Items 14 to 20 of Study Habits Scale (maximum score: 35)
   Student score: ....
10. Student Efforts: -
    Items 21 to 25 of Study Habits Scale (maximum score: 25)
    Student score: ....
11. Test Management: -
    Items 26 to 37 of Study Habits Scale (maximum score: 60)
    Student score: ....
12. Remarks: -
    Areas of strength of the student: .... &
    Areas of weakness of the student: ....

Appendix C & D

FAROOK TRAINING COLLEGE

FAROOK COLLEGE P.O. 673632

List of Schools Selected for Phases I & II

List of Schools Selected for Survey in Phase I

Sl. No.	Name	Locality	Type
1	Govt. HSS, East Hill	Urban	Government
2	Govt. Model HSS, Kozhikode	Urban	Government
3	Govt. HSS, Medical College Campus, Chevayoor	Urban	Government
4	Govt. HSS, NGO Quarters, Marikkunnu	Urban	Government
5	GHSS, Karaparamba	Urban	Government
6	GBHSS, Parayancherry, Puthiyara	Urban	Government
7	Rahmania HSS for Handicapped, Medical College	Urban	Aided
8	Zamorin's HSS, Chalappuram	Urban	Aided
9	Malabar Christian College HSS, Kozhikode	Urban	Aided
10	Savio HSS, Devagiri	Urban	Aided
11	Ramakrishna Mission HSS, Kozhikode	Urban	Aided
12	MM VHSS, Parappil	Urban	Aided
13	Himayathul Islam HSS, Kozhikode	Urban	Aided
14	Silver Hills HSS, Marikkunnu	Urban	Unaided
15	Presentation HSS, Chevayoor	Urban	Unaided
16	JDT Islam HSS, Vellimadukunnu	Urban	Unaided
17	Govt. HSS, Koduvally	Rural	Government
18	Govt. HSS, Kokkallur	Rural	Government
19	Govt. HSS, Mavoor	Rural	Government
20	Govt. HSS, Poonur	Rural	Government
21	Govt. HSS, Narikuni	Rural	Government
22	Govt. HSS, Kakkodi	Rural	Government
23	Govt. VHSS, Atholi	Rural	Government
24	Govt. HSS, Peringolam	Rural	Government
25	Govt. HSS, Neduvannur	Rural	Government
26	Nanminda HSS, Nanminda	Rural	Aided

Sl. No.	Name	Locality	Type
27	Markaz HSS, Karanthoor	Rural	Aided
28	St. Sebastian’s HSS, Koodaranji	Rural	Aided
29	Nochad HSS, Nochad	Rural	Aided
30	Chennamangallur HSS, Mukkam	Rural	Aided
31	Palora HSS, Ulliyeri	Rural	Aided
32	Thiruvangoor HSS, Thiruvangoor	Rural	Aided
33	Holy Family Higher Secondary School, Kattippara	Rural	Aided
34	St. Mary’s Higher Secondary School, Koodathai	Rural	Aided
35	Mohammed Ali Johar HSS, Elettil	Rural	Aided
36	St. Mary’s Higher Secondary School, Maruthomkara	Rural	Aided
37	Ilahiya HSS, Kappad	Rural	Unaided
38	Auxiliam Nava Jyothi HSS, Kunnamangalam	Rural	Unaided
39	Venerini E M HSS, Feroke	Rural	Unaided

List of Schools Selected for Experiment in Phase II

1. St Joseph’s Boys’ HSS, Kozhikode
2. Providence Girls’ HSS, Kozhikode

Appendix E

FAROOK TRAINING COLLEGE

FAROOK COLLEGE P.O. 673632

MATHEMATICS STUDY ATTITUDE AND BELIEF SCALE

(Preliminary Draft)

Dr. Noushad. P P
Associate Professor
SGTDS, MG University

Philip Joseph
Research Scholar
Farook Training College

General Instruction: Dear students, kindly give the required responses as directed. All the responses provided by you will be kept confidential and used for research purpose only.

PART I: Personal Details

Instruction: Kindly provide the following information. Write in the space provided or show your response by putting a '✓' for the items against the appropriate alternative.

1) Name: ______________________________ **2) Gender: Boy/Girl**

3) School: ______________________________

4)Type of School: Govt./Aided/Unaided **5) Locality of School: Urban/Rural**

6) SSLC/THSLC/CBSE/ICSE Score/Percentage/Grade in Mathematics: _______

PART II: Students' Attitude towards Mathematics Learning

Instructions: Please read the following statements related with your attitude towards mathematics learning and select the extent to which you agree or disagree with them. Then indicate your level of agreement by bubbling the circle given along. Do not bother about right or wrong answers. What you feel about each statement is the appropriate answer.

Sl. No.	Items	Strongly agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
1	I believe that I am capable of getting A or A+ grade this year	O	O	O	O	O
2	I find it difficult to learn each and every topic in Mathematics	O	O	O	O	O
3	I like to study Mathematics	O	O	O	O	O
4	I am preparing for competitive examinations like N T S E/ K V P Y /Mathematics Olympiad	O	O	O	O	O
5	I am proud of being a student of Mathematics	O	O	O	O	O
6	I would prefer Mathematics as one of my subjects in higher studies	O	O	O	O	O

Sl. No.	Items	Strongly agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
7	I dream about where my Mathematics studies will lead me	O	O	O	O	O
8	I am planning a Mathematics-related career	O	O	O	O	O
9	Mathematics is my favourite subject	O	O	O	O	O
10	I sincerely participate in Mathematics club activities such as quizzes, seminars, fairs	O	O	O	O	O
11	I read Maths-related books and magazines	O	O	O	O	O
12	Solving Mathematics problems is my hobby	O	O	O	O	O
13	I feel uncomfortable and nervous in Maths class	O	O	O	O	O
14	I feel blank when my Maths teacher asks me questions in the class	O	O	O	O	O
15	During Maths exam, I tend totally blank and cannot remember what I have learned before	O	O	O	O	O
16	I think learning Mathematics is not essential to my career development	O	O	O	O	O
17	I feel dull and bored whenever I sit to learn Mathematics	O	O	O	O	O

PART III: Students' Beliefs in Mathematical Abilities

Instructions: Kindly read the following statements related with beliefs in your Mathematical abilities and indicate your level of agreement with them by bubbling the circle given along.

Sl. No	Items	Strongly agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
1	I am not able to recall Mathematics concepts studied in lower classes whenever required	O	O	O	O	O
2	I know the basic concepts of school Mathematics, so I can understand the new lessons completely	O	O	O	O	O
3	Before I start learning new lessons in standard XI, I thoroughly revise the previous topics required which I already learnt	O	O	O	O	O

Sl. No	Items	Strongly agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
4	I must learn Mathematics concepts meaningfully	O	O	O	O	O
5	I find it difficult to understand the language and symbols of Mathematics	O	O	O	O	O
6	I by-heart certain concepts in Mathematics without sufficient understanding	O	O	O	O	O
7	I try to solve Maths problems with full understanding	O	O	O	O	O
8	I feel good when I solve Maths problems by myself	O	O	O	O	O
9	When a Maths problem is given to me, I simply glance at it and leave it there	O	O	O	O	O
10	I cannot understand the relationship between the steps of solving a Mathematics problem	O	O	O	O	O
11	I make number of mistakes while solving problems in Mathematics	O	O	O	O	O
12	While solving problems in Mathematics, I give priority to accuracy than speed	O	O	O	O	O
13	I am able to apply the most appropriate mathematical method to solve a given problem	O	O	O	O	O

Thank You for Your Participation

Appendix F

FAROOK TRAINING COLLEGE

FAROOK COLLEGE P.O. 673632

MATHEMATICS STUDY ATTITUDE AND BELIEF SCALE

(Final Form)

Dr. Noushad. P P
Associate Professor
SGTDS, MG University

Philip Joseph
Research Scholar
Farook Training College

General Instruction: Dear students, kindly give the required responses as directed. All the responses provided by you will be kept confidential and used for research purpose only.

PART I: Personal Details

Instruction: Kindly provide the following information. Write in the space provided or show your response by putting a '✓' for the items against the appropriate alternative.

1) Name: ______________________________ 2) Gender: Boy/Girl
3) School: ____________________________
4)Type of School: Govt./Aided/Unaided 5) Locality of School: Urban/Rural
6) SSLC/THSLC/CBSE/ICSE Score/Percentage/Grade in Mathematics: _______

PART II: Students' Attitude towards Mathematics Learning

Instructions: Please read the following statements related with your attitude towards mathematics learning and select the extent to which you agree or disagree with them. Then indicate your level of agreement by bubbling the circle given along. Do not bother about right or wrong answers. What you feel about each statement is the appropriate answer.

Sl. No	Items	Strongly agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
1	I believe that I am capable of getting A or A+ grade this year	O	O	O	O	O
2	I find it difficult to learn each and every topic in Mathematics	O	O	O	O	O
3	I like to study Mathematics	O	O	O	O	O
4	I am preparing for competitive examinations like N T S E/ K V P Y /Mathematics Olympiad	O	O	O	O	O
5	I am proud of being a student of Mathematics	O	O	O	O	O

Sl. No	Items	Strongly agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
6	I would prefer Mathematics as one of my subjects in higher studies	O	O	O	O	O
7	I dream about where my Mathematics studies will lead me	O	O	O	O	O
8	I am planning a Mathematics-related career	O	O	O	O	O
9	Mathematics is my favourite subject	O	O	O	O	O
10	I sincerely participate in Mathematics club activities such as quizzes, seminars, fairs	O	O	O	O	O
11	I read Maths-related books and magazines	O	O	O	O	O
12	Solving Mathematics problems is my hobby	O	O	O	O	O
13	I feel uncomfortable and nervous in Maths class	O	O	O	O	O
14	I feel blank when my Maths teacher asks me questions in the class	O	O	O	O	O
15	During Maths exam, I tend totally blank and cannot remember what I have learned before	O	O	O	O	O
16	I think learning Mathematics is not essential to my career development	O	O	O	O	O
17	I feel dull and bored whenever I sit to learn Mathematics	O	O	O	O	O

PART III: Students' Beliefs in Mathematical Abilities

Instructions: Kindly read the following statements related with beliefs about your mathematical abilities and indicate your level of agreement with them by bubbling the circle given along.

Sl. No.	Items	Strongly agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
1	I am not able to recall Mathematics concepts studied in lower classes whenever required	O	O	O	O	O
2	I know the basic concepts of school Mathematics, so I can understand the new lessons completely	O	O	O	O	O
3	Before I start learning new lessons in standard XI, I thoroughly revise the previous topics required which I already learnt	O	O	O	O	O

Sl. No.	Items	Strongly agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
4	I must learn Mathematics concepts meaningfully	O	O	O	O	O
5	I find it difficult to understand the language and symbols of Mathematics	O	O	O	O	O
6	I by-heart certain concepts in Mathematics without sufficient understanding	O	O	O	O	O
7	I try to solve Maths problems with full understanding	O	O	O	O	O
8	I feel good when I solve Maths problems by myself	O	O	O	O	O
9	When a Maths problem is given to me, I simply glance at it and leave it there	O	O	O	O	O
10	I cannot understand the relationship between the steps of solving a Mathematics problem	O	O	O	O	O
11	I make number of mistakes while solving problems in Mathematics	O	O	O	O	O
12	While solving problems in Mathematics, I give priority to accuracy than speed	O	O	O	O	O
13	I am able to apply the most appropriate mathematical method to solve a given problem	O	O	O	O	O

Thank You for Your Participation

Appendix G

FAROOK TRAINING COLLEGE

FAROOK COLLEGE P.O. 673632

MATHEMATICS STUDY HABITS SCALE

(Preliminary Draft)

Dr. Noushad. P P
Associate Professor
SGTDS, MG University

Philip Joseph
Research Scholar
Farook Training College

General Instruction: Dear students, kindly give the required responses as directed. All the responses provided will be kept confidential and used for research purpose only.

PART I: Personal Details

Instruction: Kindly provide the following information. Write in the space provided or show your response by putting a '✓' for the items against the appropriate alternative.

1) Name: ____________________________ **2) Gender: Boy/Girl**

3) School: ___________________________

4)Type of School: Govt./Aided/Unaided **5) Locality of School: Urban/Rural**

6) SSLC/THSLC/CBSE/ICSE Score/Percentage/Grade in Mathematics: _______

PART II: Study Habits in Mathematics

Instructions: After reading the following statements, kindly rate yourself honestly based on what you actually do and bubble the circle given along

Sl. No	Items	Always	Often (Frequently)	Sometimes	Seldom (Rarely)	Never
1	With deep concentration I can study Mathematics	O	O	O	O	O
2	Most of the time allotted to Mathematics study I use social media or play online games or watch television	O	O	O	O	O
3	When I start studying Mathematics, a lot of things flow into my mind or I start daydreaming	O	O	O	O	O
4	I study Mathematics according to a self- framed time table	O	O	O	O	O
5	I don't have daily, weekly and monthly plans to study Mathematics	O	O	O	O	O

Sl. No	Items	Always	Often (Frequently)	Sometimes	Seldom (Rarely)	Never
6	I study Mathematics at a specific time of the day / week /month	O	O	O	O	O
7	I postpone the study of Mathematics saying that I will start tomorrow	O	O	O	O	O
8	I study Mathematics in a quiet and comfortable place	O	O	O	O	O
9	I use the N C E R T Mathematics Text Book to study the concepts and problems of Mathematics	O	O	O	O	O
10	I do not use reference books and previous years question papers of Mathematics for practice	O	O	O	O	O
11	I keep the class notebook neat and complete	O	O	O	O	O
12	I visit SAMAGRA and other websites for studying Mathematics	O	O	O	O	O
13	I don't like the company of students who study Mathematics regularly	O	O	O	O	O
14	I go through the topics in the text book before I come to Mathematics class	O	O	O	O	O
15	I like to skip certain Mathematics classes	O	O	O	O	O
16	I review my notes and text book before I start home work	O	O	O	O	O
17	I prepare my own study notes on the basis of regular classes and references	O	O	O	O	O
18	I do Mathematics home works daily	O	O	O	O	O
19	After learning mathematical concepts, I try to meditate and write them	O	O	O	O	O
20	I do not practice problems in Mathematics every day	O	O	O	O	O
21	I discuss the doubtful and unclear topics in Mathematics with my Mathematics teacher or classmates	O	O	O	O	O
22	I don't seek help from my Mathematics teacher or classmates for the problems in Mathematics which I fail to solve	O	O	O	O	O

Sl. No	Items	Always	Often (Frequently)	Sometimes	Seldom (Rarely)	Never
23	I make charts, diagrams and tables to organize Mathematics concepts	O	O	O	O	O
24	If a topic in Mathematics is to be learned, I study and memorize it part by part	O	O	O	O	O
25	The lessons in Mathematics I have already learned is repeated weekly and monthly	O	O	O	O	O
26	I attend as many test papers as possible in each chapter	O	O	O	O	O
27	I practice mock tests using previous year question papers	O	O	O	O	O
28	Since I am afraid of Mathematics exam, I feel tensed	O	O	O	O	O
29	I cannot sleep the night before Maths exam	O	O	O	O	O
30	I do not study for a long time in the night before Mathematics exam	O	O	O	O	O
31	I study Mathematics till I enter the exam hall	O	O	O	O	O
32	I do not read very carefully the entire question paper before I begin to answer	O	O	O	O	O
33	First, I answer the questions which I know well in serial order and present them neatly	O	O	O	O	O
34	While writing exam, I find it difficult to express what I wish to write	O	O	O	O	O
35	Because of tension and nervousness, I make silly mistakes	O	O	O	O	O
36	I check my answers after I finish answering	O	O	O	O	O
37	I am not able to complete Mathematics exam on time	O	O	O	O	O
38	I lose marks due to illegible presentations in answering	O	O	O	O	O

Thank You for Your Participation

Appendix H

FAROOK TRAINING COLLEGE

FAROOK COLLEGE P.O. 673632

MATHEMATICS STUDY HABITS SCALE

(Final Form)

Dr. Noushad. P P
Associate Professor
SGTDS, MG University

Philip Joseph
Research Scholar
Farook Training College

General Instruction: Dear students, kindly give the required responses as directed. All the responses provided will be kept confidential and used for research purpose only.

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2	Most of the time allotted to Mathematics study I use social media or play online games or watch television	O	O	O	O	O
3	When I start studying Mathematics, a lot of things flow into my mind or I start daydreaming	O	O	O	O	O
4	I study Mathematics according to a self- framed time table	O	O	O	O	O
5	I do not have daily, weekly and monthly plans to study Mathematics	O	O	O	O	O
6	I study Mathematics at a specific time of the day / week /month	O	O	O	O	O

Sl. No	Items	Always	Often (Frequently)	Sometimes	Seldom (Rarely)	Never
7	I postpone the study of Mathematics saying that I will start tomorrow	O	O	O	O	O
8	I study Mathematics in a quiet and comfortable place	O	O	O	O	O
9	I use the N C E R T Mathematics Text Book to study the concepts and problems of Mathematics	O	O	O	O	O
10	I do not use reference books and previous years question papers of Mathematics for practice	O	O	O	O	O
11	I keep the class notebook neat and complete	O	O	O	O	O
12	I visit SAMAGRA and other websites for studying Mathematics	O	O	O	O	O
13	I don’t like the company of students who study Mathematics regularly	O	O	O	O	O
14	I go through the topics in the text book before I come to Mathematics class	O	O	O	O	O
15	I like to skip certain Mathematics classes	O	O	O	O	O
16	I review my notes and text book before I start home work	O	O	O	O	O
17	I prepare my own study notes on the basis of regular classes and references	O	O	O	O	O
18	I do Mathematics home works daily	O	O	O	O	O
19	After learning mathematical concepts, I try to meditate and write them	O	O	O	O	O
20	I do not practice problems in Mathematics every day	O	O	O	O	O
21	I discuss the doubtful and unclear topics in Mathematics with my Mathematics teacher or classmates	O	O	O	O	O
22	I don’t seek help from my Mathematics teacher or classmates for the problems in Mathematics which I fail to solve	O	O	O	O	O
23	I make charts, diagrams and tables to organize Mathematics concepts	O	O	O	O	O
24	If a topic in Mathematics is to be learned, I study and memorize it part by part	O	O	O	O	O

Sl. No	Items	Always	Often (Frequently)	Sometimes	Seldom (Rarely)	Never
25	The lessons in Mathematics I have already learned is repeated weekly and monthly	O	O	O	O	O
26	I attend as many test papers as possible in each chapter	O	O	O	O	O
27	I practice mock tests using previous year question papers	O	O	O	O	O
28	Since I am afraid of Mathematics exam, I feel tensed	O	O	O	O	O
29	I cannot sleep the night before Maths exam	O	O	O	O	O
30	I study Mathematics till I enter the exam hall	O	O	O	O	O
31	I do not read very carefully the entire question paper before I begin to answer	O	O	O	O	O
32	First, I answer the questions which I know well in serial order and present them neatly	O	O	O	O	O
33	While writing exam, I find it difficult to express what I wish to write	O	O	O	O	O
34	Because of tension and nervousness, I make silly mistakes	O	O	O	O	O
35	I check my answers after I finish answering	O	O	O	O	O
36	I am not able to complete Mathematics exam on time	O	O	O	O	O
37	I lose marks due to illegible presentations in answering	O	O	O	O	O

Thank You for Your Participation

Appendix I

FAROOK TRAINING COLLEGE

FAROOK COLLEGE P.O. 673632

QUESTIONNAIRE FOR THE ASSESSMENT OF NEED OF BRIDGE PROGRAMME

Dr. Noushad. P P
Associate Professor
SGTDS, MG University

Philip Joseph
Research Scholar
Farook Training College

General Instruction: Dear students, kindly give the required responses as directed. All the responses provided will be kept confidential and used for research purpose only.

PART I: Personal Details

Instruction: Kindly provide the following information. Write in the space provided or show your response by putting a '✓' for the items against the appropriate alternative.

1) Name: ______________________________ 2) Gender: Boy/Girl
3) School: ____________________________
4)Type of School: Govt./Aided/Unaided 5) Locality of School: Urban/Rural
6) SSLC/THSLC/CBSE/ICSE Score/Percentage/Grade in Mathematics: _______

PART II: Questionnaire

Instructions: Please read the following questions and bubble the appropriate answer. Remember only one marking should be done for each question and there is no right or wrong answer here. You are requested to reflect your opinion. Kindly respond to all the items.

Sl. No	Items	Yes	No
1	Have you ever felt the need for any special programmes to improve Mathematics learning and achievement?	O	O
2	Did you participate in any programmes for enhancing achievement in Mathematics?	O	O
3	Do you feel that diagnosis, guidance and training (bridge) programmes in Mathematics will have impact on Mathematics learning and achievement?	O	O
4	Do you think positive attitude towards Mathematics can be developed through special programmes?	O	O

Sl. No	Items	Yes	No
5	Do you think that it is very useful to get guidance on correcting the shortcomings in attitude towards Mathematics?	O	O
6	Do you think it is useful to get training in basic concepts in Mathematics before learning new lessons in class XI?	O	O
7	Do you think concept formation and problem solving in Mathematics can be developed through special programmes?	O	O
8	Do you think it is beneficial to get training in good Mathematics study habits?	O	O
9	Do you think it is useful to get training in preparing for Mathematics examinations?	O	O
10	Do you like to participate in diagnosis, guidance and training (bridge) programmes in Mathematics scheduled with regular Mathematics classes?	O	O

Thank You for Your Participation

Appendix J

FAROOK TRAINING COLLEGE

FAROOK COLLEGE P.O. 673632

BRIDGE PROGRAMME STRATEGIES AND THEIR DESCRIPTIONS

Sl. No.	Plan	Strategy	Description
1	Favourable Attitude Boosters	1)Motivation by Motivational Capsules	➢ Motivation is the prime factor in initiating a child to study. ➢ The investigator himself will conduct a motivational talk focussing on the importance of favourable attitude towards Mathematics learning and achievement. A motivated learner learns and achieves much more than an indifferent learner in Mathematics. Pupils learn effectively when they are motivated. ➢ Student motivation is possible by stating the number of benefits of learning the subject Mathematics meticulously. ➢ Power of achievement motive is immense. Mathematics is necessary for various courses, competitive tests and careers. Explain why and how Mathematics learning and excellent achievements help the students in future (e g: winning the competitive examinations, getting into prestige institutions, finding good job) ➢ There are two basic classifications of motivation- intrinsic and extrinsic. Intrinsic motivation arises from within, namely, a desire to learn to achieve the mastery of the subject; whereas extrinsic motivation is originating from something external, namely, the drive to achieve external rewards. Both play motivational roles in the academic achievement. Intrinsically motivated students are naturally motivated to learn. Extrinsically motivated students are motivated by external influences. ➢ There is external as well as internal motivators. Intrinsic motivation (satisfaction and self-development) has better long-term benefits for learning and achievement in Mathematics at HSS level. ➢ It is critical to get and hold the learners' interest in learning Mathematics. This can be done by stating the various purposes, relevance and usefulness of the subject. Students should be encouraged to keep a passion in learning more and more.

<table>
<tr><th>Sl. No.</th><th>Plan</th><th>Strategy</th><th>Description</th></tr>
<tr><td rowspan="2"></td><td rowspan="2">Favourable Attitude Boosters</td><td>1)Motivation by Motivational Capsules</td><td>

Promote them to take membership in Mathematics club and participate actively in various club activities such as reading history of Mathematics, biographies of Mathematicians, seminar presentations, power point presentations etc.
Students' confidence level should be enhanced. The ability to determine to learn the subject is much more important. Students have to believe that they can learn Mathematics and achieve better.
Photocopies of print materials like articles and selected pages of relevant books may be distributed for thought and discussion.
Audio clippings and video presentations of great Mathematicians are provided directly.
Students may be encouraged to view inspirational and motivational programmes in Kite Victors Channel.

</td></tr>
<tr><td>2) Goal Setting</td><td>

Prepare students for short-term and long-term goals in Mathematics learning and achievement. Students are expected to plan for them and work towards achieving them.

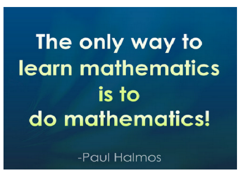
The set goals should be SMART (Specific, Measurable, Achievable, Realistic and Time bound)

Setting SMART goals can significantly impact better performance in the subject. Goal setting involves the development of an action plan designed in order to motivate and guide a person or group towards a goal. It means that a person has committed thought, emotion and behaviour towards attaining the goal. Top- level athletes, successful business people and achievers in all fields all set goals. It helps a person remain focused on being successful, stay away from distractions and will help with motivation.

For the selected students in the class XI (experimental group), the attainable goal should be to succeed with the best grade (minimum of C plus or 50% in Mathematics) and all efforts should be directed to that.
</td></tr>
</table>

Sl. No.	Plan	Strategy	Description
	Favourable Attitude Boosters	2) Goal Setting	➢ Use variety of methods and approaches (e.g., presentations, discussions, lectures) to set goals ➢ Provide Mathematics related courses and careers (e.g., official publications by career guidance cell) to get help in setting the desired goal. <u>High level courses and opportunities in the field of Mathematics:</u>  MSc and Integrated MSc -PhD courses can be taken at IIT, IISc, IISER, NISER, ISI, CMI etc. B Tech students can also get admission in many institutions. In addition to Mathematics, there are opportunities for further study in various disciplines such as Statistics, Operations Research, Computer Science, Data Science, Econometrics, Financial Engineering, Actuarial Science, Bio Statistics and Bioinformatics. MSc Data Science from Chennai Mathematical Institute, Post Graduate Diploma in Business Analytics jointly conducted by ISI and IIT Gorakhpur and IIM Kolkata, various MA courses in Industrial Mathematics & Scientific Computing conducted by IIT Madras, MSc Population from International Institute of Population Studies Mumbai. The programs are suitable for Maths graduates. Those who have studied Mathematics as a subject at the undergraduate level can join MSc Industrial Mathematics at the University of Pune, MSc Operations Research at Delhi University, MSc Economics at IGI DR Mumbai, MSc Mathematics Education jointly conducted by Delhi University and Jamia Millie Islamia, and MSc Maths & Computing at IIT Guwahati. After studying MSc / BTech, there are many opportunities in India for research. The following are some of the exams that Maths graduate students must prepare for higher studies: National Board of Higher Mathematics Scholarship Test JAM- Mathematics / Statistics GATE Mathematics / Statistics There are some other institutes in India which offer higher education opportunities • Centre for Applicable Mathematics, Bengaluru • Institute of Mathematical Sciences, Chennai

Sl. No.	Plan	Strategy	Description
			• Harish Chandra Research Institute, Allahabad • Institute of Physics, Bhuvneshwar • Ramanujan Institute of Advanced Studies in Mathematics, Chennai Almost all Arts & Science colleges in Kerala have undergraduate / postgraduate courses in Mathematics and Statistics. PG and P h. D courses are also available in university departments. Kerala School of Mathematics, Kozhikode is a specialized institute which offers integrated MSc -Ph.D. courses and research programs. IIT Palakkad and IIIT Kottayam also have excellent research facilities. There are many study opportunities outside of India in Mathematics and related subjects. Post-graduate employment opportunities are not limited to teaching. Mathematical experts are needed in many fields such as research, space science, IT, data analytics, government departments, banking, finance and business. ➢ The students are promoted to decide goals in Mathematics, write them on a paper and paste it on the study place or table. ➢ The students are insisted to read it regularly so that it keeps reminding about the set goals.
2	**Unfavourable Attitude Reducers**	3)Walk with Top Achievers/Toppers meet	➢ Success stories of top achievers in Mathematics, public and competitive examinations are very beneficial. Hence such common programmes are arranged by the investigator by himself for students. ➢ The students are directed to follow those students who get A plus grade in Mathematics i.e., watch them carefully and learn the plus points as to know how they study; how they overcome study related problems. ➢ Related materials (videos, audio, power point presentations) are provided directly or through the online platforms as reading, listening and watching experiences ➢ It is also a good idea to meet people regularly who can help for achieving the study goals.

Sl. No.	Plan	Strategy	Description
	Unfavourable Attitude Reducers	4)Auto Suggestion	➢ Start paying attention to the self-talk. Whenever he/she catches himself/herself in negative self-talk, replace it with more encouraging positive words. ➢ Actually, the learner oneself gives suggestions to the subconscious mind by keeping the conscious mind totally active. The principle of auto suggestion is to keep continuously reminding the subconscious mind and keep reminding it about what you want to do and store it there so that it gradually begins working. It keeps you to get rid of all worries and tensions. ➢ If the student continuously keeps reminding the subconscious mind about the negative attitude and instructs that 'I am capable of giving them up', then the student can gradually move away from those habits.  ➢ One has to say over and over again that 'I need to study Maths well', 'I can study Mathematics' or 'I determine to study Mathematics' and at the same time one has to have good faith, hope and enthusiasm in the mind that it can happen i.e., say with full emotion and visualize that one has achieved it. Focus the entire attention on the meaning of what is being said during this exercise. In order to make auto suggestion work, it must trigger feelings. The more meaningful auto suggestion is, the more effective it is. ➢ Also, by-heart famous quotes and enchant them frequently. Number of such quotes can be provided directly. 

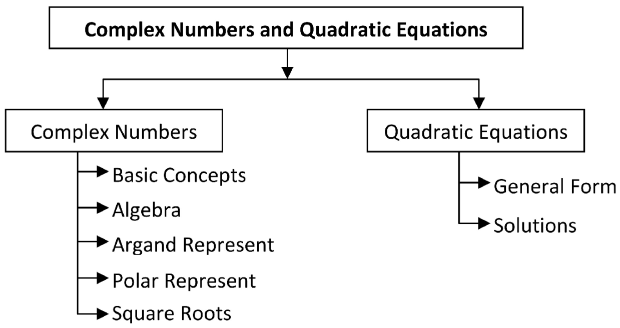
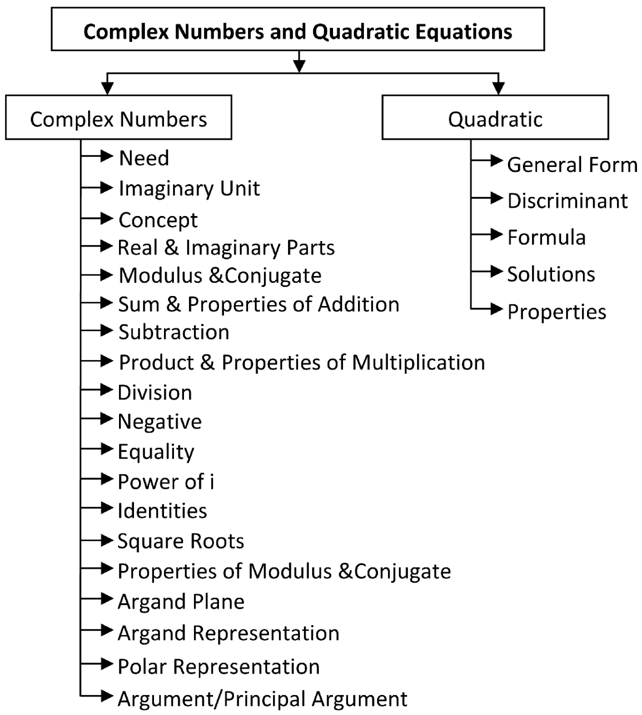
Sl. No.	Plan	Strategy	Description
3	**Enhanced Concentration**	5) Concentration Techniques	➢ The problem of lack of concentration power can be solved by doing exercises for 5 to 10 minutes on regular basis. ➢ Students are directed to study Mathematics with full concentration. As a beginning, it is simple to practise deep breathing and relaxation techniques. ➢ To practise it, sit in a comfortable position with one's hands on the stomach. Inhale deeply and slowly. Let the stomach expand as much as possible. Hold breath for five seconds. Then exhale slowly through pursed lips, as if whistling. Repeat the cycle three or four times. The technique of breathing is very simple; as one inhales, know that he/she is breathing in. As one exhales, know that he/she is breathing out. ➢ Another best way to improve the power of concentration is meditation. In meditation the rays of the mind are focused at a fixed point. It is difficult to concentrate in such a way but as one keeps practising, it becomes easy. ➢ Choose a comfortable time, place and posture. General steps of meditation are the following: Meditation should be started by breathing exercise. • Along with the breathing exercise, need to slowly start concentrating on one particular thing or object. Then close the eyes and visualize an image on the screen of the mind. It could be a beautiful flower, a candle or a portrait. One's attention and concentration must be on that particular object. Don't let anything distract the mind. One needs to avoid them and try concentrating on the image. • Then slowly open the eyes, rub the hands against each other and pass them over the eyes and face. The hands should touch the eyes and the face. Finally, open the eyes slowly. ➢ Tratak for concentration is a model exercise. Tratak means yogic visual concentration. Participants were asked to fix their gaze on the flame of a candle for approximately two or three minutes; suppressing the urge to blink as far as possible. Then they were asked to visualize the candle flame in between the eye brows. This process was repeated for two or three rounds. Finally, the participants were asked to defocus and the practice ended with silence and prayer.

Sl. No.	Plan	Strategy	Description
	Enhanced Concentration	5) Concentration Techniques	➢ Light the candle or Diya and sit in solitude in front of it and gaze it till 5 to 8 minutes. Repeat this exercise daily for at least five minutes  ➢ More concentration techniques like mindful breathing, time piece exercise, vipassana meditation etc. are discussed.
4	**Time Management**	6)Managing Time-wasters	➢ The students are directed to prepare the list of time-wasters. ➢ Some of the internal factors are day dreaming, idleness, procrastination, inertia, laziness etc. ➢ Some of the external factors are problem friendships i.e., too much socializing and distracting friendships, idle talk, prolonged television watching, addiction to TV, Radio, Internet, uncontrolled hobby, too much craze for sports and games, unplanned use of mobile, computer and internet, online games, texting, Facebook, Twitter, Instagram, WhatsApp, and such social media etc.  ➢ The students are promoted to take firm decision to abstain from all these kinds of time -wasters. ➢ Inspiring models and stories of top achievers and sports personalities may be provided directly by the investigator (World Badminton Champion P V Sindhu, for example).
		7)Time Table Preparation	➢ Students are directed firstly to check the present schedules and how they currently spend time. ➢ Encourage the students to frame a suitable time table keeping the guidelines for an efficient time table. For example, give due place and emphasis to various subjects and activities according to their relative importance and difficulty. ➢ It is customary to allocate four hours in working days and eight hours in holidays personally for learning.

Sl. No.	Plan	Strategy	Description
			➢ Study time must further be divided into the study of various school subjects. Encourage the students to set aside a fixed time for daily study at home or study Mathematics in the prime time. ➢ It is good to check the implementation of the time table daily before going to bed. ➢ There will be some initial difficulties in complying with the prepared time table properly. Try again. Gradually everything will come one's own way. Be consistent with the study and follow the set schedule. ➢ Personal preferences need to be taken into account and it is worth experimenting with a number of different approaches to discover what works best for the individual.
5	**Study Aids**	8) Organisation of Study Aids	➢ Firstly, arrange a comfortable place for study where study table, chair, and almirah are available. If the student chooses this same study place every day, learning will occur smoothly.  ➢ Also keep all the study materials in the convenient locations. Remember to have a place for everything and everything in its place. ➢ Collect the following five important things which are very beneficial for Mathematics learning and achievement: Syllabus (using source book), Textbook (NCERT), Reference books (for examples, M L Khanna, R D Sharma) and solution guides, Question Bank (Edumate Questions, Previous Year Question Papers; minimum five years, both March and Improvement) and Digital Resources like Samagra portal (Internet) and auxiliary materials. ➢ As a common procedure the text and other books may be marked by highlighting the points. ➢ Students are trained to prepare 'marked copy of the text'. ➢ It is paramount to prepare notes by oneself for effective learning and students are directed to maintain a Mathematics notebook.

Sl. No.	Plan	Strategy	Description
	Study Aids	9) Note-making	➢ The notes students prepare by combining the notes written in the class and later with organized study aids given in previous strategy make the learning and achievement in Mathematics easy. ➢ Assign main title, various titles and subtitles carefully while preparing notes. Also include necessary diagrams, graphs, concepts, theory and examples.
6	**Basic Concepts (Previous Content Knowledge)**	10)Module of Basic Concepts	➢ Necessary units learned in previous years should be revised before starting the new chapter, since previous knowledge determines the achievement. ➢ Hence a comprehensive syllabus of the prerequisites is provided to the students in advance for self-preparation. It includes topics such as Real numbers, number line, algebraic operations, various properties, squares and square roots, identities, laws of exponents, solution of linear equations in one variable and two variables, quadratic equations and their solutions, Pythagoras theorem, plotting points in a plane, distance formula, slope of a line, trigonometric ratios and trigonometric values of certain angles. ➢ Training classes using detailed study notes including worked out examples are also conducted, if necessary. ➢ Certain practice questions are also provided. (For example, solve: $x^2 - 3x + 2= 0$) ➢ It is essential to revise all concepts which are connected to the new chapter as far as possible.
		11) Follow up (Remedial) Measures	➢ Initially a **pre-requisite test** in basic Maths has been administered. ➢ Based on the module and **analysis** of the pre-requisite test, **follow up measures** were provided to improve their pre-requisite knowledge. ➢ Remedial sessions, group or individual, if needed, are conducted without fail on the basis of the above module which the students revised by self and the test conducted because prior drilling in the fundamentals is very beneficial. ➢ Causes of errors were located and proper instructions were given to overcome these types of errors. For this, use the detailed answer sheets of the test in basic Mathematics attended by the students. ➢ Encourage the students to do the task again and again as they really benefit from it in future too.

Sl. No.	Plan	Strategy	Description
7	**Comprehension (Meaningful Learning)**	12)Discussion on Specifications of Maths Content and Communication of Learning Objectives	➢ For meaningful learning, the following two points i.e., the **'what'** and **'why'** of learning the lesson are discussed giving due importance. The students are pushed through the lower levels of remember and understand new information, to being able to apply it, analyse it, evaluate its impact and ultimately to solve unique problems by creating solutions that would not have been possible without the new knowledge (Revised Bloom's Taxonomy). ➢ Informing students, the details of the content and desired learning objectives is, no doubt, very beneficial. ➢ Familiarise all the prescribed specifications related with textual content using the source book for Higher Secondary Mathematics.(For an example, **Unit 5: Complex Numbers and Quadratic Equations** Need for complex numbers, especially $\sqrt{-1}$, to be motivated by inability to solve every quadratic equation. Brief description of algebraic properties of complex numbers. Argand plane and polar representation of complex numbers. Square root of a complex number. Statement of Fundamental Theorem of Algebra, solution of quadratic equations in the complex number system. ➢ Familiarise all the desired learning objectives related with Mathematics content using the source book for Higher Secondary Mathematics.(For example, **Unit 5** 5.1. Identifies the idea of imaginary numbers and complex numbers. 5.2. Recognizes the real and imaginary parts of a complex number. 5.3. Computes sum of complex numbers. 5.4. Verifies closure law, commutative law, associative law for addition of complex numbers. 5.5. Writes additive identity and additive inverse of complex numbers. 5.6. Computes product of complex numbers. ➢ The students will be enriched more from these tasks. 5.7. Recognizes closure law, commutative law and associative law of multiplication of complex numbers. 5.8. Writes multiplicative identity and multiplicative inverse of complex number. 5.9. Computes division of complex numbers and writes in $a + ib$ form. 5.10. Observes higher powers of i and solves problems related to it. 5.11. Recognizes the identities and uses in related problems. 5.12. Identifies and computes modulus and conjugate of complex number. 5.13. Locates complex numbers in argand diagram. 5.14. Converts complex number into polar form, $z = r(\cos\theta + i \sin \theta)$ 5.15. Solves quadratic equation which have imaginary roots. 5.16. Finds square root of a complex numbers.

Sl. No.	Plan	Strategy	Description
	Comprehension (Meaningful Learning)	13)Learning Maps	➢ The students must be well-versed with the concepts and worked out examples in the chosen area of study. For that purpose, learning maps help students be on the topic and make it easier for them to study. ➢ It consists of a **starting map** which usually includes the core idea, often the name of the unit and subtopics in the introduction of the unit and an **ending map** which usually includes important details to be used in the summary discussion when the unit is completed. Thus, it depicts all things to be learned in a chapter. ➢ Learning maps in the chapter Complex Numbers and Quadratic Equations are given as follows as examples. **Starting Mapping of Unit 5**  **Ending Mapping of Unit 5** 

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<tr><th>Sl. No.</th><th>Plan</th><th>Strategy</th><th>Description</th></tr>
<tr><td></td><td>Comprehension (Meaningful Learning)</td><td>14) Maths Concept Quiz</td><td>
➢ Conduct a short Quiz based on the concepts and examples learnt. (For example,
1. Say the real and imaginary parts of the complex number z = -3 + i 1/2,
2. Give the modulus and conjugate of the complex number z = a + i b,
3. Find the multiplicative inverse of z = x +i y,
4. Give the polar form of a complex number z = a+ ib,
5. What is the root of a quadratic equation whose other root is given by -2 – i 7.
➢ The students are expected to prepare well in advance and participate in this quiz programme.
➢ Arrange feedback sessions in group or individual, if needed. Remedial instructions are provided as and when needed.
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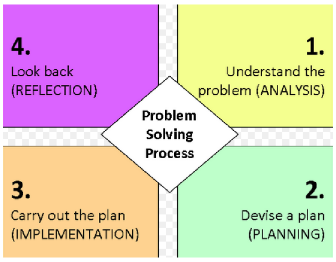
<tr><td>8</td><td>Problem Solving</td><td>15) Polya's Problem Solving Model</td><td>
➢ Polya, G. (1945) found a model of the problem-solving process. In his book, 'How to Solve It ', Polya presented four phases of the problem solving process.
➢ Mathematical problem solving consists of 1) Understanding the problem 2) Devising a plan 3) Carrying out the plan 4) Looking back


➢ First phase relates with the analysis of the problem which is the foundation to successful problem solving. This is actually the 'getting started' phase. The activities in this step are to formulate what is known, what is asked, whether the information is sufficient and restate the original problem in an operational manner. Once the problem is clearly understood, one can list all the components and data that are involved.
➢ The second phase involves 'working on the problem'. Here main focus is to plan, explore and choose a strategy that would lead to the solution of the problem. Then they come up with a way to solve the problem.
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Sl. No.	Plan	Strategy	Description
	Problem Solving	15) Polya's Problem Solving Model	➢ The third phase involves 'digging deeper'. It is the implementation or execution of the proposed plan of actions that have been created in the previous step. ➢ The fourth phase is the concluding step. It is the verification or evaluation of the work done from the first phase to the third phase and the obtained solution. In problem solving it is good to check and interpret, namely, check to see whether all information is used and the answer makes sense. ➢ Encourage the students to follow the proposed model to solve the mathematical problems. (For example, Step 1: Understand the problem: Make sure that you read the question carefully several times. Since we are looking for a solution, we will let x= a solution Step 2: Devise a plan: It can be solved using the formula Step 3: Carry out the plan (solve) Step 4: Look back (check and interpret): Hence the answer is)
		16) Unit Problem Test	➢ The students are expected to prepare well in advance and participate in the comprehensive unit problem test. ➢ Usually, a worked-out example is accompanied by step-by-step procedure for completing it. Pay special attention to the mathematical procedures for completing the solutions provided there. ➢ Conduct a **unit test** based on the problems (worked out examples as well as exercise questions) given in the chapter. (For example, 1. Find the product of 2+ i and 3- i 2. Give the modulus and conjugate of the complex number z = 3 + i 4, 3. Find the multiplicative inverse of z = 5 +i 2, 4. Obtain the polar form of z = 1 + i, 5. What are the roots of the quadratic equation $x^2+ x +10= 0$) ➢ Arrange **feedback sessions** in group or individual, if needed. Take some time to review it and work on the problems that are done incorrectly. ➢ There may be three type of errors as careless mistakes such as writing wrong numbers or signs, conceptual errors such as -2 -3i < 2+3i and procedural or computational errors such as the square of (2+ 3i) is equal to 4+ 9i. Help the students to learn from mistakes committed.

Sl. No.	Plan	Strategy	Description
9	**Mathematics Study Method**	17) PQPRR Method of Study	➢ It is good to carry out an effective Mathematics study strategy. ➢ P= Preview: this is done to get an overall picture of the lesson learned in the class. While previewing, the students may note headings, sub headings, important sentences in each paragraph, charts, diagrams, their captions and the matters given in the boxes. This will give a good starting. ➢ Q= Question: collect and read questions as far as possible from the text, reference books and note book based on the topic. It will increase the efficiency of learning and make them to be focussed. ➢ P= Practise: study and write the answers to the above questions formed i.e., stands for the habit of writing after studying the content. When studying Mathematics, you need paper and pen in hand to practise the question answering. Learn and write formulas, equations and definitions over and over again. ➢ R= Retrieve or rehearse or recollect: after practising, close the book and keep in mind the main points of what you have learned i.e., meditate over the learned things. Here pupils look at how they can remember what they have learned. ➢ R= Review: check the retrieved topics by examining the text and note books and repeat if needed. ➢ The real study of Mathematics occurs when these five learning processes happen together.
10	**Student Efforts**	18) Self study	➢ Mainly, **drilling** and **help-seeking** are two means for applying this strategy of self-study. ➢ The subject Mathematics needs more drilling the topics learned and the timely completion of home works or assignments given by the teachers. Insist the students to do the home works by self without fail. If they copy what others have written without understanding it, the topics will go unnoticed. ➢ Help-seeking is much beneficial to the students. Ask the classmates or teachers what one does not understand. Do not hesitate to ask the teacher or clever companions or good performers in the subject the things one does not grasp clearly. Never leave difficulties unanswered, as this will put one in greater difficulty later. When clearance of doubt occurs, the study can proceed in a positive way.

Sl. No.	Plan	Strategy	Description
	Student Efforts	19)Memorization and Retention	➢ For memorising and retaining the topics learned in Mathematics, the best way suggested is **repetition, practice** and **revision** of the lesson in proper time intervals. They can be made mainly by habit of revision and repetition. Revisit the previously studied concepts and problems regularly. The greatest mistake committed by majority of students is that they revise their lessons only at the end of the academic year. This may be a major cause of forgetting their lessons. Hence students are encouraged to revisit the topics at regular intervals to secure them in memory. Surely, revision will raise the standard of memorization. ➢ It is a good practice to revise the topic taught in the class within twelve hours or the same day itself. After that, if one studies again within twenty-four hours, it will be very well memorized. ➢ A topic learned once must be gone through again before it may be erased from memory. It is highly recommended weekly, monthly, term and annual revision schedules. It is when the topics learned are repeated many times that they enter into long-term memory.  ➢ Revision and repetition are fruitful only when it is done sincerely with genuine interest and attention.
11	**Test Management**	20)Test Preparation	➢ It is a good practice to re-examine the answer sheets of the previously written tests and evaluate the shortcomings and prepare sincerely. ➢ Look upon **previous year question papers** critically and carefully to get an idea of the important portions of the syllabus and how questions are worded. It is also helpful to get acquainted with a lot of question patterns. Further it is useful to know the style, number and scores of the questions so that students can attend the exam with full confidence. ➢ The best way to take a test is to take a practice test, namely, do **mock tests** using previous question papers, as many years ahead as you can. Practise writing answers to them in a time- bound manner. Then evaluate oneself, correct any mistakes and re-learn.

Sl. No.	Plan	Strategy	Description
	Test Management	21)Test Paper Presentation	➢ By now, the students are able to collect the **examiners' favourites.** Carefully guess some questions that are likely to come up in the exam and be prepared to give them the most appropriate answers. Using these important questions, prepare note cards with one question per card and the solution on the back of the card. These are very useful for immediate revision before the examination. ➢ Make it a point to organize oneself before the exam by setting all the essentials needed. ➢ The students are directed to be very calm and quiet in the exam hall. Close eyes for a couple of minutes, focus only on inhaling and exhaling. When this is done, the fear and anxiety will decrease and the mind will be enlightened. Also talk self-confidently about performing well in the exam. ➢ During fifteen minutes cool off time, read the entire question paper carefully and plan the order of preference for the questions to be answered and the answer can be thought out in advance. This additional time is provided for students to read the questions properly and draft a plan in their mind about how they will solve the paper correctly without getting panicked. So, students must utilise these 15 minutes very carefully to make a strategy for writing their exam smoothly and correctly. ➢ First answer the questions which are known very well in serial order i.e., write those answers which one knows correctly. This will help to gain confidence and will also help to spare enough time to think about the answers to other questions which are a bit blur in the mind. ➢ Quality of content is certainly of prime importance in the answers. Along with it, the presentation needs attention. While writing an exam, give the examiner the least possible stress. An examiner always like well-structured answers presented neatly and coherently. Proper spacing, well-organized content and neat handwriting make for good presentation, which will leave a strong impact on the examiner's mind. As far as possible avoid cancellations, confused corrections or cramped insertions. Make cancellations and corrections neatly. Whenever you need to

Sl. No.	Plan	Strategy	Description
			cut a word or an answer, just draw a line with your pen over that particular text/word. Avoid scribbling or scratching as it will make answer sheet look messy and unclean. Insert new words or sentences legibly and in an orderly way. In short, a neat and orderly paper answered in a legible handwriting make a favourable impression on the examiner. ➢ While answering problem type questions in Mathematics, remember to write systematically the relevant data, related theory and necessary steps. This will help to get a partial score even if the final answer is wrong. ➢ Be aware of conceptual, application, computational and careless errors. ➢ Don't leave any questions unanswered. Support them with appropriate graphs, diagrams, figures etc. Whenever necessary. ➢ Set time in such a way that the written answers are scrutinized and rechecked finally. On completion, don't forget to check answer sheet and that even twice at least. Silly mistakes that would have been left unaltered could be corrected. Make sure if he/she hasn't skipped any question. ➢ Also, make sure that the roll number is neatly and properly written before handing over the answer paper to the invigilator. *All the very best!!!*

Appendix K

FAROOK TRAINING COLLEGE

FAROOK COLLEGE P.O. 673632

ACHIEVEMENT TEST IN MATHEMATICS FOR STANDARD XI

(Draft)

Dr. Noushad. P P
Associate Professor
SGTDS, MG University

Philip Joseph
Research Scholar
Farook Training College

Personal Details

Name:.. School : ....
Class: .... Roll Number : ....

Instructions

- This is a test in Complex Numbers and Quadratic Equations
- There are 40 questions
- Each question has 4 responses as a, b, c, d
- In the response sheet given to you, the question numbers are written in order. Find out the correct answer and enter the corresponding letter code or correct answer in the space given.
- If you find that you have marked wrongly, then draw a circle around it and write the correct answer nearby.
- Answer all the questions
- Each question carries one score
- Maximum score is 40
- Duration is 60 minutes (with 15 minutes cool off time)

Questions

1) If x = $\sqrt{-16}$ then,
   a) x = 4 b) x = - 4i c) x = 4i d) x = - 4
2) The value of $\sqrt{-25}$x $\sqrt{-9}$ is
   a)15 b)-15 c)25 d)225
3) Which of the following is the real part and imaginary part of the complex number z = -3+i√7
   a) -3 and √7 b) 3 and √7 c) √7 and – 3 d) √7 and 3
4) If (1-i) x + (1+i) y = 1-3i, then (x, y) is equal to
   a) (2, -1) b) (2,1) c) (1,2) d) (-1,2)
5) If z = 5i ($\frac{-3i}{5}$), then z is equal to
   a) 0+3i b) 3+0i c) 3-0i d) -3+0i

6) If z_1 = 2+3i and z_2 = 3+2i, then z_1+z_2 equals to

a) 5+5i b) 5+10i c) 4+6i d) 6+4i

7) The real values of x and y for which the equation (x +i y) + (2-3i) = 4+i satisfied are

a) - 2, -4 b) - 2,4 c) 2, -4 d) 2,4

8) If z_1 = 1+3i and z_2 = 1-2i, then z_1/z_2 equals to

a) -1+i b) 1+i c) 5+i d) -1+5i

9) If z = i^{-39}, then standard form of z is equal to

a) 1+0i b) 0+i c) 0+0i d) 1+i

10) If z = $(1-i)^4$, then the standard form of z is

a) 4+0i b) 0+4i c) – 4+0i d) 1+i

11) The multiplicative inverse of z = 1+i is

a) 1+i b) 1-i c) 1/2+i/2 d) 1/2-i/2

12) The multiplicative inverse of z = 3i is

a) i/3 b) -i/3 c) i/9 d) -3i

13) Square roots of the complex number -7-24i are

a) 3 – 4i, -3+4i b) 6-8i, -6+8i c) 6+8i, -6+8i d) 3-4i, 3+4i

14) If z = i^9+i^{19}, then z is equal to

a) 0+0i b) 1+0i c) 0+i d) 1+2i

15) The value of $(1+i)^5\,(1-i)^5$ is

a) - 8 b) 8i c) 8 d) 32

16) The value of $(1+i)^8+(1-i)^8$ is

a) 16 b) -16 c) 32 d) -32

17) If $\left(\frac{1-i}{1+i}\right)^{100}$ = a+ib, then find (a, b)

a) (0,1) b) (1,0) c) (0,0) d) (1,1)

18) Find the incorrect option

a) i^3 = - i b) i^4 = 1 c) i^5 = i d) i^6 = 1

19) Which of the following is correct?

a) 1+i>2-i b)2+i>i+1 c) 2-i<1+i d) None of these

20) A: (2+3i) [(3+2i) +(2+i)] = 13i+(1+8i)

R: $z_1(z_2+z_3) = z_1z_2+z_1z_3$, where z_1, z_2, z_3 are three complex numbers. Then

a) both A and R are correct and R is the correct explanation of A

b) both A and R are correct and R is not the correct explanation of A

c) A is correct, R is incorrect

d) A is incorrect, R is correct

21) Conjugate of the complex number 3-2i is

a) 2+3i b) 3+2i c) 2-3i d) 3-2i

22) If $z_1 = \sqrt{2}(\cos \pi/4 + i \sin \pi/4)$ and $z_2 = \sqrt{3}(\cos \pi/3 + i \sin \pi/3)$, then $|z_1z_2|$ is equal to

a) 6 b) $\sqrt{2}$ c) $\sqrt{6}$ d) $\sqrt{3}$

23) Conjugate of $\frac{1+2i}{1-i}$ lies in .... Quadrant

a) I b) II c) III d) IV

24) If Z $\overline{z}$ = 16, then |Z| is

a) 4 b) 8 c) 2 d) 16

25) If| z| = r and arg (z) = θ, then

a) z = r (cosθ + i sinθ) b) z = r (sinθ+i cosθ) c) z = r (sinθ- i cosθ) d) None of these

26) The modulus and argument of the complex number z = 1+i are

a) 1 and π/2 b) 2 and π/3 c) √2 and π/4 d) √2 and π/6

27) The amplitude of - 1+$\sqrt{-3}$ is

a) π/3 b) π/4 c) π/2 d) 2π/3

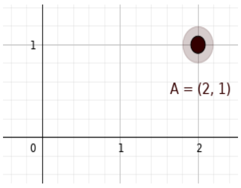
28) The polar form of the complex number z = 1+i√3 is

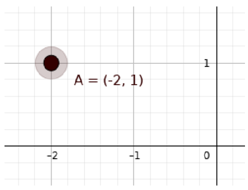
a) 2 (cos π/3-i sin π/3) b) 2 (cos π/3+i sin π/3)
c) 2 (cos 2π/3+isin 2π/3) d) 2 (cos 4π/3+i sin 4π/3)

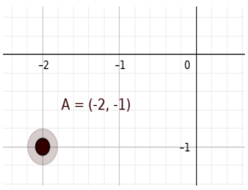
29) The polar form of the complex number $\frac{1+i}{1-i}$ is

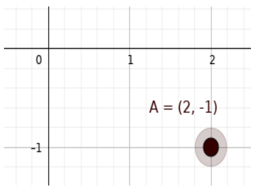
a) 1(cos π/2+i sin π/2) b) 2(cos π/2+i sin π/2)
c) 1(cos π/2-i sin π/2) d) 2 (cos π/2-i sin π/2)

30) Which of the following is the argand (graphical) representation of the complex number z = 2-i

a) 

b) 

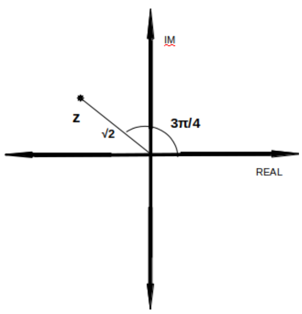
c) 

d) 

31) Consider z = - 1+i. Then the modulus and amplitude of $\overline{z}$(conjugate of z) are

a) √2 and 3π/4 b) √2 and – 3π/4 c) √2 and π/4 d) 1 and π/2

32)



The complex number represented above is

a) √2+i b) 1+i c) -1+i d) -1-i

33) If $|z| = 2$ and $\arg(z) = \pi/3$, then z in a+ib form is

a) $\sqrt{3}+i$ b) $\sqrt{3}-i$ c) $1+i\sqrt{3}$ d) $1-i\sqrt{3}$

34) If $|z| = 4$ and $\arg(z) = 5\pi/6$, then z =...........

a) $-2\sqrt{3}+2i$ b) $2+2\sqrt{3}i$ c) $3\sqrt{3}+2i$ d) $3-2\sqrt{3}i$

35) If $3x^2+4x+2 = 0$, then equation has

a) real roots
b) imaginary roots
c) one real and one imaginary root
d) distinct real roots

36) One of the roots of the quadratic equation $x^2-x+1 = 0$ is $1/2+\sqrt{3}i/2$, then the other root is.....

a) $1/2+\sqrt{3}i/2$ b) $1/3+\sqrt{3}i/2$ c) $1/2-\sqrt{3}/3$ d) $1/2-\sqrt{3}i/2$

37) The solution of the quadratic equation $3x^2- 6x+5 = 0$ are

a) $1 \pm i(2/\sqrt{7})$ b) $1 \pm i(2/\sqrt{11})$ c) $1 \pm i(2/\sqrt{6})$ d) $1 \pm i(2/\sqrt{5})$

38) Roots of the quadratic equation $x^2-x+2 = 0$ are

a) $(1 \pm \sqrt{7i})/2$ b) $(1 \pm \sqrt{7i})/3$ c) $(1 \pm \sqrt{9i})/2$ d) $(1 \pm \sqrt{9i})/3$

39) E: $x^2+x+1= 0$, R_1: $x = (-1+\sqrt{3}i)/2$, R_2: $x = (-1-\sqrt{3}i)/2$, R_3: $x = (1+\sqrt{3}i)/2$, R_4: $x =(1-\sqrt{3}i)/2$, then which of the following are correct?

a) Roots of E are R_1 and R_2
b) Roots of E are R_3 and R_4
c) Roots of E are R_1 and R_3
d) All of the above

40) If one root of a quadratic equation with real coefficients is $(2+4i)/3$, then the quadratic equation is

a) $2x^2+4x+3 = 0$
b) $3x^2-4x+20/3 = 0$
c) $3x^2-4x+20 = 0$
d) $3x^2+4x+20/7 = 0$

Achievement Test in Mathematics for Standard XI (Draft)

RESPONSE SHEET

Personal Details

Name: **School:**

Class: **Roll Number:**

Qn. No.	Answer	Qn. No.	Answer
1		21	
2		22	
3		23	
4		24	
5		25	
6		26	
7		27	
8		28	
9		29	
10		30	
11		31	
12		32	
13		33	
14		34	
15		35	
16		36	
17		37	
18		38	
19		39	
20		40	

Score/Grade of Mathematics – Term I: Total Score:

Achievement Test in Mathematics for Standard XI(Draft)

SCORING KEY

Qn. No.	Answer	Qn. No.	Answer
1	c) $x= 4i$	21	b) $3+2i$
2	b) -15	22	c) $\sqrt{6}$
3	a) -3 and $\sqrt{7}$	23	c) III
4	a) (2, -1)	24	a) 4
5	b) $3+i0$	25	a) $z = r(\cos\theta + i\sin\theta)$
6	a) $5+5i$	26	c) $\sqrt{2}$ and $\pi/4$
7	d) 2,4	27	d) $2\pi/3$
8	a) $-1+i$	28	b) $2(\cos\pi/3+i\sin\pi/3)$
9	b) $0+i$	29	a) $1(\cos\pi/2+i\sin\pi/2)$
10	c) $-4+i0$	30	d) graph
11	d) $1/2-i/2$	31	b) $\sqrt{2}$ and $-3\pi/4$
12	b) $-i/3$	32	c) $-1+i$
13	a) $3-4i, -3+4i$	33	c) $1+i\sqrt{3}$
14	a) $0+0i$	34	a) $-2\sqrt{3}+2i$
15	d) 32	35	b) imaginary roots
16	c) 32	36	d) $1/2-\sqrt{3}i/2$
17	b) (1,0)	37	c) $1 \pm i(2/\sqrt{6})$
18	d) $i^6 = 1$	38	a) $(1\pm\sqrt{7}i)/2$
19	d) None of these	39	a) Roots of E are R_1 and R_2
20	a) Both A and R are correct and R is the correct explanation of A	40	b) $3x^2-4x+20/3 = 0$

Appendix L

FAROOK TRAINING COLLEGE

FAROOK COLLEGE P.O. 673632

ACHIEVEMENT TEST IN MATHEMATICS
(Final)

Dr. Noushad. P P
Associate Professor
SGTDS, MG University

Philip Joseph
Research Scholar
Farook Training College

Personal Details

Name:.. School : ....
Class: .... Roll Number : ....

Instructions

- This is a test in Complex Numbers and Quadratic Equations
- There are 30 questions
- Each question has 4 responses as a, b, c, d
- In the response sheet given to you, the question numbers are written in order. Find out the correct answer and enter the corresponding letter code or correct answer in the space given.
- If you find that you have marked wrongly, then draw a circle around it and write the correct answer nearby.
- Answer all the questions
- Each question carries one score
- Maximum score is 30
- Duration is 60 minutes (with 15 minutes cool off time)

Questions

1) The value of $\sqrt{-25}$X $\sqrt{-9}$ is
   a)15 b)-15 c)25 d)225
2) If (1-i) x + (1+i) y = 1-3i, then (x, y) is equal to
   a) (2, -1) b) (2,1) c) (1,2) d) (-1,2)
3) If z = 5i $(\frac{-3i}{5})$, then z is equal to
   a) 0+3i b) 3+0i c) 3-0i d) -3+0i
4) The real values of x and y for which the equation (x +iy) + (2-3i) = 4+i satisfied are
   a) - 2, -4 b) - 2,4 c) 2, -4 d) 2,4
5) If z_1 = 1+3i and z_2 = 1-2i, then z_1/z_2 equals to
   a) -1+i b) 1+i c) 5+i d) -1+5i
6) The multiplicative inverse of z = 1+i is
   a) 1+i b) 1-i c) 1/2+i/2 d) 1/2-i/2

7) The multiplicative inverse of $z = 3i$ is

a) $i/3$ b) $-i/3$ c) $i/9$ d) $-3i$

8) Square roots of the complex number $-7-24i$ are

a) $3 - 4i, -3+4i$ b) $6-8i, -6+8i$ c) $6+8i, -6+8i$ d) $3-4i, 3+4i$

9) If $z = i^9+i^{19}$, then z is equal to

a) $0+0i$ b) $1+0i$ c) $0+i$ d) $1+2i$

10) The value of $(1+i)^5 (1-i)^5$ is

a) $- 8$ b) $8i$ c) 8 d) 32

11) The value of $(1+i)^8+ (1-i)^8$ is

a) 16 b) -16 c) 32 d) -32

12) If $\left(\frac{1-i}{1+i}\right)^{100} = a+ib$, then find (a, b)

a) (0,1) b) (1,0) c) (0,0) d) (1,1)

13) A: $(2+3i) [(3+2i) +(2+i)] = 13i+(1+8i)$

R: $z_1 (z_2+z_3) = z_1z_2 + z_1z_3$, where z_1, z_2, z_3 are three complex numbers. Then

a) both A and R are correct and R is the correct explanation of A

b) both A and R are correct and R is not the correct explanation of A

c) A is correct, R is incorrect

d) A is incorrect, R is correct

14) If $z_1 = \sqrt{2}(\cos \pi/4 +i \sin \pi/4)$ and $z_2= \sqrt{3}(\cos \pi/3+i \sin \pi/3)$, then $|z_1z_2|$ is equal to

a) 6 b) $\sqrt{2}$ c) $\sqrt{6}$ d) $\sqrt{3}$

15) If $Z \bar{z} = 16$, then $|Z|$ is

a) 4 b) 8 c) 2 d) 16

16) If$| z| = r$ and $\arg (z) = \theta$, then

a) $z = r (\cos \theta+ i \sin \theta)$ b) $z = r (\sin \theta+ i \cos \theta)$

c) $z = r (\sin \theta- i \cos \theta)$ d) None of these

17) The modulus and argument of the complex number $z = 1+i$ are

a) 1 and $\pi/2$ b) 2 and $\pi/3$ c) $\sqrt{2}$ and $\pi/4$ d) $\sqrt{2}$ and $\pi/6$

18) The amplitude of $- 1+\sqrt{-3}$ is

a) $\pi/3$ b) $\pi/4$ c) $\pi/2$ d) $2\pi/3$

19) The polar form of the complex number $z = 1+i\sqrt{3}$ is

a) $2 (\cos \pi/3-i \sin \pi/3)$ b) $2 (\cos \pi/3+i \sin \pi/3)$

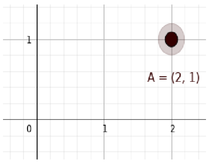
c) $2 (\cos 2\pi/3+i\sin 2\pi/3)$ d) $2 (\cos 4\pi/3+i \sin 4\pi/3)$

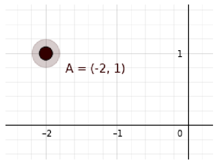
20) The polar form of the complex number $\frac{1+i}{1-i}$ is

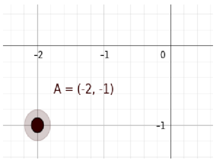
a) $1(\cos \pi/2+i \sin \pi/2)$ b) $2(\cos \pi/2+i \sin \pi/2)$

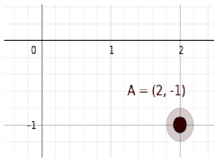
c) $1(\cos \pi/2-i \sin \pi/2)$ d) $2 (\cos \pi/2-i \sin \pi/2)$

21) Which of the following is the argand (graphical) representation of the complex number z = 2-i

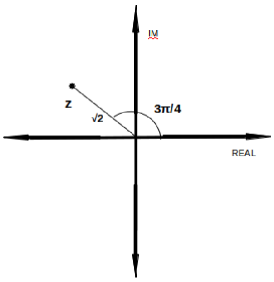
a) 

b) 

c) 

d) 

22)



The complex number represented above is

a) √2+i b) 1+i c) -1+i d) -1-i

23) If |z| = 2 and arg(z) = π/3, then z in a+ ib form is

a) √3+i b) √3-i c) 1+i√3 d) 1-i√3

24) If |z| = 4 and arg(z) = 5π/6, then z =..........

a) – 2√3+2i b) 2+2√3i c) 3√3+2i d) 3-2√3i

25) If $3x^2+4x+2 = 0$, then equation has

a) real roots b) imaginary roots
c) one real and one imaginary root d) distinct real roots

26) One of the roots of the quadratic equation $x^2-x+1 = 0$ is 1/2+√3i/2, then the other root is.....

a) 1/2+√3i/2 b) 1/3+√3i/2 c) 1/2-√3/3 d) 1/2-√3i/2

27) The solution of the quadratic equation $3x^2- 6x+5 = 0$ are

a) $1 \pm i(2/\sqrt{7})$ b) $1 \pm i(2/\sqrt{11})$ c) $1 \pm i(2/\sqrt{6})$ d) $1 \pm i(2/\sqrt{5})$

28) Roots of the quadratic equation $x^2-x+2 = 0$ are

a) $(1 \pm \sqrt{7}i)/2$ b) $(1 \pm \sqrt{7}i)/3$ c) $(1 \pm \sqrt{9}i)/2$ d) $(1 \pm \sqrt{9}i)/3$

29) E: $x^2+x+1= 0$, R_1: x = (-1+√3i)/2, R_2: x = (-1-√3i)/2, R_3: x = (1+√3i)/2, R_4: x =(1-√3i)/2, then which of the following are correct?

a) Roots of E are R_1 and R_2 b) Roots of E are R_3 and R_4
c) Roots of E are R_1 and R_3 d) All of the above

30) If one root of a quadratic equation with real coefficients is (2+4i)/3, then the quadratic equation is

a) $2x^2+4x+3 = 0$ b) $3x^2-4x+20/3 = 0$
c) $3x^2-4x+20 = 0$ d) $3x^2+4x+20/7 = 0$

Achievement Test in Mathematics for Standard XI(Final)

RESPONSE SHEET

Personal Details	
Name:	**School:**
Class:	**Roll Number:**

Qn. No.	Answer	Qn. No.	Answer
1		16	
2		17	
3		18	
4		19	
5		20	
6		21	
7		22	
8		23	
9		24	
10		25	
11		26	
12		27	
13		28	
14		29	
15		30	

Score/Grade of Mathematics – Term I: Total Score:

Achievement Test in Mathematics for Standard XI(Final)

SCORING KEY

Qn. No.	Answer	Qn. No.	Answer
1	b) -15	16	a) $z = r(\cos\theta + i\sin\theta)$
2	a) (2, -1)	17	c) $\sqrt{2}$ and $\pi/4$
3	b) 3+i0	18	d) $2\pi/3$
4	d) 2,4	19	b) $2(\cos\pi/3 + i\sin\pi/3)$
5	a) -1+i	20	a) $1(\cos\pi/2 + i\sin\pi/2)$
6	d) 1/2-i/2	21	d) graph
7	b) -i/3	22	c) -1+i
8	a) 3-4i, -3+4i	23	c) $1+i\sqrt{3}$
9	a) 0+0i	24	a) $-2\sqrt{3}+2i$
10	d) 32	25	b) imaginary roots
11	c) 32	26	d) $1/2-\sqrt{3}i/2$
12	b) (1,0)	27	c) $1 \pm i(2/\sqrt{6})$
13	a) Both A and R are correct and R is the correct explanation of A	28	a) $(1\pm\sqrt{7}i)/2$
14	c) $\sqrt{6}$	29	a) Roots of E are R_1 and R_2
15	a) 4	30	b) $3x^2-4x+20/3 = 0$

Appendix M

FAROOK TRAINING COLLEGE

FAROOK COLLEGE P.O. 673632

The Design and Blue Print of the Prerequisite Test in Basic Mathematics

Weightage in terms of Objectives

Sl. No	Objectives	No. of Items	Scores	Percentage
1	Remember	4	4	10.00%
2	Understand	12	12	30.00%
3	Apply	8	8	20.00%
4	Analyse	6	6	15.00%
5	Evaluate	6	6	15.00%
6	Create	4	4	10.00%
	Total	40	40	100.00%

Weightage in terms of Content

Sl. No	Content	Number of Items	Score	Percentage
1	Arithmetic	12	12	30.00%
2	Algebra	18	18	45.00%
3	Geometry	2	2	5.00%
4	Co-ordinate Geometry	4	4	10.00%
5	Trigonometry	4	4	10.00%
	Total	40	40	100.00%

Weightage in terms of Difficulty Level

Sl. No	Difficulty Level	Score	Percentage
1	Easy	8	20.00%
2	Average	24	60.00%
3	Difficult	8	20.00%
	Total	40	100.00%

Blue Print

Sl. No.	Content	Learning Objectives						Total
		Remember	Understand	Apply	Analyse	Evaluate	Create	
1	Arithmetic	2	6	-	-	4	-	12
2	Algebra	-	4	7	2	2	3	18
3	Geometry	-	-	1	1	-	-	2
4	Co-ordinate Geometry	-	1	-	3	-	-	4
5	Trigonometry	2	1	-	-	-	1	4
	Total	4	12	8	6	6	4	40

Note: The objective type (multiple choice) items are opted and hence the blue print is a two-dimensional chart indicating the content area and the number of questions under each learning objectives.

Appendix N

FAROOK TRAINING COLLEGE

FAROOK COLLEGE P.O. 673632

PREREQUISITE TEST IN BASIC MATHEMATICS

(Draft Form)

Dr. Noushad. P P
Associate Professor
SGTDS, MG University

Philip Joseph
Research Scholar
Farook Training College

Personal Details

Name:	**School:**
Class:	**Roll Number:**

Instructions

- This is a test in Basic Mathematics (Arithmetic, Algebra, Geometry, Co-ordinate Geometry and Trigonometry)
- There are 40 Questions
- Each question has 4 responses as a, b, c, d
- In the response sheet given to you, the question numbers are written in order. Find out the correct answer and enter the corresponding letter code or correct answer in the space given.
- If you find that you have marked wrongly, then draw a circle around it and write the correct answer nearby.
- Answer all the questions
- Each question carries one score
- Maximum score is 40
- Duration is 60 minutes (with a cool of time 15 minutes)

Questions

1) If n = $\sqrt{16}$ then,

   a) n = 16 b) n = - 16 c) n = 4 d) n = 8

2) The conjugate pair of $\sqrt{3}$-1 is

   a) √3+1 b) √3-1 c) √3 d) -√3

3) Which of the following collection of integers is arranged from greatest to least

   a) -5,2, -1,2 b) 2, -1-2, -5 c) -2,1, -5,2 d) 2, -1, -2, -1

4) $\frac{1}{2}+\frac{1}{3}-\frac{2}{3}=$..........

   a) 0 b) 1 c) $\frac{1}{6}$ d) $\frac{1}{2}$

5) The rational number equivalent to $\frac{-5}{7} + \frac{2}{7} + 3$ is

a) $\frac{5}{7}$ b) $\frac{1}{7}$ c) $\frac{22}{7}$ d) $\frac{18}{7}$

6) The real number equivalent to $\frac{-\sqrt{3}+\frac{1}{\sqrt{3}}}{2}$

a) $\frac{1}{\sqrt{3}}$ b) $\frac{-1}{\sqrt{3}}$ c) $\sqrt{3}$ d) $\frac{1}{2}$

7) $(3^3 \text{ x } 3^4)/\ 3^5$ =............

a) 3 b) 3^2 c) 3^3 d) 1

8) $\frac{\sqrt[3]{8}}{\sqrt[3]{27}}$

a) $\frac{1}{3}$ b) $\frac{8}{27}$ c) $\frac{2}{3}$ d) 1

9) Which of the following is correct?

a) $\frac{2}{3} < \frac{3}{5}$ b) $\frac{2}{3} > \frac{3}{5}$ c) $\frac{2}{3} = \frac{3}{5}$ d) None of the above

10) If $n = m^{2/3}$, then m is

a) n^2 b) n^3 c) $n^{3/2}$ d) $n^{2/3}$

11) Consider A: $3a^2+9a = 3a(a+3)$ and

R: $a(b+c) = ab + ac$. Then which of the following is true?

a) Both A and R are correct; R is not correct explanation of A

b) Both A and R are correct; R is the correct explanation of A

c) A is correct; R is incorrect

d) A is incorrect; R is correct

12) The square of-3n is

a) $-3n^2$ b) $-9n^2$ c) $9n^2$ d) $3n^2$

13) If 2x-5 = 11, then x is

a) 2 b) 4 c) 16 d) 8

14) The quadratic equation $x^2-6x+9 = 0$ has

a) real and unequal roots

b) real and equal roots

c) non-real and unequal roots

d) non-real and equal roots

15) The solutions of the equation $x^2-4 = 0$ are

a) – 2,2 b) -4,4 c) $-\sqrt{2}, \sqrt{2}$ d) 0,2

16) The roots of the equation $x^2+5x+6 = 0$ are

a) -2, -3 b) 2,3 c) $\frac{1}{2}, \frac{1}{3}$ d) $\frac{-1}{2}, \frac{-1}{3}$

17) Let $x^2 = 39^2 + 23^2 - 2\ (39)\ (23)$ and x>0. Then the value of x is

a) 8 b) 62 c) 4 d) 16

18) Given x + y = 14 and $x^2+y^2 = 100$. Then x and y are

a) -6,8 b) 2,14 c) 8,6 d) 14,2

19) The solution of 7x+3 = 5x+7 is

a) -2 b) 2 c) 4 d) -4

20) The value of x satisfying 5(4x+3) = 3(x-2) is

a) 0 b) 21 c) $\frac{21}{17}$ d) $\frac{-21}{17}$

21) If (2,0) is solution of the linear equation 2x+3y = k, then value of k is

a) 4 b) 6 c) 5 d) 2

22) The sum of squares of the roots of the equation $x^2+p\,x-3 = 0$ is equal to 10. Then the values of p can be

a) -16,16 b) -4,4 c) -2,2 d) $-\sqrt{2}$, $\sqrt{2}$

23) The length of a rectangular field is greater than its width by 10 meters. If the area of the field is 144 sq. m, its length and width are

a) 20,10 b) 28,18 c) 18,8 d) 10,2

24) The product of the roots of the quadratic equation $3x^2-5x-6 = 0$ is

a) 6 b) -6 c) -5 d) -2

25) The values of k for which the quadratic equation $2x^2+3x+k = 0$ has all real solutions are given by

a) $k \leqslant \frac{9}{8}$ b) $k \geq \frac{9}{8}$ c) $k \leqslant \frac{8}{9}$ d) $k \geq \frac{8}{9}$

26) E: (x-7) (x-3) + 2 = 0, R: $x = 5+4\sqrt{3}$, R_2: $x = 5-4\sqrt{3}$, R_3: $x = 5+\sqrt{2}$, R_4:$5-\sqrt{2}$, where E and R denote equation and root. Then which of the following are correct?

a) E with R_1 and R_2 b) E with R_3 and R_4

c) E with R_1 and R_3 d) All of the above

27) Which of the following is not true?

a) $(x+y)^2 = (x-y)^2 + 4xy$ b) $(x-y)^2 = (x+y)^2 - 4xy$

c) $x^2-y^2 = (x+y)(x-y)$ d) $(x+y)^2 = x^2+y^2$

28) The quadratic equation whose solutions are 2 and 3 is

a) $x^2+5x+6 = 0$ b) $x^2-5x+6 = 0$ c) $x^2+5x-6 = 0$ d) $x^2-5x-6 = 0$

29) The quadratic equation whose roots are $1+\sqrt{5}$ and $1-\sqrt{5}$ are

a) $x^2-2x-4 = 0$ b) $x^2+2x+4 = 0$ c) $x^2+x+1 = 0$ d) $x^2+2x-4 = 0$

30) If one of the roots of a quadratic equation with rational coefficients is $2-\sqrt{3}$, then the quadratic equation is

a) $x^2+4x+1 = 0$ b) $x^2+4x-1 = 0$ c) $x^2-4x+1 = 0$ d) $x^2-4x-1 = 0$

31) In the triangle ABC, right angled at B, AB = 3 cm and AC = 5 cm. Then BC is given by

a) 3 cm b) 5 cm c) 4 cm d) 2 cm

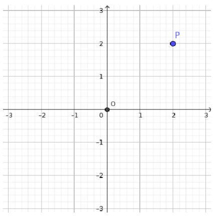
32) The three numbers given in each option are the lengths of the sides of a triangle in centimetres, Which of them are right-angled

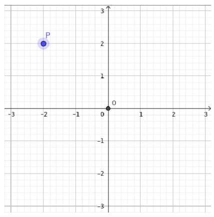
a) 13,12,5 b) 5,6,7 c) 39,36,16 d) 19,18,6

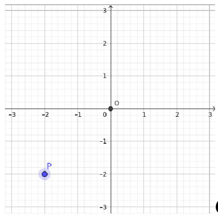
33) The distance AB between the points A (-3,7) and B (9,2) is

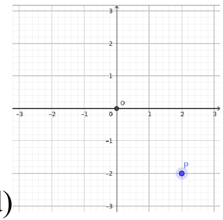
a) 10 b) 11 c) 12 d) 13

34) Which of the following represents plotting of the point P (-2, -2) in the x-y plane?

a) 

b) 

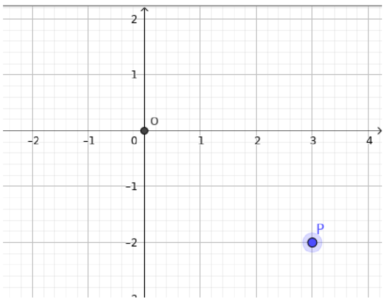
c) 

d) 

35) If the distance between points (x, -1) and (3,2) is 5, the values of x are

a) -1,7 b) 1,7 c) 2,3 d) 1, -7

36)



From the above figure, the co-ordinates of the point P are given by

a) (3,2) b) (-3, -3) c) (3, -2) d) (-2,3)

37) sin 60^0 =............

a) 0 b) 1/2 c) $2/\sqrt{3}$ d) $\sqrt{3}/2$

38) Which of the following is true?

a) $\sin^2\theta + \cos^2\theta = 1$ b) $\sec^2\theta - \tan^2\theta = 1$

c) $\text{cosec}^2\theta - \cot^2\theta = 1$ d) All of the above

39) If $\tan^2\theta + \cot^2\theta = 2$, $0^o<\theta<90^o$, the angle θ is

a) 0^o b) 30^o c) 45^o d) 60^o

40) If $\sin(x-y) = 1/2$ and $\cos(x+y) = 1/2$, $0^o < x+y < 90^o$, then x and y are

a) $45^o, 15^o$ b) $60^o, 30^o$ c) $30^o, 15^o$ d) $45^o, 30^o$

Pre-requisite Test in Basic Mathematics for Standard XI (Draft)

RESPONSE SHEET

Personal Details	
Name:	**School:**
Class:	**Roll Number:**

Qn. No.	Answer	Qn. No.	Answer
1		21	
2		22	
3		23	
4		24	
5		25	
6		26	
7		27	
8		28	
9		29	
10		30	
11		31	
12		32	
13		33	
14		34	
15		35	
16		36	
17		37	
18		38	
19		39	
20		40	

Total Score:

Pre-requisite Test in Basic Mathematics for Standard XI (Draft)

SCORING KEY

Qn. No.	Answer	Qn. No.	Answer
1	c) n=4	21	a) 4
2	a) $\sqrt{3}+1$	22	c) -2,2
3	b) 2, -1, -2, -5	23	c) 18,8
4	c) $\frac{1}{6}$	24	d) -2
5	d) $\frac{18}{7}$	25	a) $k \leqslant \frac{9}{8}$
6	b) $\frac{-1}{\sqrt{3}}$	26	b) E with R_3 and R_4
7	b) 3^2	27	d) $(x+y)^2 = x^2+y^2$
8	c) $\frac{2}{3}$	28	b) $x^2 -5x+6 = 0$
9	b) $\frac{2}{3} > \frac{3}{5}$	29	a) $x^2-2x-4 = 0$
10	c) $n^{3/2}$	30	c) $x^2 -4x+1 = 0$
11	b) Both A and R are correct; R is the correct explanation of A	31	c) 4 cm
12	c) $9n^2$	32	a) 13,12,5
13	d) 8	33	d) 13
14	b) real and equal roots	34	c) graph
15	a) – 2,2	35	a) -1,7
16	a) -2, -3	36	c) (3, -2)
17	d) 16	37	d) $\sqrt{3}/2$
18	c) 8,6	38	d) All of the above
19	b) 2	39	c) 45°
20	d) $\frac{-21}{17}$	40	a) $45^\circ, 15^\circ$

Appendix O

FAROOK TRAINING COLLEGE

FAROOK COLLEGE P.O. 673632

Data and Results of Item Analysis of Pre-requisite Test in Basic Mathematics

Table

Data and Results of Item Analysis

Qn. No	U	L	DI	DP	Status	Qn. No	U	L	DI	DP	Status
1	26	21	0.87	0.18		21	25	4	0.53	0.78	Selected
2	26	8	0.62	0.66	Selected	22	16	7	0.42	0.33	
3	26	17	0.79	0.33		23	27	5	0.59	0.81	Selected
4	26	7	0.61	0.70	Selected	24	13	7	0.37	0.22	
5	27	2	0.53	0.92	Selected	25	19	6	0.46	0.48	Selected
6	22	4	0.48	0.66	Selected	26	17	7	0.44	0.37	
7	27	8	0.64	0.70	Selected	27	22	7	0.53	0.56	Selected
8	23	9	0.59	0.51	Selected	28	22	11	0.61	0.40	Selected
9	27	13	0.74	0.51		29	15	3	0.33	0.44	
10	22	6	0.51	0.59	Selected	30	19	7	0.48	0.44	Selected
11	19	8	0.5	0.40	Selected	31	26	4	0.55	0.81	Selected
12	24	5	0.53	0.70	Selected	32	25	2	0.5	0.85	Selected
13	25	10	0.64	0.55	Selected	33	25	6	0.57	0.70	Selected
14	21	11	0.59	0.37	Selected	34	27	16	0.79	0.40	
15	25	4	0.53	0.78	Selected	35	19	3	0.40	0.59	Selected
16	24	3	0.5	0.77	Selected	36	27	13	0.74	0.51	
17	24	4	0.51	0.74	Selected	37	25	10	0.64	0.55	Selected
18	24	8	0.59	0.59	Selected	38	19	7	0.48	0.44	Selected
19	26	11	0.68	0.56	Selected	39	21	9	0.55	0.44	Selected
20	25	3	0.51	0.81	Selected	40	15	1	0.29	0.51	

Note: U = The number of correct responses in the upper group

L = The number of correct responses in the lower group

D I = Difficulty Index

D P = Discriminating Power

Appendix P

FAROOK TRAINING COLLEGE

FAROOK COLLEGE P.O. 673632

PRE-REQUISITE TEST IN BASIC MATHEMATICS FOR STANDARD XI

(Final Form)

Dr. Noushad. P P
Associate Professor
SGTDS, MG University

Philip Joseph
Research Scholar
Farook Training College

Personal Details

Name: **School:**

Class: **Roll Number:**

Instructions

- This is a test in Basic Mathematics (Arithmetic, Algebra, Geometry, Co-ordinate Geometry and Trigonometry)
- There are 30 Questions
- Each question has 4 responses as a, b, c, d
- In the response sheet given to you, the question numbers are written in order. Find out the correct answer and enter the corresponding letter code or correct answer in the space given.
- If you find that you have marked wrongly, then draw a circle around it and write the correct answer nearby.
- Answer all the questions
- Each question carries one score
- Maximum score is 30
- Duration is 45 minutes (with a cool of time 15 minutes)

Questions

1) The conjugate pair of $\sqrt{3}-1$is

   a) √3+1 b) √3-1 c) √3 d) -√3

2) $\frac{1}{2}+\frac{1}{3}-\frac{2}{3}=$..........

   a) 0 b) 1 c) $\frac{1}{6}$ d) $\frac{1}{2}$

3) The rational number equivalent to $\frac{-5}{7}+\frac{2}{7}+3$ is

   a) $\frac{5}{7}$ b) $\frac{1}{7}$ c) $\frac{22}{7}$ d) $\frac{18}{7}$

4) The real number equivalent to $\frac{-\sqrt{3}+\frac{1}{\sqrt{3}}}{2}$

a) $\frac{1}{\sqrt{3}}$ b) $\frac{-1}{\sqrt{3}}$ c) $\sqrt{3}$ d) $\frac{1}{2}$

5) $(3^3 \text{ x } 3^4)/ 3^5$ =............

a) 3 b) 3^2 c) 3^3 d) 1

6) $\frac{\sqrt[3]{8}}{\sqrt[3]{27}}$

a) $\frac{1}{3}$ b) $\frac{8}{27}$ c) $\frac{2}{3}$ d) 1

7) If $n = m^{2/3}$, then m is

a) n^2 b) n^3 c) $n^{3/2}$ d) $n^{2/3}$

8) Consider A: $3a^2+9a = 3a(a+3)$ and

R: a(b+c) = ab+a c. Then which of the following is true?

a) Both A and R are correct; R is not correct explanation of A

b) Both A and R are correct; R is the correct explanation of A

c) A is correct; R is incorrect

d) A is incorrect; R is correct

9) The square of-3n is

a) $-3n^2$ b) $-9n^2$ c) $9n^2$ d) $3n^2$

10) If 2x-5 = 11, then x is

a) 2 b) 4 c) 16 d) 8

11) The quadratic equation $x^2-6x+9 = 0$ has

a) real and unequal roots

b) real and equal roots

c) non-real and unequal roots

d) non-real and equal roots

12) The solutions of the equation $x^2-4 = 0$ are

a) – 2,2 b) -4,4 c) $-\sqrt{2}, \sqrt{2}$ d) 0,2

13) The roots of the equation $x^2+5x+6 = 0$ are

a) -2, -3 b) 2,3 c) $\frac{1}{2}, \frac{1}{3}$ d) $\frac{-1}{2}, \frac{-1}{3}$

14) Let $x^2 = 39^2+23^2-2(39)(23)$ and x>0. Then the value of x is

a) 8 b) 62 c) 4 d) 16

15) Given x+ ly = 14 and $x^2+y^2 = 100$. Then x and y are

a) -6,8 b) 2,14 c) 8,6 d) 14,2

16) The solution of 7x+3 = 5x+7 is

a) -2 b) 2 c) 4 d) -4

17) The value of x satisfying $5(4x+3) = 3(x-2)$ is

a) 0 b) 21 c) $\frac{21}{17}$ d) $\frac{-21}{17}$

18) If (2,0) is solution of the linear equation $2x+3y = k$, then value of k is

a) 4 b) 6 c) 5 d) 2

19) The length of a rectangular field is greater than its width by 10 meters. If the area of the field is 144 sq. m, its length and width are

a) 20,10 b) 28,18 c) 18,8 d) 10,2

20) The values of k for which the quadratic equation $2x^2+3x+k = 0$ has all real solutions are given by

a) $k \leqslant \frac{9}{8}$ b) $k \geq \frac{9}{8}$ c) $k \leqslant \frac{8}{9}$ d) $k \geq \frac{8}{9}$

21) Which of the following is not true?

a) $(x+y)^2 = (x-y)^2 + 4xy$

b) $(x-y)^2 = (x+y)^2 - 4xy$

c) $x^2-y^2 = (x+y)(x-y)$

d) $(x+y)^2 = x^2+y^2$

22) The quadratic equation whose solutions are 2 and 3 is

a) $x^2+5x+6 = 0$ b) $x^2 -5x+6 = 0$ c) $x^2+5x-6 = 0$ d) $x^2-5x-6 = 0$

23) If one of the roots of a quadratic equation with rational coefficients is $2-\sqrt{3}$, then the quadratic equation is

a) $x^2+4x+1 = 0$ b) $x^2 +4x-1 = 0$ c) $x^2 -4x+1 = 0$ d) $x^2 -4x-1 = 0$

24) In the triangle ABC, right angled at B, AB = 3 cm and AC = 5 cm. Then BC is given by

a) 3 cm b) 5 cm c) 4 cm d) 2 cm

25) The three numbers given in each option are the lengths of the sides of a triangle in centimetres, which of them are right-angled

a) 13,12,5 b) 5,6,7 c) 39,36,16 d) 19,18,6

26) The distance AB between the points A(-3,7) and B(9,2) is

a) 10 b) 11 c) 12 d) 13

27) If the distance between points (x, -1) and (3,2) is 5, the values of x are

a) -1,7 b) 1,7 c) 2,3 d) 1, -7

28) $\sin 60^0$ =............

a) 0 b) 1/2 c) $2/\sqrt{3}$ d) $\sqrt{3}/2$

29) Which of the following is true?

a) $\sin^2\theta + \cos^2\theta = 1$ b) $\sec^2\theta - \tan^2\theta = 1$

c) $\mathrm{cosec}^2\theta - \cot^2\theta = 1$ d) All of the above

30) If $\tan^2\theta + \cot^2\theta = 2$, $0^o<\theta<90^o$, the angle θ is

a) 0^o b) 30^o c) 45^o d) 60^o

Pre-requisite Test in Basic Mathematics for Standard XI (Final)

RESPONSE SHEET

Personal Details

Name: **School:**

Class: **Roll Number:**

Qn. No.	Answer	Qn. No.	Answer
1		16	
2		17	
3		18	
4		19	
5		20	
6		21	
7		22	
8		23	
9		24	
10		25	
11		26	
12		27	
13		28	
14		29	
15		30	

Total Score:

Pre-requisite Test in Basic Mathematics for Standard XI (Final)

SCORING KEY

Qn. No.	**Answer**	**Qn. No.**	**Answer**
1	a) $\sqrt{3}+1$	16	b) 2
2	c) $\frac{1}{6}$	17	d) $\frac{-21}{17}$
3	d) $\frac{18}{7}$	18	a) 4
4	b) $\frac{-1}{\sqrt{3}}$	19	c) 18,8
5	b) 3^2	20	a) $k \leqslant \frac{9}{8}$
6	c) $\frac{2}{3}$	21	d) $(x+y)^2 = x^2+y^2$
7	c) $n^{3/2}$	22	b) $x^2 -5x+6 = 0$
8	b) Both A and R are correct; R is the correct explanation of A	23	c) $x^2 -4x+1 = 0$
9	c) $9n^2$	24	c) 4 cm
10	d) 8	25	a) 13,12,5
11	b) real and equal roots	26	d) 13
12	a) – 2,2	27	a) -1,7
13	a) -2, -3	28	d) $\sqrt{3}/2$
14	d) 16	29	d) All of the above
15	c) 8,6	30	c) 45^o

Appendix Q

FAROOK TRAINING COLLEGE

FAROOK COLLEGE P.O. 673632

QUESTIONNAIRE FOR SEEKING STUDENTS' FEEDBACK ON BRIDGE PROGRAMME

Dr. Noushad. P P
Associate Professor
SGTDS, MG University

Philip Joseph
Research Scholar
Farook Training College

Instructions: Please read the following questions. Give your responses in Yes or No. Remember only one marking should be done for each question and there are no right or wrong answers. Take under consideration only your situation while giving answers.

Sl. No	Items	Yes	No
1	Do you agree that the Bridge Programme in Mathematics meets the needs of Higher Secondary students' Mathematics learning?	O	O
2	Do you think that the plans and strategies in the programme are beneficial to you for enhancing the learning and achievement in Mathematics?	O	O
3	Did the Bridge Programme in Mathematics make difference in your attitude towards Mathematics?	O	O
4	Do you feel that the procedure (i.e., diagnosis, guidance and training) used in the programme is appropriate?	O	O
5	Do you think that the Bridge Programme plans and strategies are easy to practise?	O	O
6	Do you agree that your mathematical abilities are improved while participating in the programme?	O	O
7	Did the Bridge Programme in Mathematics help you to develop good study habits in Mathematics learning?	O	O
8	Do you believe that the Bridge Programme in Mathematics is helpful to enhance learning and achievement in Mathematics?	O	O
9	Do you feel that the Bridge Programme plans and strategies are difficult to practise and continue?	O	O
10	Are the materials used in the programme relevant?	O	O
11	Do you feel now that Mathematics learning is made tension-free?	O	O
12	Do you think that the guidelines given in the programme for Mathematics examinations are beneficial to you?	O	O
13	Are the materials provided in online as well as offline useful?	O	O
14	Do you feel that the plans and strategies in the Bridge Programme in Mathematics are beneficial in future Mathematics learning too?	O	O

Thank you for your participation