A STUDY OF CONCEPTUAL UNDERSTANDING OF MATHEMATICS AMONG GOVERNMENT SECONDARY SCHOOL STUDENTS OF NASWADI TALUKA.

A

Dissertation Submitted to

The Maharaja Sayajirao University of Baroda, Vadodara

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DECLARATION

I, Rajeshree Barot **hereby declare that the Dissertation study titled "a study of conceptual understanding of mathematics among government secondary school students of Naswadi city.";** is my original research work and no whole or partial part in the dissertation has been taken from anywhere. Wherever contributions of others are involved, every effort is made to indicate this clearly with due reference to the literature, acknowledgement of collaborative research and discussions. The work was done under the guidance of Prof. Satish Pathak.

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CERTIFICATE

It is certified that, the dissertation entitled, **"a study of conceptual understanding of mathematics among government secondary school students of naswadi city**.**"**, which is being submitted by **Ms. Rajeshree Barot** for the degree of Master of Education through the Department of Education, Faculty of Education and Psychology, The Maharaja Sayajirao University of Baroda, Vadodara, Gujarat, is carried out by her under my supervision and guidance. She has completed the thesis with best of her capacities. I certify that this is her original work and find it fit for the submission and evaluation.

Vadodara **(Prof. Satish P. Pathak)**
April, 2021 **Guiding Teacher**

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(Barot Rajeshree)

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CONCEPTUAL FRAMEWORK

1.1 INTRODUCTION

"Mathematics consists of proving the most obvious thing in the least obvious way."

- George Polya

(Quoted in N Rose Mathematical Maxims and Minims (Raleigh N C 1988)).

In the field of education, two primary concepts are involved. They are teaching and learning. The accomplishment of education depends on the effectiveness of teaching-learning process. The learner attains the knowledge when the teaching process fulfils its desired output. Mathematics is a methodical application of matter. It is so said because the subject makes a man methodical or systematic. Mathematics makes our life orderly and prevents chaos. Certain qualities that are nurtured by mathematics are power of reasoning, creativity, abstract or spatial thinking, critical thinking, problem- solving ability and even effective communication skills.

Modern mathematics careers are now requiring conceptual skills such as, critical thinking, modeling, and application of the content. This change in skillset needed for careers has strongly impacted mathematics curriculum and assessment. Meaningful assessment involves examining students' ability to inquire, to reason on targeted questions or tasks, and to promote conceptual understanding, not just focusing on discreet facts and principles. Mathematics assessment tools still focus solely on this procedural side of understanding mathematics instead of the equally important conceptual aspect of learning mathematics. Given that math is an active process that encourages higher-order thinking and problem solving, an assessment focusing on the growth of **conceptual understanding** is required. The proposed research focuses on the development of a tool that will be used to assess the student's ability to apply their conceptual understanding of a mathematic concept to scientific phenomena through modeling. The assessment using Netlogo would be very useful for math educators to have good tools to assess students' conceptual understanding, as well as to develop instructional Strategies used.

1.2 MATHEMATICS EDUCATION

In Oxford English Dictionary, the definition for "Mathematics" is furnished as the abstract science of number, quantity, and space, either as abstract concepts (pure mathematics), or as applied to other disciplines such as physics and engineering (applied mathematics). Mathematics is the science that deals with the logic of shape, quantity and arrangement. Mathematics is all around us, in everything we do. It is the building block for everything in our daily lives, including mobile devices, architecture (ancient and modern), art, money, engineering, and even sports.

In schools Mathematics is learnt from initial stage. Concept of numbers is taught from the very beginning of school. Basic concept of Mathematics should be learnt by every human being. As elementary school education has become compulsory for every child of the age 6- 18 years, keeping this in mind tremendous change has been made in school Mathematics in our country since Independence Day.

It is important for our students to acquire the foundations of knowledge and skill, to develop the capabilities for learning learn how to learn, to think logically, creatively and critically, to develop and use knowledge, to analyze and solve problems, to access and process information, to make sound judgements and communicate with others effectively. Students should be enabled to build up confidence and positive attitude towards Mathematics learning, to value Mathematics and to appreciate the beauty of Mathematics. Mathematics pervades all aspects of life; it is not possible to live in the modern world without making some use of Mathematics. Many of the developments and decisions made in industry and commerce, the provision of social and community services as well as government policy and planning etc., rely to some extent on the use of Mathematics. It should be important in the sense that students feel the need to solve such problems, that students and teachers find worth their time and energy addressing these problems and that Mathematics consider it an activity that is Mathematics worthwhile. An important sequence of such requirement is that school Mathematics must be activity oriented. Mathematics is an exact and organized science. It deals mainly with measurements, reasoning, calculations, discovering relationships and the problems of space.

According to Report of Education Commission (1964-66) "Mathematics and science should be taught as a compulsory subject to all students as a part of general education during the first ten years of schooling. According to National Policy on Education 1986 (NPE 1986), Mathematics should be visualized as the vehicle to train a child to think, reason, analyze and articulate logically. Apart from being a specific subject, it should be treated as a concomitant to any subject involving analysis and reasoning. With the recent introduction of computers in schools, educational computing and the emergence of learning through the understanding of cause-effect relationships and the interplay of variables, the teaching of Mathematics will be suitably redesigned to bring it in line with modern technological devices. Further, National Curriculum Framework 2005 (NCF 2005) called for Mathematization of the child's mind.

1.3 STRUCTURE OF MATHEMATICS

Mathematics relies on both logic and creativity, and it is pursued both for a variety of practical purposes and for its intrinsic interest. "Mathematics is a word of symbols and their interrelation. It is also known as science which is related to is measurements, calculation, discovering relationship. Mathematics systematized, branch of science. It has its own language and characteristics. It is numerical and calculation part of man's life and knowledge. It is a science of logical reasoning and numerical problems. It deals with quantitative facts and relationship as well as problems involving space and form."(Sidhu, 2005) Mathematics is a mother of all sciences. Science is a systematic study of knowledge. The structure of Mathematics is nothing but structure of science. The structure of science can be compared to the framework of a building consists of a foundation, vertical pillars and horizontal beams. The foundation of the framework is comparable to broad generalization and principles of science. The facts are comparable to building materials. i.e., stone, bricks, concrete etc. In the analogy, the vertical pillars and the horizontal beams of science are subject to the attention on the basis of empirical tests. It should be noted that this analogy of a building under construction is to facilitate understanding of science.

1.4 NATURE OF MATHEMATICS

According to Benjamin Peirce (1870), "Mathematics is a science which draws necessary conclusions." Mathematics is abstract in nature which investigates deductively the conclusions implicit in the elementary conceptions of spatial and numeric relations. Mathematics has its unique nature on the basis of which we can compare it with other subjects. Mathematical knowledge is applied in the study of science and its different branches; for e.g., physics, chemistry, biology and other sciences. Mathematical language is well defined, useful and clear. Mathematics helps in the development of sense of appreciation among children.

Mathematics does not leave any doubt in mind of learner about theories, principle, concepts etc. Mathematics helps to develop the habit of self-confidence and self-reliance in children. Mathematical rules, laws and formulas are universal and that can be verified at any place and time. Language of Mathematics consists of Mathematical terms, concepts, formulas, theories, principle and signs etc. It gives accurate and reliable knowledge. Mathematical knowledge is based on sense organs. It is the science of logical reasoning. It is said that Mathematics is the mirror of civilization.

It deals with quantitative facts and relationship as well as with problem involving space and force. Mathematics is enumerative and calculative form of human life and knowledge. It helps the person give the exact interpretation to his ideas and to reach on certain calculations. It helps in conversion of abstract concept into concrete form.

Kumar (1993) explains the nature of mathematics as follows:

- **Mathematics is abstract**.

The complexity of mathematics lies in its high level of abstractness. The mathematical concepts represent events and situations in its own ways. One, who gets acquainted in this, masters the concepts of mathematics and learns to derive new techniques. But the one, who does not understand it, creates the feeling of dislike for mathematics.

- **Mathematics has its own language.**

The unique language of mathematics consists of symbols, signs and notations. This language reduces the lengthy statements into short equations. The language is simple to interpret and at the same time it is difficult for those who do not know the meaning of the symbols, signs and notations.

- **Mathematics is accurate and precise**.

Accuracy, exactness and precision form the beauty of mathematics. There is no scope for vagueness either in thought or in argument.

- **Mathematics is certain**

In mathematics, the results are definite and exact. There is no any scope for difference in opinion. The mathematical answers are either right or wrong.

- **Mathematics is original.**

In mathematics reasoning, there is no scope for cramming or reproduction of ideas. One has t0 first understand the mathematical concepts and then he/she can apply it to solve the problems. So, an individual has to think in his/her original way for getting the solution.

- **Mathematics is verifiable**.

In mathematics, all the solutions are reached by a systematic and step by step procedure. Those solutions can be verified by doing reverse procedure.

According to Roger Bacon ND," Mathematics is the gateway and key of all sciences."

1.5 PLACE OF MATHEMATICS IN SCHOOL CURRICULUM

Everybody needs some knowledge of Mathematics in one way or the other. But it is felt that for an ordinary man, the knowledge acquired during the primary and middle stages will suffice. It is also believed that Mathematics is an exceptionally difficult subject, i.e., study requires special ability and intelligence. Mathematics is very useful subject for more vocations and higher specialized courses for learning. Therefore, the duty of the school is to give to the high school student a broad view of what he is capable of achieving in future.

Ignorance of Mathematics will be a great handicap in the progress of his studies in many other subjects. During the age of education of 3 R's Mathematics was one of the three, rather two, subjects of study; its importance in the present age is no less. There can be no true schooling without Mathematics.

Math’s is utilized in each and every sphere of life. If Mathematics is removed from our lives, then our civilization will take a shape of a skeleton of a human being without spinal cord. We cannot take a decision correctly in science without help of Mathematics. Hence, it is quite non-practical to separate Mathematics from our daily life. It is probably true stated by a writer" Mathematics is the mother of all sciences and carrier of all arts.

Kothari Commission has expressed his views in the above context" We adopt scientific views to express the things in Quantitative form". Hence Mathematics acquires an important position. Mathematics has contributed in direct or indirect manner in the progress of achievement.

1.5.1 Objectives of Teaching Mathematics

According to National Curriculum Framework for School Education (NCFSE 2000) following are the objectives of teaching Mathematics

- To enhance the capacity of the students to employ Mathematics in solving problems that they face in their day-to-day life
- To start a systematic study of Mathematics as a discipline and continue it further, here the emphasis is on systematic arrangement of contents i.e., arithmetic, algebra, geometry, trigonometry, statistics etc.
- To develop idea of proofs with thrust of deductive reasoning.
- To lay emphasis on the wider applications of Mathematics by way of making data based problems pertaining to actual data on population, agriculture, environment, industry, physical and biological science, engineering, defense etc.
- To enable the students to solve problems using algebraic methods and apply the knowledge of simple trigonometry to solve problems of height and distance etc.
- To appraise the students about the history of Mathematics with special reference to India and nature of mathematical thinking.
- To encourage the students to enhance their computational skills by use of Vedic Mathematics.

Through all these objectives, the teaching learning process of Mathematics tends to develop certain abilities in students in a perfect blend and therefore at different levels, different developmental aspects are focused through definite content areas.

NPE (1986) formulated the following basic tenets of Mathematics teaching at school level

- The teaching and learning of Mathematics should enable the child to consolidate the mathematical knowledge and skills acquired at primary stage.

- Assimilated knowledge of Mathematics should enable the child to solve the real- life problems by developing abilities to analyze, to articulate, to reason and to see inter relationship to involved, to think and reason.
- To develop the ability to articulate logically.
- To develop necessary & sufficient skills to work with modern technological devices such as calculators, computers etc. To develop appreciation for Mathematics as a problem- solving tool in various fields, for its beautiful structures and patterns etc.

So, to make the teaching learning compatible to the above tenets, an alternate method of instruction or teaching method has to be evolved so that, teaching process of Mathematics at school level becomes effective and meaningful.

1.5.2 Objectives of Teaching Mathematics at Secondary Stage

NCF (2000) states that the general objectives of teaching mathematics should be to promote mathematical abilities among the learners’ mathematical abilities to develop a logical mind that would help learners perform mathematical operations and apply them in everyday life. Today's mathematics teachers are experiencing major changes not only in the mathematics content they teach, but also in the way they teach. Nearly all of these teachers came through school when mathematics consisted of a collection of facts and skills to be memorized or mastered by a relatively homogeneous group of students taught using a lecture approach. Now teachers are called on to teach new, more challenging mathematics to a very diverse audience using active learning approaches designed to develop understanding.

The mathematics syllabus has undergone changes from time to time in accordance with growth of the subject and emerging needs of the society. The present revised syllabus has been designed in accordance with the (NCF, 2005) and as per the guidelines in the Focus Group Teaching of Mathematics which is to meet the emerging needs of all the categories of students.

The Curriculum at the Secondary stage primarily aims at enhancing the capacity of to employ mathematics in solving day-to-day life problems. It is expected that Students should acquire the ability to solve problems using the content taught from Algebraic expressions and apply the knowledge of simple trigonometry to solve the problems of Heights and Distances. Carrying out experiments with numbers and forms of geometry, framing hypothesis and verifying these with further observations form the inherent part of Mathematics learning at this stage. The proposed curriculum includes the study of number system, algebra, geometry, trigonometry, mensuration, statistics, graphs and coordinate geometry etc. The teaching of Mathematics should be imparted through activities which may involve the use of concrete materials, models, patterns, charts, pictures, posters, games, puzzles and experiments.

According to NCF (2005) Teaching and learning of mathematics is a complex activity and many factors determine the success of this activity. The main goal of mathematics education emphasized in NCF (2005) was 'mathematization' of the child's thought and processes. In doing so the document visibly enlarges the vision of school mathematics taking it beyond areas of obvious utility in daily life to enriching a student's scope of thought and Visualization and in turn her ability to relate to the world and to mathematics. It suggested two main aims of school mathematics;

a. The narrow aim of school mathematics is to develop 'useful' capabilities, numbers, number operations, particularly those relating to numeracy measurement, decimals and percentages.

b. The higher aim to develop the child's resources to think and reason mathematically, to pursue assumptions to their logical conclusion and to handle abstraction. It includes a way of doing things, and the ability and the attitude formulate and solve problems.

As per Rashtriya Madhyamik Shiksha Abhiyaan (RMSA, 2009) states that second school In mathematics curriculum continues the development of learning of mathematics in prirnary school and it has stated main objectives of teaching of mathematics as follows;

1) To develop the ability of students to conceptualize, inquire reason communicate mathematically.

2) To enable students to manipulate numbers, symbols and other mathematical objects.

3) To develop the number sense, symbol sense, spatial sense and a sense measurement as well as the capability in appreciating structures and patterns

4) To develop a positive attitude towards mathematics and the capability in appreciating the aesthetic nature and cultural aspect of mathematics.

According to CBSE (2012) (Central Board of Secondary Education); Mathematics teaching should not only include acquiring the concepts related to their syllabus but also should develop on their skills of calculation, organization, reasoning, problem solving, analysis and hence build up on their ability to apply this knowledge and acquired skills in their daily life. It also emphasizes on Mathematics Lab activities as an integral and an indispensable part of the mathematics curriculum. Objectives of teaching of Mathematics at secondary stage stated by CBSE (2012) are to help the learners to:

- Consolidate the Mathematical knowledge and skills acquired at the upper primary stage,
- Acquire knowledge and understanding, particularly by the way of motivation and visualization of basic concepts, terms, principles and symbols and underlying processes and skills,
- Develop mastery of basic algebraic skills;
- Develop drawing skills;
- Feel the flow of reason while proving a result or solving a problem;
- Apply the knowledge and skills acquired to solve problems and wherever possible, by more than one method,
- To develop positive ability to think, analyze and articulate logically;
- To develop awareness of the need for national integration, protection of environment, observance of small family norms, removal of social barriers, elimination of gender biases,
- To develop necessary skills to work with modern technological devices such as calculators, computers, etc.
- To develop interest in mathematics as a problem-solving tool in various fields for its beautiful structures and patterns, etc.
- To develop reverence and respect towards great Mathematicians for their contributions to the field of Mathematics;
- To develop interest in the subject by participating in the related competitions;
- To acquaint students with different aspects of mathematics used in daily life;
- To develop an interest in students to study mathematics as a discipline.

The above stated objectives accentuate the teachers to take up the responsibility of planning of the content, understanding the level and quality of subject matter knowledge, the repertoire of pedagogical skills the teachers possess to meet the needs of diverse groups.

1.6 Status of Mathematics Education at Secondary stage

Secondary Education is a crucial stage.in the educational hierarchy as it prepares the students for higher education and also for the world of work. Classes IX and X constitute the secondary stage, whereas classes XI and XII are designated as the higher secondary stage. The normal age group of the children in secondary classes is 14-16 whereas it is 16-18 for higher secondary classes. The rigor of the secondary and higher secondary stage, enables Indian students to compete successfully for education and for jobs globally. Therefore, it is absolutely essential to strengthen this stage by providing greater access and also by improving quality in a significant way. Ever since the Constitution was adopted in 1950, the focus of educational programmers was concentrated on elementary education. Since the constitutional committee is free and compulsory education to all the children up to the age Of fourteen years and now with the introduction of (RMSA, 2009) the government wishes to envisage the Secondary Section in which there is a mention of Universalization of Secondary Education and whose one of the important objectives was to improve the quality of secondary education. It has emphasized in giving more focus on Science, Mathematics and English education. It also accentuates on the need to establishment of Science and Mathematics Laboratories, ICT enabled education, Curriculum reforms and Teaching Learning reforms and In-service training of teachers. The various educational bodies have given reforms to be made in the system of secondary education from time to time but probably a gap is left to confirm the efficacy of implementation of the reforms. This research study has been taken up in the Vadodara district of Gujarat state to study the status of teaching of mathematics in schools of Vadodara city. There are three different types of board followed by the schools in the city of Vadodara. They are the Central board, international board and the state board. The Gujarat State board was formed on 1st May, 1960 whose main academic task of is the preparation of syllabus for secondary schools and also the recommendation of text-books to be taught in government schools. The main responsibilities of the Board include academics, conducting examinations and research and development. The Board also performs the duties of recognizing new schools, performance evaluation of schools and inspections of various schools associated with the Board. The board also notifies the schools to allot the periods for all the subjects per week for classes IX and X. The periods for class IX for mathematics are seven per week and for class X for Science, Mathematics and Social Science are twenty. It provides guidelines to the Principal, Supervisors and the teachers to carry out their assigned duties in the best possible manner. It publishes a handbook called "Vinimay" which provides a brief outline about the same. The researcher has tried to list down the various duties relevant to the topic undertaken.

1.7 IMPORTANCE OF MATHEMATICS

"Mathematics is the mirror of civilization"

- Hogben

We cannot live without the use of Mathematics. Mathematics forms major part of everyone's life. The needs of mathematics are based on the requirements of the society. The more complex a society, the more complex the mathematical needs. There are countless examples of mathematical patterns in nature's fabric. A good curriculum of mathematics is helpful in effective teaching and learning of the subject.

Experience says learning mathematics can be made easier and enjoyable if our curriculum includes mathematical activities and games. Mathematics puzzles and riddles instill an alert and open-minded attitude among youngsters and help them develop clarity in their thinking. Emphasis should be laid on development of clear concept in mathematics in a child, right from the primary classes.

For explaining a topic in mathematics, a teacher should take help of pictures, sketches, diagrams and models as far as possible. The process of learning is complete when our sense of hearing is accompanied by our sense of sight. Students should be encouraged to think about the solutions in all possible manners. The students should be appreciated for every correct attempt and the mistakes/errors must be immediately corrected without any criticism.

Mathematics has certain unique features which are absent in most other disciplines. The following are the important characteristics of mathematics.

- Precision and accuracy
- Logical sequence
- Applicability
- Generalization and classification
- Mathematical language and symbolism

- Abstractness
- Structures in mathematics
- Mathematical systems
- Rigor and logic

1.8 CHALLENGES IN LEARNING MATHEMATICS

The greatest hurdle in the process of learning mathematics is lack of interest/ practice. Students should work out at least 10 problems from different areas in order to master the concept and develop speed and accuracy in solving a problem.

Another very effective means of spreading the knowledge of mathematics among children is through peer-teaching. Once a child has learned a concept from his teacher, the teacher should ask him/her to explain the same to fellow students. Moreover, in the process all the children will be able to express their doubts on the topic and clear them through discussions in a group.

The present age is of skill-development and innovations. The more mathematical we are in our approach, the more successful we will be. Mathematics offers rationality to our thoughts. It is a tool in our hands to make our life simpler and easier. Let us realize and appreciate the beauty of the subject and embrace it with all our heart. It is a talent which should be compulsorily honed by all in every walk of life.

As per the University of Oregon, the challenges faced by the students in learning mathematics are as follows: -

- Problem Solving
- Reasoning and Proof
- Communication
- Connections
- Representation

1.8.1 Problem Solving

Problem solving is an integral part of all mathematics learning. In everyday life and in the workplace, being able to solve problems can lead to great advantages. However, solving problems is not only a goal of learning mathematics but also a major means of doing so. Problem solving should not be an isolated part of the curriculum but should involve all Content Standards. Its features are-

- build new mathematical knowledge through problem solving;
- solve problems that arise in mathematics and in other contexts;
- apply and adapt a variety of appropriate strategies to solve problems;
- Monitor and reflect on the process of mathematical problem solving.

1.8.2 Reasoning and Proof

Instructional programs from prekindergarten through grade 12 should enable all students to—

- recognize reasoning and proof as fundamental aspects of mathematics;
- make and investigate mathematical conjectures;
- Develop and evaluate mathematical arguments and proofs;
- Select and use various types of reasoning and methods of proof.

Systematic reasoning is a defining feature of mathematics. Exploring, justifying, and using mathematical conjectures are common to all content areas and, with different levels of rigor, all grade levels. Through the use of reasoning, students learn that mathematics makes sense. Reasoning and proof must be a consistent part of student's mathematical experiences in prekindergarten through grade 12.

1.8.3 Communication

Instructional programs from prekindergarten through grade 12 should enable all students to-

- organize and consolidate their mathematical thinking through communication;
- communicate their mathematical thinking coherently and clearly to peers, teachers, and others;
- analyze and evaluate the mathematical thinking and strategies of others;
- Use the language of mathematics to express mathematical ideas precisely.

As students are asked to communicate about the mathematics they are studying--to justify their reasoning to a classmate or to formulate a question about something that is puzzling--they gain insights into their thinking. In order to communicate their thinking to others, students naturally reflect on their learning and organize and consolidate their thinking about mathematics.

1.8.4 Connections

Instructional programs from prekindergarten through grade 12 should enable all students to-

- recognize and use connections among mathematical ideas;

- understand how mathematical ideas interconnect and build on one another to produce a coherent whole;
- Recognize and apply mathematics in contexts outside of mathematics.

Mathematics is an integrated field of study, even though it is often partitioned into separate topics. Students from prekindergarten through Grade 12 should see and experience the rich interplay among mathematical topics, between mathematics and other subjects, and between mathematics and their own interests. Viewing mathematics as a whole also helps students learn that mathematics is not a set of isolated skills and arbitrary rules.

1.8.5 Representation

Instructional programs from prekindergarten through grade 12 should enable all students to-

- create and use representations to organize, record, and communicate mathematical ideas;
- select, apply, and translate among mathematical representations to solve problems;
- Use representations to model and interpret physical, social, and mathematical phenomena.

Representations are necessary to students' understanding of mathematical concepts and relationships. Representations allow students to communicate mathematical approaches, arguments, and understanding to themselves and to others. They allow students to recognize connections among related concepts and apply mathematics to realistic problems.

1.9 CHALLENGES IN TEACHING MATHEMATICS

1.9.1 The over-dependency on scientific instruments

With the advancement in scientific inventions, students tend to make use of the scientific instruments such as Calculators and Computers in solving numerical operations. Although the use of scientific instruments is appreciable, the same should not result in avoiding learning tables. It is a disappointing feature that most of the children avoid learning tables which results in scoring low marks in Mathematics exams.

1.9.2 Teaching students of different levels of intelligence.

In a classroom, there will be a combination of students with different levels of intelligence. It is very difficult for the teachers to have different styles of teaching to suit each student of different types of intelligence. For this, the teacher may adopt collective learning or Group Learning among students. This not only results in good academic achievement, but also in developing self confidence among students.

1.9.3 Fear of Learning Mathematics among students

To reduce "Math Phobia" among students is the greatest challenge for Math Teachers. It is generally believed that math is dry and abstract subject. We people are trying to overcome this mentality at our level best. But it is rather difficult to teach each and every topic with the real-world situations like the topics of Abstract Algebra. Many students think that little mathematical knowledge is sufficient to enter into different careers. They don't know the wide applications of it.

1.10 GOALS OF MATHEMATICS EDUCATION

The main goal of mathematics education in schools is the mathematisation of the child's thinking. Clarity of thought and pursuing assumptions to logical conclusions is central to the mathematical enterprise. There are many ways of thinking, and the kind of thinking one learns in mathematics is an ability to handle abstractions, and an approach to problem solving.

The study of mathematics should instill in students an ever-increasing sense of wonder and awe at the profound way in which the world displays order, pattern, and relation.

1.10.1 Children learn to enjoy mathematics:

This is an important goal, based on the premise that mathematics can be both used and enjoyed life-long, and hence that school is best placed to create such a taste for mathematics. On the other hand, creating (or not removing) a fear of mathematics can deprive children of an important faculty for life.

1.10.2 Children learn important mathematics:

Mathematics should be learnt from its basics. The basic concepts such as Addition, Subtraction, Multiplication and Division are to be understood without ambiguity. The school should provide infrastructure for making students understand Mathematics easily. The responsibility of Mathematics teacher is to develop the confidence level of students in learning Mathematics interestingly.

1.10.3 Children pose and solve meaningful problems:

Mathematics provides an opportunity to make up interesting problems, and create new dialogues. Children use abstractions to perceive relationships, to see structure, to reason about things, to argue the truth of mathematical statements. Logical thinking is a dominant factor in learning mathematics. Only on obtaining the adequate skills, all the concepts of Mathematics could be understood without any hurdle.

1.10.4 Children understand the basic structure of mathematics:

Arithmetic, algebra, geometry and trigonometry, the basic content areas of school mathematics, all offer a methodology for abstraction, structuration and generalization.

1.10.5 Teachers expect to engage every child in class:

Teaching ends with the attainment of set goals of learning by students. All children should be encouraged to effectively involve in solving any mathematical problem. Each student is to be rewarded for correct reply/answer so that the entire student community could involve solving mathematics with lots of interest.

1.11 CONCEPT IN MATHEMATICS

1.11.1 Concept - Meaning and Definition

"Concept" is the basic unit of learning. From infancy to old age, an individual accumulates different concepts through learning and maturation, but level of concept formation is not the same in all the individuals. It differs with age, intelligence and chance of experience of the learners. For example, a layman will not have the same concept of inflation as a student of economics has because the experiences of the latter are wide and more sophisticated than the former.

Concept is defined by Lynn Erickson as "a mental construct that is timeless, universal and abstract." Concepts, such as intertextuality, ecosystems, prime numbers, and culture, are rich ideas to which facts and examples are attached.

The word "concept" can be defined as "referring to the common characteristics of similar or sometimes even different objects and events with one word, or one term." On the other hand, in a broad sense, "concept" is information structure that represents the changeable common characteristics of different objects and phenomena, it is assigned meaning in our minds, and it can be expressed with one word, and is shaped as a result of people's opinions (Celikoz, 1998).

The word "concept" is not purely subjective and designates the mental constructs of the individual only. It is objective in nature also because it is understood on the basis of substances and mechanism used in a particular discipline. Different concepts are identifiable, comparable and measurable because of its objectivity.

A concept is the mental model of an object. The mental model encompasses the object's definition, blueprint and examples. For example, the concept of "boat" includes linguistic description, drawing and picture, etc., The development of concept is through a prototyping process, where tentative models are tested until a polished model is derived.

We can define a concept with special features, or traits. For instance, "chair" has four legs, a flat seat, a back, and it can be seated upon. Some concepts have formal definitions, which are based on the universal conceptual system. The basic concepts are defined in the dictionary, while the advanced concepts are defined by specialized texts. Some concepts have a commonly accepted definition, and some are more open to debate.

One concept is always linked to other concepts. Concepts serve multiple functions. We recognize objects by matching the sensory data with known spatial concepts. We describe causal mechanisms with a causal model. Finally, we develop concepts to solve problems.

Logically, a concept refers to a phenomenon in a given field that is grouped together because of their common characteristics. For example, a square is a figure that has equal length and breadth and that is why it is different from a circle or triangle.

Practically a concept may be defined as public entities or organized information to the meaning of words which a particular society has accepted for the purpose of communication. They are the standard of which a language is judged. In other words when we say that the particular word is understood in standard form, we mean concept by that word.

The Frayer model is a graphic organizer used to analyze a concept by:

- Name or Label
- Definition
- Examples
- Essential Attributes
- Non-Essential Attributes
- Non-Examples

1.11.2 Characteristics of Concepts

The characteristics of concepts are as follows:

- Concepts differ in difficulty value. Some concepts are learnt more easily than others. For example, concrete concepts are easier than abstract concepts and more easily perceptible concepts are learnt more readily than less perceptible concepts.
- Some concepts are used more than others in understanding communication and forming principles, for example, symbols of numbers 1,2,3… are used more than symbols of ratio or theta.
- A concept is valid to the extent that experts agree to its meaning and definitions. Concepts of natural sciences are more valid than those of social sciences because of their objectivity.
- The individual concept comes closer to the concept of the expert when he grows in age and attains maturity and experiences. Thus, development of concepts is a dynamic process.
- Concepts which are higher in taxonomy have fewer defining attributes than those which are lower in the taxonomy. Living things are highly general concepts in the sense that they are higher in the taxonomy.

Some concepts are more powerful than the other. Power refers to the extent to which a particular concept

- ▪ Facilitates the learning of other concepts. According to Bruner (1961) "every discipline has some fundament concepts which are necessary to learn the subject or discipline in the beginning". Concepts must have some attributes on the basis of which they can be identified and differentiated from other concepts.

1.11.3 Levels of Concept Development

Concepts do not develop in the individual's over-night.

The four levels of concept development are,

(i) Concrete level
(ii) Identity level
(iii) Classification level
(iv) Formal level

(i) Concrete level:

The building of concepts starts with the process of sensation. This is done by the process of perception. Concept at the concrete level is developed when an individual perceives an object next time and identifies it. Woodruff (1961) writes "All learning begins with some form of personal contact with actual objects or events. When individual gives attention to some objects through a light wave or sound wave or some form of direct contact with a sensory organ in the body, an impression is picked up and lodged in the mind."

For the purpose of developing concrete concepts, the person must be able to differentiate it from other concepts on the basis of his identification. Thus, following steps are needed for concept formation.

- Attending to the object several times.
- Formation of the memory image with respect to the object.
- Differentiating from other objects.

(ii) Identity level:

When the students are able to generalize the characteristics of an object in different properties it means that they are at the identity level of concept formation. They are not only able to differentiate an object from other objects on the basis of its properties, but can identify it also on the basis of its properties. They can even recognize the object when only the properties of the object are supplied to them. This is the highest concrete level but the lowest abstract level of concept formation.

(iii) Classification level:

When the students are able to classify different categories of the same object or the basis of its properties, it means that they have attained the classification level of concept formation. They are now able to treat at least two different instances of the same class as equivalent. It is the higher level of abstract concept.

(iv) Formal level:

When the students are able to define a concept and name it accurately with examples it means that they have attained the formal level of concept formation. The distinctive aspect of this level is that they are able to specify and name the defining attributes and to differentiate newly encountered instances and non- instances on the basis of presence or absence of defining attributes.

1.11.4 The Mechanism of a Conceptual Sector

The brain develops many conceptual sectors through learning. A conceptual sector is composed of templates and scripts that can manipulate coherent mental models stored in the explicit memory.

Each person's conceptual activity is supported by his or her distinct cognitive styles, including systematic method, heuristic strategy, insight, intuition, and trial and error. In a conceptual sector, information is processed in input stage, analysis stage, and composition stage.

1.11.5 Types of concepts

The three types of concepts are

(i) Conjunctive concepts
(ii) Disjunctive concepts
(iii) Relational concepts

(i) **Conjunctive concepts**:

It is the joint presence of the appropriate value of several attributes.

(ii) **Disjunctive concepts**:

It involves a critical combination of criteria attributes.

(iii) **Relational concepts**:

It involves the notion of a common relation among the various elements of attribute values that define the concept.

1.11.6Types of Concept Development

The concept development takes place through Sensory and Symbolic ways. Identification of sensory concept of physical objects with their distinct traits and identify symbolic concept of abstract matter through the deliberate learning of symbolic rules. Sensory information can be described with lower level distinct fundamental prototypes where an object is defined with traits (object = {trait1, trait2, J). When the traits match, an object is identified.

1.11.7 Traits

A concept can be defined with traits. A trait is a simple pattern that can be analyzed autonomously with feature space. The conceptual input module identifies patterns based on predefined traits. For instance, a triangle is a trait that is made up of three lines connecting to each other. The cognitive system handles distinct patterns better than random images because patterns can be stored into memory and recalled without losing significant details.

There are several types of traits. A spatial trait can be reduced into lower resolution without losing its resemblance to the original image. An auditory trait is the pattern of sound that is associated with an object or event. A linguistic trait is the pattern of words that corresponds to an event. A mathematical trait describes the quantitative nature of matter. Some of these traits have no immediate spatial implication and are abstract. A non- measurable trait cannot be quantified and is referred to as a secondary quality of matter. For instance, the quality of "kindness" is a non-measurable secondary trait. Other traits that do not belong to either one of these categories often utilize other prototyping tools as needed.

1.12 MISCONCEPTIONS

The thought process of students consists of many things. Formulae, relevance and enjoyment are part of their attitudes and thinking about mathematics. Students may have different levels of misconception. From the Encarta online dictionary, a misconception is "a mistaken idea or view resulting from a misunderstanding of something." Paraphrasing from the educational literature [Pines, 1985] , we offer, certain conceptual relations that are acquired may be inappropriate within a certain context. Such relations are termed as "misconceptions." A misconception does not exist independently, but is contingent upon a certain existing conceptual framework. Misconceptions can change or disappear as the framework changes.

1.12.1 Types of Misconceptions

Misconceptions can be categorized as follows:

- Preconceived notions are popular conceptions rooted in everyday experiences. For example, many people believe that water flowing underground must flow in streams because the water they see at the earth's surface flows in streams.

- Non-scientific beliefs include views learned by students from sources other than scientific education, such as religious or mythical teachings. For example, some students have learned through religious instruction about an abbreviated history of the earth and its life forms.
- Conceptual misunderstandings arise when students are taught scientific information in a way that provoke them to confront paradoxes and conflicts resulting from their own preconceived notions and nonscientific beliefs.
- Vernacular misconceptions arise from the use of words that mean one thing in everyday life and another in a scientific context (e.g., "work").
- Factual misconceptions are falsities often learned at an early age and retained unchallenged into adulthood.

Misconceptions might also be referred to as preconceived notions, non- scientific beliefs, naive theories, mixed conceptions, or conceptual misunderstandings. Basically, in science these are causes in which something a person knows and believes does not match what is known to be scientifically correct.

Most people who hold misconceptions are not aware that their ideas are incorrect. When they are simply told they are wrong, they often have a hard time giving up their misconceptions especially if they have had a misconception for a long time. Possessing misconceptions can have serious impacts on our learning. Many people have difficulty letting go of misconceptions because the false concepts may be deeply ingrained in the mental map of an individual. Some people also don't like to be proven wrong and will continue clinging to a misconceptions in the face of evidence to the contrary. This is a known psychological phenomenon and is due to the lack of will or inability to reevaluate information.

Misconceptions form in a variety of ways. One person passes on often misconceptions to the next. In other cases, students may be presented with two correct concepts, but combine or confuse them. Sometimes students make what to them seems like a logical conclusion, but are simply drawn from too little evidence or lack of experiences. One of the most common sources of misconceptions is the fact our everyday language is often at odds with science; common vernacular doesn't always match the precise language used by scientists.

Though the connotation of "misconception" is negative, we must remember that the formation of these ideas often represent a child's effort to organize and understand the world around him/ her. The success of these efforts will depend both on the developmental stage of the child and experiences to which he/she is exposed.

1.13 CONCEPTUAL UNDERSTANDING

The term "Conceptual Understanding" refers to the development of fundamentally new concepts, through restructuring elements of existing concepts, in the course of knowledge acquisition.

Conceptual Understanding is a particularly profound kind of learning-it goes beyond revising one's specific beliefs and involves restructuring the very concepts used to formulate those beliefs. Explaining how this kind of learning occurs is central to understanding the tremendous power and creativity of human thought.

The emergence of fundamentally new ideas is striking in the history of human thought, particularly in science and mathematics. Examples include the emergence of Darwin's concept of evolution by natural selection, Newton's concepts of gravity and inertia, and the mathematical concepts of zero, negative, and rational numbers. One of the challenges of education is how to transmit these complex products of human intellectual history to the next generation of students.

While learning a concept, it is to be kept in mind that the core of the concept is not modified or altered. Thus, conceptual change is generally defined as learning that changes an existing conception that is belief, idea or way of thinking. Learning for conceptual understanding is not merely accumulating new facts or learning a new skill. In conceptual understanding, an existing conception is fundamentally changed or even replaced and becomes the conceptual framework that students use to solve problems, explain phenomena and function in their world.

Teaching for conceptual change primarily involves uncovering students' preconceptions about a particular topic or phenomenon and using various techniques to help students change their conceptual framework. Conceptual Understanding instruction can help students overcome misconceptions and learn difficult concepts in all subject areas.

Like almost every subject of human interest, mathematics is just as easy or as difficult as the concept is properly explained or not. The misconception can take place even from the primary education. If proper method is used to make the concepts very clear, then mathematics can be pleasant, useful, practical and enjoyed for its own sake. Children should not only be asked to "do math problems", but also "to experience mathematics". This means that they will need to become involved with the concepts being presented, not "just get answers".

There is no difference of opinion on the need for teaching of mathematics as a part of general education. As a matter of fact, for a long-time education was equated with acquiring 3R's Reading, Writing and Arithmetic. Even in the broader concept of education which we have today, the 3R's form an important form of education.

Our society is moving into a technical era. Mere acquisition of arithmetical skills is not sufficient. We need people with sound mathematical skills. For this, the misconceptions are to be avoided in the school and college level subjects.

While learning mathematics so many misconceptions can be had to the students of high school level. Particularly in the areas of Vector Algebra, Analytical Geometry, Probability Theory, Modern Algebra etc.

How Conceptual Understanding is Achieved

Combining academic learning, assessment and soft skills doesn't have to be difficult. As Kaku noted in his keynote speech, information can be taught in various ways, from MOOCs and robots, to the Internet, people and more. Robots can replace the way information is taught or how basic tasks are performed, but creativity, experience and underlying structures may not be as replaceable.

What needs to be taught that hasn't been an emphasis in previous decades is the common thread throughout concepts, the underlying structure of information and how ideas are related. To achieve this, we have to take our students through real world examples of professions and embed the learning within.

Just as an effective learning game has the learning tied into the core mechanics of the game, effective teaching activities need to incorporate real strategies that students will use in the real world. Instead of purely teaching memorization and facts, we have to prepare people to take abstract ideas to form thoughtful opinions and decisions as they would in a future profession.

One way to get people to understand something is to take what they're interested in and have them explore it as if they were in that field. Especially in a school district that might not have the resources to pursue personalized learning, project-based learning and exploratory units are excellent ways to approach conceptual understanding.

In social studies, for example, rather than giving your students facts and dates, ask them to approach history as an anthropologist — have them read books as a historian who wants to understand why an event happened, and identify people groups and traditions and customs as an anthropologist. When students can piece these ideas together, they're developing the skills to see underlying patterns and cause and effect.

1.13.1 Process of Conceptual Change

Mathematics deals with a number of concepts. If the concepts are not properly conceived by the students, it gives ground for Misconceptions. Misconceptions obstruct the structuring of the acquired knowledge. To avoid that and for meaningful learning, we need to revise the old information and replace the wrong one with the right one. This is called "Conceptual Change Process." (Smith, Blakeslee and Anderson, 1993)

Concepts are not universal. The same concept may be understood by different communities and the culture in different ways. Similarly, the same word may have different concepts in different communities and languages.

Changing the conceptual framework of students is one of the key goals in repairing mathematics misconceptions. That is to say, it is not usually successful to merely inform (e.g. lecture) the student on a misconception. The misconception must be changed internally partly through the student's belief systems and partly through their own cognition.

In another misconception's framework, we may say many students do not come to the classroom as "blank slates" (Resnick, 1983). Rather, they come with informal theories constructed from everyday experiences. These theories have been actively constructed. They provide an everyday functionality to make sense of the world but are often incomplete half-truths (Mestre, 1987). They are misconceptions.

For example, in Algebra, students are confronted with troubles in grasping with mathematics from the most elementary concepts. In turn, student misconceptions cause teachers immense frustration about why their teaching is not "getting through."

In conceptual change, an existing conception is fundamentally changed or even replaced, and becomes the conceptual framework that students use to solve problems, explain phenomena and function in their world.

1.13.2 Teaching for conceptual change

Teaching for conceptual change primarily involves,

- Uncovering students' preconceptions about a particular topic or phenomenon.

- Using various techniques to help students change their conceptual framework.

However, in the outside environment of schools, students develop strong misconceptions about a wide range of concepts related to non- scientific domains. Conceptual change instructions can help students overcome misconceptions and learn difficult concepts in all subjects' areas. Conceptual change is not only relevant to teaching in the content areas, but it is also applicable to the professional development of teachers and administrators. Teachers must learn different instructional strategies, but they must also reconceptualize or change their conception about the meaning of teaching.

1.13.3 Practical issues of Conceptual Change Approach

Concepts change with learning and development in different subject matter areas with a focus on explaining students' difficulties in learning the more advanced and counterintuitive concepts in these areas. Some researchers are not persuaded that there is a need to distinguish "conceptual change" processes from "learning" in general. But it is important to differentiate it from other types of learning because it requires fundamental changes in the content and organization of existing knowledge as well as the development of new' learning strategies for deliberate knowledge restructuring and the acquisition of new concepts. The problem of conceptual change is one of the major reasons behind students' widespread failure to understand counterintuitive concepts, mostly (but not only) in science and mathematics. We also argue that, to a large extent, the general ineffectiveness of instructional interventions in these areas could be attributed to the inadequate attention that has been given so far to the problem of conceptual change (Vosniadou, Vamvakoussi, & Skopeliti, 2008).

Teachers can be astonished to learn that despite their best efforts, students do not grasp fundamental ideas covered in class. Even some of the best students give the right answers but are only using correctly memorized words. When questioned more closely, these students reveal their failure to understand fully the underlying concepts.

In many cases, students have developed partially correct ideas that can be used as the foundation for further learning. However, many students have not developed an appropriate understanding of fundamental concepts from the beginning of their studies, and this shortcoming can interfere with subsequent learning.

- Although the students themselves can often easily correct vernacular and factual misconceptions, it is not effective for a teacher simply to insist that the learner dismiss preconceived notions. Students' must confront their own beliefs along with their associated paradoxes and limitations and then attempt to reconstruct the knowledge and then attempt to reconstruct the knowledge necessary to understand the scientific model being presented. This process requires the teacher to,
- Identify students' misconceptions.
- Provide a forum for students to confront their misconceptions.
- Help students reconstruct and internalize their knowledge, based on scientific models.

1.14 CONCLUSION

The conceptual framework related to ‘conceptual understanding in mathematics’, ‘Importance of conceptual understanding’, “Advantages of conceptual understanding’ and ‘Scope of using conceptual understanding in teaching of Mathematics’ has been described under this chapter. Based on the developed conceptual framework, rationale of the study has been strengthened logically to establish significance of the study. Further the review of the related literature has been described in the next chapter.

CHAPTER 2

REVIEW OF RELATED LITERATURE

CHEPTER-II

REVIEW OF RELATED LITERATURE

2.1 INTRODUCTION

The present chapter includes a review of previous researches related to the present study. Researcher has taken an attempt carefully to review the research journals, books, dissertations, thesis and other sources of information related to the objectives of the study. Through reviewing related literature, the researcher came to know about the recommendations of the previous researches. Researcher takes an advantage of the knowledge, which has been already accumulated from the constant human endeavor in the form of past researches. Review of the related literature allows the researcher to be acquainted with the current knowledge in the area of the present research. The review of related literature updates the researcher through providing background for understanding latest knowledge on the topic under research. Through the review of previous studies, one can have a clear perspective of the process. By reviewing the related literature, the researcher can avoid the selection of the problem areas which have already been selected earlier. Review of related literature enables the researcher to define the limits of his research study. It helps researcher to delimit and define the problem properly. It helps the investigator with the new understanding and insight which subsequently helps him in proper planning of the study, adopting the suitable methodology, developing tools for the data collection and adopting proper techniques for analysis and interpretation of the data. The review or related literature gives the researcher an understanding of the research methodology which refers to the way the study has to be conducted.

2.2 REVIEW OF RELATED LITERATURE

Review of related literature is an essential prerequisite to actual planning and execution of any research project. Further through the reviews, the researcher can understand that the study being undertaken does not exist in vacuum and that considerable work on similar type of studies has been done. These reviews can guide the researcher to enhance his study by contemplating on what further developments the investigator should focus on.

In post independent India, great emphasis has been placed on Mathematics teaching and learning. In 1937, when Gandhiji propounded the idea of 'basic education', a committee under the chairmanship of Dr. Zakir Hussain was appointed to submit a report on this idea. It recommended: "Knowledge of Mathematics is an essential part of any curriculum. Every child is expected to work out the ordinary calculations required in the course of his craft work or his personal and community concerns and activities".

The secondary education commission appointed in 1952 also emphasized the need for Mathematics as a compulsory subject in the schools. Keeping in view its importance, the 'Education Commission' (1964-66) recommended it as a compulsory subject for students at school level.

2.2.1 STUDIES CONDUCTED IN MATHEMATICS

Novillis (1980) conducted a research on misconception of, "Fraction in Mathematics". Students had greater difficulty associating a proper fraction with a point of a number line than associating a proper fraction with a part- whole model where the unit was either a geometric region or a discrete set. Also, students who were able to associate a proper fraction on a number line of length one often were not successful when the number line had length two (i.e., they ignore the scaling and treat the available length as the assumed unit) Finally, though able to form equivalents for a fraction, students often did not associate the fractions (1/3) and (2/6) with the same point on a number line.

Thakore (1980) constructed diagnostic tests and preparing remedial material as well as testing its effectiveness on fractions and decimal fractions for the students of grade V of Gujarati medium school in greater Bombay. The tests and the remedial material prepared by the investigator. Ten diagnostic tests were prepared. Tests were administered to the students of I I schools of Bombay. The major findings were that the students of class V did not have clear concept of fractions. They did not understand the place value of respective figures in decimal fractions. They did not understand addition, subtraction, multiplication and division of decimal fractions.

Hiebert, (1981) conducted a research entitled, "Number relationship conservation and a child's ability to learn or do Mathematics". In the study some students' misconceptions on learning number system reported in the literature were investigated and presented. With this aim, a detailed literature review of misconception in number system was carried out and the collected data was presented from past to day historically. On the basis of the results some suggestions for teaching were made.

Manika (1983) tried to investigate the relationship between acquisition of the concept in Mathematics and some personal and environmental variables of the students at primary school level in Bombay. The sample size was 524 students from different schools of urban area from standard I-V. Tools used were Raven’s colored progressive matrices and mathematical concepts test. Major findings were:

1. Majority of the students who were promoted to the next grade did not show the acquisition of concepts of the lower grade.
2. Student's concept of higher mathematical hierarchy could not be developed unless lower concepts are cleared. 3. For the better development and acquisition of mathematical concepts, individualized instruction was found useless.

ThreadgillI-Sowder, (1984) conducted research on misconception entitled "Understanding of place value in Decimals." For example, students used to mentally separate a decimal into its whole number part and its pure decimal part, such as rounding 148.26 to 150.3 or, students assumed that "more digits" implied that a number was larger, such as 0.1814 being larger than 0.385 and 0.3. The outcome of the research was the necessity for connecting the familiar (e.g., written symbols, place value principles, procedural rules for whole number computations and ordering) with the unfamiliar (e.g., decimal notation and the new quantities they represent) and finally arrived at a conclusion that the concrete representations of both the symbols and potential actions on these symbols would help make these connections.

Shah (1985) made a psychometric exploration to study relationship between achievement in arithmetic and three psychological factors viz. intelligence, problem faced by children, parent-child relationship, in few primary schools in 84 Block for the first grade. The sample was selected through the purposive sampling technique. A total population of 897 children was included from twenty-two primary 29 schools of 84 Block. Data was collected using Arithmetic Achievement Test, Interview Schedule for the parents, student problem inventory, And Individual Intelligence Test. The major findings were inattentiveness of parents; School had no special programs for finding out backward children. It was found that some teachers were not qualified to teach arithmetic. Teachers had to teach all subjects and had not under gone any special training to teaching of mathematics.

Kothari (1985) investigated the efficacy of different instructional media into the teaching of Mathematics to the pupils of class IX in relation to certain variables. The sample of 120 students was selected from two schools of Anand. The tools used were Junior Index of Motivation, Reasoning ability and Criterion Tests. The study disclosed under observation that pupils were very eager to know about the different instructional media. It was their demand that all the units of Mathematics should be taught through visual projection. In case of instructional media namely Activities and experiment, pupils were very busy in drawing figures. They enjoyed studying through this media as it was activity oriented. Visual projection is comparatively more effective than any other Instructional media like Activities and experiment or even programmed learning material for teaching of Mathematics. The low achieving pupils are comparatively more benefited by programmed learning material than the high achievers and the average achieving pupils.

Rawool (1988) studied the conceptual maturity of students belonging to the age group 11 to 14 in non-metric geometry. The sample of the study consisted of 50 students. The data were collected using three tests. The first consisted of the task of classification, the second of the task of drawing geometrical figure as per the given description, third involved the task of describing a verbally for given geometrical figure. The major finding of the study were, The evidences showed that students were familiar with the terminology, assumptions and figural and concrete representation related to the non-metric geometrical concepts, but they failed to use these concepts at the understanding and applications" levels. The students failed to use geometrical terms, assumptions and figural representations rigorously and failed to deduce relationships in the geometrical context with the different concepts they added their own ideas and formulated their own assumptions, which were not accepted by the geometrical structure.

Hiebert, (1988) conducted research on the concept of "Written symbol system such as decimals in mathematics and studied the problems faced by the students confronting with a new written symbol system such as decimals need to engage in activities (e.g., using base-ten blocks) that help construct meaningful relationships" The key was to build bridges between the new decimal symbols and other representational systems (e.g., whole number place values and fractions) before "searching for patterns within the new symbol system or practicing procedures" such as computations with decimals.

Wearne, Hiebert and J. Sowder (1988) conducted research on the "Effectiveness of learning place-value connections (or analogs) between whole numbers and decimal numbers".

They discovered the fact that children often focused directly on the whole number aspects but failed to adjust for the decimal aspects. For example, a common error confronted by students, was ordering of decimal numbers as if they were whole numbers, claiming 0.56 greater than 0.7 with the misconception since 56 is greater than 7. The reading of decimal numbers seemingly as whole numbers (e.g., "point five six" or "point fifty-six") contributed to the previous error.

Sowder and Schappelle, (1989) conducted research on "The concept of Rational number". The authors arrived at a conclusion that the primary difference between rational number and whole number seemed to be that rational number sense was directly connected to students' understanding of decimal and fraction notations, while whole number sense did not have to be directly connected to the written symbols.

Bergeron and Herscovics (1990) conducted a research dealing with a "Child's acquisition of and fluency with the number-word sequence (e.g., one, two, three ...) and the ability to count". It was evaluated that a worthy goal is for the student's fluency to be bidirectional, where the number-words can be produced in sequence in either direction easily and subsequently offered some valuable suggestions for teaching.

Chel (1990) attempted to diagnose and suggest remediation of underachievement in the Compulsory Mathematics of the Madhyamik examination in West Bengal. The sample Corn prized urban, semi-urban and rural students of class VI to X of West Bengal. The case study method was used in collecting the data. The main difficulties faced by students included content gaps, confusion in understanding Mathematics language, stereotype way of Presenting contents and lack of openness in training. The major mistakes found in the performance of students and teacher trainees in the area included mathematization of verbal Problem's interpretation of Mathematics results and learning new topics in Mathematics.

Under achievement was caused due to lack of understanding of Mathematics concepts of t earlier stage and the abstract nature of Mathematics.

Lyn D English and Graeme S Halford, (1995) conducted research on "Place value concept in teaching number system". They took the practical demonstration used viz. colored chips and money often used as manipulatives to represent place value concepts and operations. They concluded that such a demonstration prompted increased cognitive complexity. Finally, they discovered the reason that the place value notions are not explicitly represented in the color of the chips or the physical sizes of the money. Lyn D English and Graeme S Halford

(1995) conducted a research on "Misconception of place value determination in number system in mathematics". The final outcome of the research was that the major reason for place value lapses was found as the linguistic complexity of place-value system in English. For example, we do not name "tens" as done in some languages (e.g., "sixty" vs. "six-tens"), arbitrarily reverse the number names between 10 and 20 (e.g., eleven and thirteen), and accept irregularities in our decade names (e.g., "twenty" vs. "sixty")

Lyn D English and Graeme S Halford, (1995) conducted research on "Students' conceptual misunderstandings of Decimals" They analyzed the concept of adoption of rote rules and computational procedures and found that the concept did not really justify the natural connection of decimals to whole number, both in notation and computational procedures.

Sumangla (1995) studied some psychological variables discriminating between high and low achievers in mathematics. The study was conducted on a stratified sample of 750 (362 boys and 388 girls) students of Standard IX drawn from twenty schools of five revenue district of Kerala. Tools used included Test of Mathematics aptitude by Sumangala and Malini, Scale of Attitude towards Mathematics by Sumangala Sunny, Scale of Self-concept in Mathematics by Sumangala and Jayshree. Mathematics Aptitude and its components viz., Numerical Ability, Numerical Reasoning, Ability to use symbols, Spatial Ability and Abstract Reasoning, Attitude towards Mathematics and Self-Concept in Mathematics discriminated significantly between high and low achievers in Mathematics. The relation among the independent variables, Mathematics Aptitude and its components viz., Numerical Ability, Numerical Reasoning, Ability to use symbols, Spatial Ability and Abstract Reasoning, Attitude towards Mathematics and self-concept in Mathematics with Achievement in Mathematics were significant and positive.

Subramaniam& Singh (1996) studied the mistake committed by students in the application of different mathematical skills and developing preventive and remedial teaching strategies using metacognitive approach for qualitative improvement in teaching of Mathematics. The data were collected from eight government primary schools in the districts (Sehore and Bilaspur districts of MP). Each school was visited on three consecutive days. On the first day, test in Mathematics was administered to children. These children were interviewed on the second day. On the last day, mistakes committed by children were identified, analyzed and Classified through a workshop and the recorded diagrams were scanned. Finally, a compendium of mistakes was prepared. The major findings were: The students committed six types of mistakes in addition, eight types of mistakes in subtraction, ten types of mistakes in multiplication and six types of mistakes in division. Some students felt that due to confusion between multiplication and addition (ii) signs, forgetfulness of the procedures, lack of opportunity to write on the book etc., they committed mistakes in the test. (iii) Poor concept of carrying over, zero & multiplication, introvert behavior, lack of writing skills, etc. were observed as possible causes of mistakes committed by students. (iv) The teachers of the schools cited home environment, SES, physical facilities in the school, extra workload on teachers, lack of interest, motivation and discipline, large size of class, general promotion policy, etc. responsible for the poor performance of children in the test.

Lyn D. English and Graeme S. Halford (1996) conducted a study entitled," Mathematics Education: Models and Processes." In this study, the authors outlined approaches to the field (Chapter 1) and relevant concepts from cognition (Chapter 2), the study addressed the question of how mathematics was understood (Chapter 3). Research in cognitive science had shown that human understanding was based on mental models which were content-specific and analogical in character. Thus, mathematical operations were first understood by analogies based on physical operations on objects, while algebraic ideas might be understood by using the structure of arithmetic operations as analogs. This research yielded explanations for why some concrete teaching aids, which were technically analogs, were effective and others were not. Good teachers recognized that teaching aids are not panaceas and required to be chosen thoughtfully, and they have intentionally linked the best insights of practitioners with the research of cognitive science. Analyses of mathematical analogs leads on to complexity theory, which further explains why some concepts seem unaccountably difficult while others are not. Again, competent teachers often sense these facts, but they lack clear explanations. Appropriate analyses of the relevant cognitive processes provide more rigorous explanations, which lead to more effective remediation. The authors illustrated the process as to how students' recognition of the correspondence between mathematical concepts, one of the most fundamental goals of mathematics learning, depended on mapping common structures (relations) from one concept to another. The authors investigated as to how links were made cognitively between concepts could help to discriminate between good and bad instructional procedures, which might have been indistinguishable otherwise. Finally, it was inferred by the authors that analyses of the cognitive processes involved in mathematics learning could do a lot to sharpen the discriminations of practitioners, who, in turn, could challenge and extend the work of cognitive scientists.

Kaarina Merenluoto and Erno Lehtinen (2002) conducted a study entitled, "Conceptual Change in Mathematics: Understanding the Real Numbers." In this study, some special features of mathematical knowledge were considered in order to better understand the nature of conceptual change in the domain. In learning mathematics, every extension to the number concept demands, not only accepting new concepts, but new logic as well. This new logic more or less contradicts the prior fundamental logic of natural numbers. Therefore, misconceptions and learning difficulties are possible at every enlargement. To understand the problems students, have in the conceptual change pertaining to the enlargement of the number concept a test was administered to 564 students (mean age 17.3) from randomly selected Finnish upper secondary schools. The test included identification, classification and construction problems in the domain of rational and real numbers. We found that changes of number conceptions, which was measured through questions in the domain of rational and real numbers was not adequately carried out by the majority of the students who had just finished their first calculus class. While working on the tasks on the more advanced numbers they spontaneously used the logic and general presumptions of natural numbers or based their answers on their everyday intuition. The number concept of the majority of these students seemed to be based on the spontaneous logic of natural numbers but had also fragmented pieces of more advanced numbers. The students tended to overestimate the certainty of their answers when they used the logic of natural numbers even if it was erroneous.

Kaarina Merenluoto and Erno Lehtinen (2004) conducted a study entitled, 'l Number concept and conceptual change: towards a systemic model of the processes of change." The research on conceptual change had so far mainly dealt with cognitive outcomes, but especially during the last few years there had been a growing interest in and discussion about the processes of conceptual change. The purpose of the article was to contribute to this discussion and to present a theoretical model of the dynamics among the cognitive and motivational factors in conceptual change. Several researchers in science education had proposed cognitive conflict as instructional strategy for teaching difficult scientific concepts. However, the authors aimed to explain why it did not always support the conceptual change. In their model, the two crucial aspects to the process of conceptual change were: the sensitivity to the novel aspects in the situation, and the ability to regulate the tolerance of ambiguity resulting from the experience where the prior knowledge was not adequate.

Susanne Predige (2006) conducted research on the "Impact of theoretical framework of conceptual change on analyzing learning difficulties". The researcher found the necessity for combining conceptual change approaches in the learning sciences with established categories from mathematics education research, such as epistemological obstacles. According to the researcher, these didactic categories helped to make explicit that obstacles in conceptual change could lie deeper in mathematical content knowledge than often seen in conceptual change approaches. The researcher discussed the results of an empirical study of the well-known conception "multiplication makes bigger" by integrating existing research into an explanatory level model. Taking into consideration, the basis of a constructivist theory of learning and inspired by Piaget's notion of accommodation, the conceptual change approach emphasized that learning was not always cumulative in the sense that new knowledge was only 'added' to the prior (as a process of enrichment). Instead, learning often necessitated the reconstruction of prior knowledge when confronted with new experiences and challenges. Problems of conceptual change could appear, when the learners' prior knowledge was incompatible with the necessary new conceptualizations. The researcher commented that the fact that students' conceptions were not always compatible with the intended scientific conceptions could often be explained by the influence of prior conceptions and non-accomplished processes of their reconstruction.

Stella Vosniadou and Xenia Vamvakoussi (2006) conducted a study entitled," Examining Mathematics learning from a Conceptual Change Point of View: Implications for the Design of Learning Environments." Most educational researchers agree that mathematics learning does not consist of the passive absorption of certain abstract, de-contextualized concepts and procedural skills to be acquired by individuals through transmission teaching methods. Rather, researchers talk about the development of a mathematical disposition which involves not only domain specific knowledge and problem- solving skills, but also meta-knowledge, self-regulatory skills, motivational factors, and epistemological beliefs about mathematics (e.g., De Corte, Greer, & Verschaffel, 1996; Schoenfeld, 1992, 2002). Nevertheless, the discussion about the design of powerful learning environments that can foster the development of a mathematical disposition is not yet settled, often reflecting the controversy between cognitive and situated approaches to learning and teaching. The situated approach movement had drawn the attention of the mathematics education community to certain aspects of learning that were not considered important in the context of cognitive approaches, such as the relevance of the social and cultural context in which learning takes place, and the role of artefacts in learning (Anderson, Reder, & Simon, 1996; De Corte, 2004; Sfard, 1998). The situated approach had also been useful in pointing out the mismatch between the way mathematics was taught in the schools and the way it is used in real-life situations. It was argued that many school activities might be meaningless for students and the same might be a source of creating inert knowledge that could not be transferred.

Hiebert James, Grouws, Douglas (2007) in their study on "The Effects of Classroom Mathematics Teaching on Students' Learning" found that the most important feature in effective teaching is giving students "opportunity to learn". Teachers can set expectations, time, kinds of tasks, questions, acceptable answers, and type of discussions that will influence students' opportunity to learn. This must involve both skill efficiency and conceptual understanding which implies that teaching of mathematics should not only be concerned with the computational know how of the subject but is also concerned with the selection of the mathematical content and communication leading to its understanding and application. So while teaching mathematics one should use the teaching methods, strategies and pedagogic resources that are much more fruitful in gaining adequate responses from the students.

Zerpa, Carlos; Kajander, Ann; Van Barneveld, Christina (2009) conducted a study entitled, "Factors that impact pre-service teachers' growth in conceptual mathematical knowledge during a mathematics methods course". This study examined pre-service teachers' change in conceptual mathematical knowledge after taking a reform-based mathematics methods course as part of a teacher certification program, and investigated the relationship between this change and factors such as pre-service teachers' academic background, initial levels of conceptual and procedural mathematical knowledge and values, and the number of mathematics courses taken in high school and university. The results of this study suggested that the number of mathematics courses taken in high school might influence growth in conceptual mathematical knowledge, while pre-service teachers' subject-area background and the number of university mathematics courses taken did not appear to influence growth in conceptual mathematical knowledge as needed to teach in a reform-based manner.

Nancy J. Nersessian (2009) conducted a study entitled, "Conceptual Change: Creativity, Cognition and Culture." In this study, the author investigated "conceptual innovation" which is one of the most creative dimensions of scientific practice. Throughout the history of the sciences changes in representational structure have provided "revolutionary" understandings of nature. As with other creative outcomes, conceptual revolutions are still widely perceived to be the outcomes of mysterious acts of individual genius, such as represented by an Isaac Newton, a Charles Darwin, or an Albert Einstein. The object of this paper was to establish to incorporate both the undoubtedly unique contributions of individual scientists and the inherently socio-cultural nature of all scientific creations into the analysis of conceptual innovation. The route to meeting this objective lies in interpreting the conceptual practices scientists employ as deriving both from aspects of mundane human cognitive capabilities and from the social and cultural contexts, scientific and ordinary, in which they are embedded. The author also attempted to construct interpretation such as 1) knowledge of pertinent aspects of human cognition, 2) knowledge of specific practices implicated in cases of conceptual innovation, and 3) an understanding of how social and cultural contexts provide conceptual, analytical, and material resources that shape such practices.

Sing-pui Chan; Mei-lin Cheng (2010) conducted a study entitled, "Young Children's Path to Conceptual Change in the Context of Questioning- Exploration-Experience Learning." This study reported the characteristics of young children's understandings that were likely to bring about conceptual change in a classroom setting. This study was grounded on the socio-cultural perspective and contemporary views of concept development and learning. A group of five- to six-year-old children's concept learning of weighing scales in the context of Questioning-Exploration-Experience (QEE) learning was explored. Qualitative methods of data collection and analysis were adopted. A path of young children's characteristics of understandings leading to conceptual change was portrayed. Several distinctive features salient to the design of instructional strategies were implied. Results of the study confirmed that human mental activity operating in the social processes, which situated in a specific cultural context, was conducive to young children's conceptual change.

Timur Koparan, Cemalettin Yildiz, Davut Kogce, Bulent Guven (2010), conducted a study entitled, "Effect of materials developed based on conceptual change approach on 9th grade students' achievement in the subject of fractions". With this aim, a worksheet, conceptual change text and a two-stage performance test on the subject of fractions were developed. Quasi-experimental research model was used in the study. Following this model, the fractions were taught with traditional method in the control group and it was taught using worksheets and conceptual change texts in the experimental group. The performance test was applied as pre- and post-tests to a total of 46 students studying at two different 9th grade classes of a high school in Trabzon during 2008-2009 school year. The results of the study revealed that the instructional materials increased students' success in the experimental group. Ultimately the researchers recommended to use the materials developed during the course in mathematics classes and to develop similar materials for other subject matters also. Conceptual change approach represented an alternative approach which encouraged students to make transition from misconceptions, i.e., their non-scientific knowledge to scientifically accepted knowledge. This approach was built upon the assimilation, organization and accommodation principles.

Stella Vosniadou (2010) conducted a study entitled, "The problem of conceptual change in the learning of science and mathematics and the role of instruct". The author investigated and commented that a distinction was required to be made between students' preconceptions before they were exposed to science or mathematics instruction and the misconceptions that resulted after exposure to instruction. Many of these misconceptions were •synthetic models' resulting from students' constructive but inappropriate attempts to incorporate new information to incompatible prior knowledge. The implications of conceptual change research for science and mathematics instruction were discussed paying particular attention to the role of instructional analogies. Instructional analogies were consistent with a constructivist approach and provided an important mechanism to foster conceptual change by drawing on existing concepts from different domains of thought.

Michelangelo (2012) conducted a study, "It's Not What They Know, It's Who They See: Ideal Selves as Central Cognitions in Conceptual Change." This study investigated the effectiveness of teaching by teachers and the phenomenal contribution of conceptual change. It was inferred that it was not so much what the teachers knew or believed but who they saw when they imagined themselves in the future that had a real impact on the depth with which they approached new ideas and educational innovations.

Per-Olof Wickman (2012) conducted a study entitled, "How can conceptual schemes change teaching?" In this study, the author investigated the relationship of the conceptual schemes produced by educational researchers to educational praxis. The relationship is described as having been transformed in three steps:

- teacher deficit and social engineering, where conceptual schemes are little acknowledged,

- reflecting practitioners, where conceptual schemes are mangled through teacher practice to aid the choices of already knowledgeable teachers, and
- the mangling of the conceptual schemes by researchers through practice with the purpose of revising theory.

Krishna, Mrinmoy, Ranju (2012) conducted a comprehensive study under the title "Study of various problems faced by the students and teachers in learning and teaching mathematics and their suggestive measures" concluded from the teacher as well as student's perspective. The teachers gave the following reasons,

- Negative attitude of the students to study mathematics.
- Lack of tools to make mathematics more interesting.
- Insufficient time to teach.
- Lack of basic skills compel students to resort to memorization of the formulas hence encouraging cramming.
- Lack of parents' support.

The reasons given by the students while solving the problems were:

- Found problems too complex
- Found uninteresting due to lack of application skills.
- Found time consuming.

William F. McComas (2014) conducted a study entitled, "Teaching for Conceptual Understanding." In this study, the author has attempted to differentiate "knowledge" and "understanding." To know means that one may recall facts and information accurately, but understanding connotes the ability to use information in a flexible fashion in multiple environments and circumstance.

Murad Moh'd Abu Sarar et al. (2014) conducted a study entitled, "The effect of using Stepans' Model of Conceptual Change on the Modification of Alternative Mathematical Concepts and the Ability of Solving Mathematical Problems of Ninth Grade Students in Jordan" The study investigated the effect of using Stepans' model of conceptual change on students' modification of alternative mathematical concepts and on their ability of solving mathematical problems. The investigation was conducted by using ninth graders in two different sections in a secondary school in Amman. This study dealt with intact groups, but the treatments were randomly assigned to the classes so that the conceptual change group (CCG) contained one section and the non-conceptual change group (NCCG) contained the other section. An analysis of covariance (ANCOVA) showed that the CCG outperformed the NCCG in terms of students' modification of alternative mathematical concepts and their ability of solving mathematical problems. Classroom implications and suggestions for further research were also studied.

ANITA M. SCHUCHARDT CHRISTIAN D. SCHUNN (25 November 2015) conducted a study entitled, “Modeling Scientific Processes with Mathematics Equations Enhances Student Qualitative Conceptual Understanding and Quantitative Problem Solving” Amid calls for integrating science, technology, engineering, and mathematics (ISTEM) in K–12 education, there is a pressing need to uncover productive methods of integration. Prior research has shown that increasing contextual linkages between science and mathematics is associated with student problem solving and conceptual understanding. However, few studies explicitly test the benefits of specific instructional mechanisms for fostering such linkages. We test the effect of students developing a modeled process mathematical equation of a scientific phenomenon. Links between mathematical variables and processes within the equation and fundamental entities and processes of the scientific phenomenon are embedded within the equation. These connections are made explicit as students participate in model development. Pre–post gains are tested in students from diverse high school classrooms studying inheritance. Students taught using this instructional approach are contrasted against students in matched classrooms implementing more traditional instruction (Study 1) or prior traditional instruction from the same teachers (Study 2). Students given modeled process instruction improved more in their ability to solve complex mathematical problems compared to traditionally instructed students. These modeled process students also show increased conceptual understanding of mathematically modeled processes. The observed effects are not due to differences in instructional time or teacher effects.

Eymur, Guluzar, Geban, omer (2017) conducted a study entitled, "The Collaboration of Cooperative Learning and Conceptual Change: Enhancing the Students' Understanding of Chemical bonding concepts." The main purpose of this study was to investigate the effects of cooperative learning based on conceptual change approach instruction on ninth-grade students' understanding in chemical bonding concepts compared to traditional instruction. Seventy-two ninth-grade students from two intact chemistry classes taught by the same teacher in a public high school participated in the study. The classes were randomly assigned as the experimental and control group. The control group (N = 35) was taught by traditional instruction while the experimental group (N = 37) was taught cooperative learning based on conceptual change approach instruction. Chemical Bonding Concept Test (CBCT) was used as pre- and post-test to define students' understanding of chemical bonding concepts. After treatment, students' interviews were conducted to observe more information about their responses. Moreover, students from experimental groups were interviewed to obtain information about students' perceptions on cooperative work experiences. The results from ANCOVA showed that cooperative learning based on conceptual change approach instruction led to better acquisition of scientific conceptions related to chemical bonding concepts than traditional instruction. Interview results demonstrated that the students in the experimental group had better understanding and fewer misconceptions in chemical bonding concepts than those in the control group. Moreover, interviews about treatment indicated that this treatment helped students' learning and increased their learning motivation and their social skills.

Harwood C., Compton V.J. (2018) conducted a study entitled, "The Importance of the Conceptual in Progressing Technology Teaching and Learning." The author investigated the necessity for the teachers to know and do, to support student learning in technology and become more technologically literate, particularly related to foundational and citizenship technological literacy. The author also discussed how the relationship between student decision-making and their undertaking of technological practice supported their progression toward a more comprehensive technological literacy.

Beth L. MacDonald Arla Westenskow Patricia S. Moyer-Packenham Barbara Child (08 January 2018) conducted a study entitled, "Components of Place Value Understanding: Targeting Mathematical Difficulties When Providing Interventions**".** Place value understanding requires the same activity that students use when developing fractional and algebraic reasoning, making this understanding foundational to mathematics learning. However, many students engage successfully in mathematics classrooms without having a conceptual understanding of place value, preventing them from accessing mathematics that is more sophisticated later. The purpose of this exploratory study is to investigate how upper elementary students' unit coordination related to difficulties they experience when engaging in place value tasks. Understanding place value requires that students coordinate units recursively to construct multi-digit numbers from their single-digit number understandings through forms of unit development and strategic counting. Findings suggest that students identified as low-achieving were capable of only one or two levels of unit coordination. Furthermore, these students relied on inaccurate procedures to solve problems with millennial numbers. These findings indicate that upper elementary students identified as low-achieving are not to yet able to (de)compose numbers effectively, regroup tens and hundreds when operating on numbers, and transition between millennial numbers. Implications of this study suggest that curricula designers and statewide standards should adopt nuances in unit coordination when developing tasks that promote or assess students' place value understanding.

Angela R. Crawford Evelyn S. Johnson Yuzhu Z. Zheng Laura A. Moylan (04 March 2020) conducted a study entitled, “Developing an understanding procedures observation rubric for mathematics intervention teachers**”** This study describes the initial psychometric evaluation of an Understanding Procedures observation rubric. The instrument is intended to provide feedback to teachers working in mathematics intervention settings. The rubric translates the research base from mathematics education and special education into practice in the form of specific items and descriptors of performance levels. A sample of 16 intervention teachers across three states provided three videos each of their instruction of students in mathematics intervention classes. Ten external raters evaluated the videos. We analyze the ratings using many-facet Rasch measurement. Analyses of the teacher, item, rater, and lesson facets show good psychometric quality for the instrument. Implications for research and professional development are discussed.

2.3 RATIONAL OF THE PRESENT STUDY

Mathematics plays a vital role in bringing up our civilization by connecting all the fields. It helps People to give exact interpretations to their various ideas and conclusions. It is an essential tool which is applied in many fields such as physics, chemistry, biology, medicine, engineering and so On. In the scientific world, the credit of all the technical progress of science goes to progress of Mathematics.

The main goal of Mathematics education in schools is the Mathematization of the child's thinking. But, on the other hand, Mathematics education in our schools is beset with problems.

Due to hierarchy of concepts and largely deductive and abstract nature of the subject. Mathematics is considered as a very dull and difficult subject.

Only when the misconceptions are refined by deploying proper methods of conceptual change approach, the teaching process would yield its desired outcome. Students misconceptions before or after formal instruction have become a major concern among researchers in mathematics education because they influence how students learn new mathematical knowledge, play an essential role in subsequent learning and become a hindrance in acquiring the correct body of knowledge.

To be successful in teaching, teachers should actively imbibe the core of the concepts into the minds of the students, so that the students clearly understand the conceptual linkages between new concepts and those they already possess. This process of elaborating personal, meaningful knowledge takes place by restructuring the already existing conceptual frameworks.

A phobia has been created the minds of the children that Mathematics is tough to learn. As a result, most of the students are not taking interest in the subject and it has become one of the main causes of students' failure in Mathematics. Therefore, to remove this phobia, it is necessary to motivate the children by arousing and maintaining their interest in Mathematics. For this, Mathematics has to be learnt by doing rather than by reading. This doing of Mathematics gives rise to the need of a suitable place performing mathematical activities.

In a study conducted by Brown and Kane, preschool children were likely to transfer skills across different situations when they were encouraged to use prior taught and shown solutions. They learned best when they saw examples of solutions rather than being given an explicit rule.

In this vein, when carried over to math or another academic subject, children should be able to make decisions based on an emerging understanding gained by witnessing example solutions, not an explicit rule that only covers one problem or one way of answering a problem.

The implications of this study are teachers should provide students with opportunities to discuss their prior conceptions and carefully compare them with the mathematical conceptions.

Career Readiness

When people perform in a workplace, they often act based on previous knowledge, assumptions and understandings they have about a particular situation. They intelligently make decisions on what to do, and this often has to be done in an exploratory, innovative way, especially if it's a novel situation. More often than not, people won't have all the necessary information they need to explicitly be told how to make the correct decision. This is where developing conceptual understanding and associations comes in.

If students aren't given the chance to experience this type of exploratory learning as young learners, they will lack the appropriate skills to develop situations to everyday problems. We can teach our students all the information they need, but if they're not building on, analyzing, evaluating or having the chance to be creative with this knowledge in a relevant way and making associations, they won't develop the ability to deeply understand and transfer knowledge to make educated assumptions about new situations.

When information isn't available, people need to use the conceptual understandings and associations they've formed about similar concepts to successfully execute decisions.

As Kaku foreshadowed, the fourth wave of technology is coming and is entirely new, so we must prepare our students to be able to make decisions and use deeper understanding to process new information.

As author Warren Berger discovered, children love having questions answered, and this lights a fire inside of them to want to know more. In the classroom, we can address this by encouraging curiosity. In a Maths unit, have your students explore a hypothesis as a mathematician. Ask them how mathematicians' approach new ideas - do they test them? What do they research? What do they need to know? Beyond knowing about number system and what they do, have them develop an understanding about how number system work in our daily life. Making these connections early on will equip them with the critical thinking and investigative tools necessary to make informed assumptions.

When they ask great questions, they generate curiosity and more questions. As they ask more questions, they understand more deeply. We have to present students with situations with common threads so they can begin to learn patterns and underlying structures by asking questions themselves.

Promoting Equity through Conceptual Understanding

While information and facts are crucial to a student's success, what's more important—but often underdeveloped because testing does not typically assess this—is the ability to find connections. Standardized testing has traditionally measured a student's ability to memorize information and quickly plug in formulas, and when students are unable to perform that way, they're placed lower than others and given special attention. In an actual workplace setting though, this memorization of skills and the specific score a student receives may not be indicative of his ability to perform or utilize prior knowledge to make an informed decision.

When we teach for understanding and not memorization, we're leveling the playing field and equipping students with the skills to succeed in the future. The ability to transfer skills and knowledge will be much more advantageous than information that might become irrelevant, and making this the primary focus will relieve the burden on students to try to memorize information separate from how it can be utilized in a project or real-world setting.

2.4 Conclusion

In this study, an attempt is made to know how Conceptual Understanding Approach enhances learning of Mathematics among Secondary School Students. Models and concepts may be useful in helping us to understand not only how teachers' understanding grow but also why teachers' Conceptual Understanding use and classroom practice may differ greatly. Using tools of Conceptual Understanding to work in interesting problem contexts can facilitate students' achievement of a variety of higher-order learning outcomes, such as reflection, reasoning, problem posing, problem solving, and decision making. It is this shared commitment to intense use of Conceptual Understanding not for the sake of using tools but for the sake of developing and enhancing students' mathematical understanding that will serve the future well. Application and Evaluation of systems, approaches and devices that enhance/optimize human learning.

CHAPTER III

RESEARCH METHODOLOGY

CHAPTER-III
METHODOLOGY

3.1 INTRODUCTION

The central aspect of any research embodied in its methodology, which shares the idea about how the study was conducted step by step. It refers to the plan and fj researcher for conducting the present study. This chapter is methodology oriented where the researcher has concentrated on the plan and procedure adopted to obtain answers to the research questions and to attain the objectives of the present study. This chapter includes Objectives of the study, Explanation of the Terms, Operationalization of the Terms, Delimitations of Study, Population of the study, Sample of the study, Design of the study, Phases under the Plan and procedure, Tools for Data Collection, Procedure of Data Collection and Data Analysis. The comprehensive detail of the methodology regarding the above aspects has been described as under.

3.2 STATEMENT OF THE PROBLEM

"A STUDY OF CONCEPTUAL UNDERSTANDING OF MATHEMATICS AMONG GOVERNMENT SECONDARY SCHOOL STUDENTS OF NASWADI TALUKA."

3.3 OBJECTIVE OF THE STUDY

1. To identify the major concepts in a selected unit of standard ix mathematics.
2. To study the conceptual understanding of the students in the identified concept in terms of their achievement.
3. To study the misconceptions in the identified concept prevalent among Students related to the mathematical concepts in terms of their achievement.
4. To construct a diagnostic test to logically identify misconceptions in learning Mathematics among Secondary School Students.

3.4 Explanation of the Term

In the statement of the problem chosen for the present study, the significant meanings of terms used in the title are given below: -

CONCEPT

A concept is an abstract idea or a mental symbol, typically associated with a corresponding representation in language or symbology, that denotes all of the objects in a given category or class of entities, interactions, phenomena, or relationships between them. Also, as per the definition in Dictionary, the concept means

- a general notion or idea; conception.
- an idea of something formed by mentally combining characteristics or particulars; a construct.
- a directly conceived or intuited object of thought.

Conceptual Understanding

Conceptual understanding, where children can grasp ideas in a transferrable way, can help students take what they learn in class and apply it across domains. It's a hot topic in the classroom today, as rote memorization and traditional methods of teaching math are becoming considered insufficient for real-world learning and application.

While teaching to the test is common for state accountability and measurement, these methods don't always arm students with the skills to complete tasks outside of the classroom.

MISCONCEPTIONS

The term 'misconceptions' has been used to refer to preconceived notions, non-scientific beliefs, naive theories, mixed conceptions, or conceptual misunderstandings that are not in agreement with accepted scientific ideas.

MATHEMATICS

"Mathematics" is the science that deals with the logic of shape, quantity and arrangement. Mathematics is all around us, in everything we do. It is the building block for everything in our daily lives, including mobile devices, architecture (ancient and modern), art, money, engineering, and even sports.

SECONDARY SCHOOL

In the study, "Secondary School" refers to Classes comprising Ninth Standards.

STUDENT

The term "Student" means an individual who is pursuing a full-time course at a qualified educational institution. Here in this study, High School students are studied.

3.5 DELIMITATIONS OF THE STUDY

- The present study was delimited to the Government Gujarati medium schools of Naswadi Taluka affiliated to the Gujarat Secondary and Higher Secondary Education Board (GSHSEB), for the academic year 2020–21.
- The study was delimited to identify the major concepts in a selected unit of standard ix mathematics.
- The study was delimited to evaluate students conceptual understanding of standard ix mathematics.

3.6 DESIGN OF THE STUDY

Once the problem and objectives of the study were decided; the next important and consequential matter in research to be determined was selecting an appropriate research design for the study. The present study was Descriptive survey research which was conducted for the description of a specific situation and studying opinions of a specific group of the participants (principals, teachers and students), which has allowed the researcher not only to present the prevailing situation but also to interpret and report the existing facts on the ground. According to Best and Kahn (2006), descriptive survey type studies are used to find out 'what is and therefore the detailed information is required for answering the research questions. So, looking at the study and its objectives, a descriptive survey design was found the most appropriate method to collect detailed information about achieving the stated objectives of the study.

3.7 POPULATION OF THE STUDY

The population for the present study consisted of 5 Gujarati medium schools of Naswadi Taluka affiliated to the GSHSEB. Thus, the Principal of the schools, teachers of Mathematics in all these schools and all of the students studying in Standard IX of these schools were the population of the study.

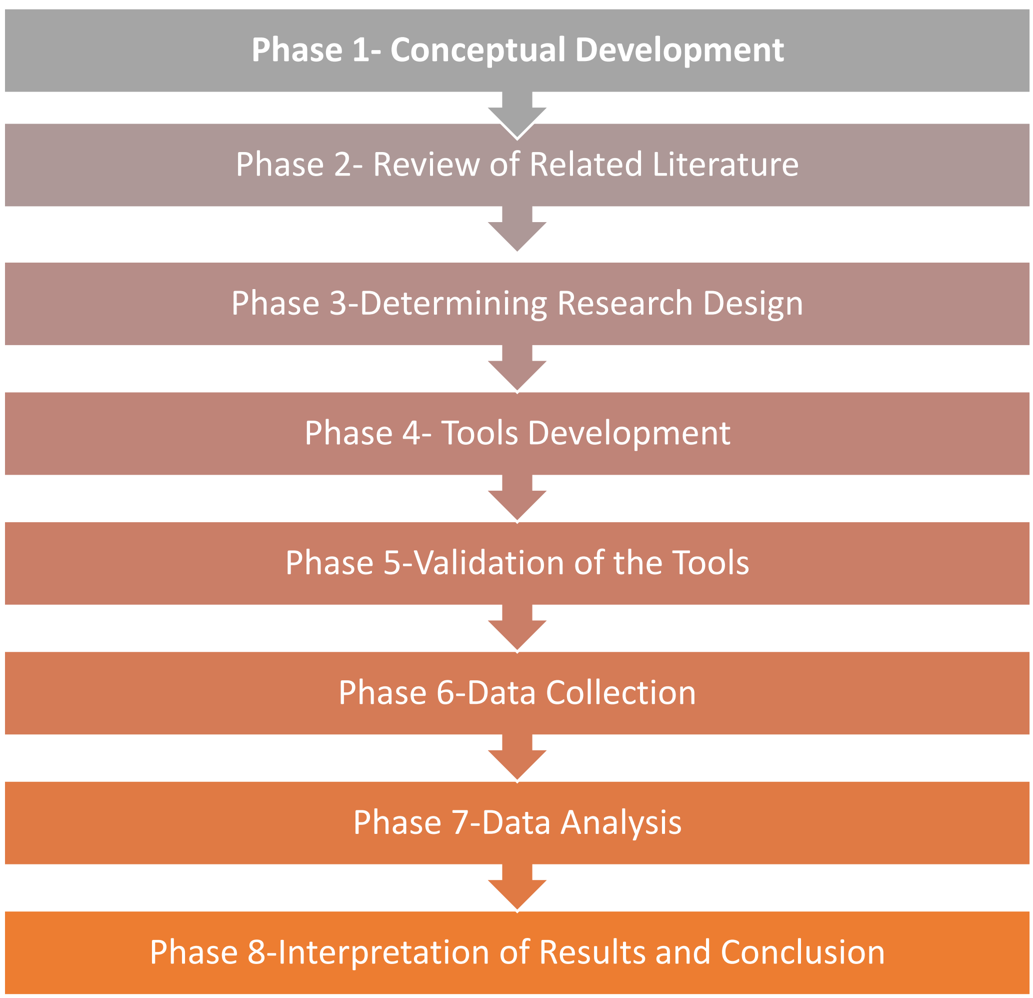
3.8 SAMPLE OF THE STUDY

To have a fair representation of the population, all schools were selected through the sampling technique. Across the selected schools, 5 Principals, 5 Mathematics teachers, and 20 students from the IXth grade from each school (total 100 students) constituted the sample for the study. The students were selected by using a random sampling technique. Thus, it was cluster sampling.

3.9 PLAN AND PROCEDURE OF THE STUDY

The study was planned in a phased manner as presented below in Figure 3.1:

Figure 3.1 Different Phases of the Study



As mentioned in Figure 3.1, the research study was planned in a phased manner with the initiation of the conceptual framework. The brainstorming exercise in the beginning about identifying the topic of research followed by the SWOT analysis helped to narrow down the domain of the area for the study. Once the topic was decided, a conceptual framework was built to understand the conceptual understanding about teaching Mathematics. In the second phase, the related literature was reviewed and analyzed to gain a better understanding of the study and to learn about the research gaps in connection with the present research. Further in the next phase deliberation on the appropriate research design was carried out. According to Best and Kahn (2006), the survey is an effective way to gather information about the status of the practices being executed in the educational institution and therefore Descriptive Research design was selected for the present study. Followed by it under Phase 4 and 5, the tools were developed by the investigator and were validated based on the experts' opinions. The next big task was the data collection which was carried out in Phase 6. The investigator collected the data personally with the help of tools and techniques developed under Phase 4. Once the data were collected, the major job of Data Analysis was carried out in Phase 7. In the last phase, that is Phase 8, results or findings were derived based on the interpretations made through analyzed data and the conclusions were arrived at.

3.10 TOOLS AND TECHNIQUES

Several studies on the topics related to the study were consulted to develop the tools required for achieving the objective of the present study.

To achieve the objective of the present study, an achievement test in Mathematics was constructed by the investigator.

Achievement test: The investigator an achievement in Mathematics for the study. The test included the items on the topics number systems, natural numbers, whole numbers, integers numbers rational numbers irrational numbers, real numbers, how numbers are interpreted on the graph, their decimal expansion and their addition, subtraction, multiplication and division. The Constructed test was validated with the help of experts.

3.10.1 CONSTRUCTION OF THE TOOL FOR DATA COLLECTION:

The investigator followed the below-mentioned steps for the construction of an achievement test which was used as the tool for the present study.

Step I: Content Analysis

The investigator had gone through the mathematics textbook of standard ix designed by the Gujarat State Board of School Textbooks (GSBST). There were two chapters on basic mathematical operations, one on addition and subtraction and the other on multiplication and division. main basic mathematical concepts were identified to design the achievement test.

Step II: Identification of Competencies

While going through the selected chapters of the mathematics textbooks, the investigator identified the competencies of basic mathematical operations based on which the content, examples and exercises have been prepared.

Step Ill: Preparation of Items for Each Competency

Based on the competencies identified in the previous step, the investigator prepared 3 test items for each competency. While preparing the test items the investigator kept in mind the criteria given by Rastogi (1991). At the end of this stage, 30 questions were prepared. so, a total of 30 items were prepared.

Step IV: Experts' Validation

The Investigator had prepared 30 test items keeping in mind the criteria given by Rastogi (1991) and it was given to the experts of mathematics subject to examine it. There were five experts selected for this purpose Overall experts were satisfied with the first draft itself in terms of the content of the items and the length of the test. So it was not needed to make any changes in it. The first draft itself was finalized as the tool for the present study.

Step V: Pilot Study

The pilot study was carried out further. A group of 5 class ix students was selected for a pilot study. The group contained high, average and low achievers which were considered based on their scores in the academic achievement test. Students having a percentage below 40 were considered as low achievers. Similarly, students having scores between 40 and 60 were average achievers and those having scores above 60 were high achievers. The minimum time taken by the students in responding to all the test items was 25 minutes and the maximum time was 30 minutes. Based on this, the average time required in writing the responses of all the test items came out to be nearly 30 minutes. Finally, there were 30 items in the test.

3.11 DATA COLLECTION

Before visiting the schools from which the data were to be collected, a formal permission letter on the letterhead of the Department of Education, Faculty of Education and Psychology duly signed by the authority was obtained. The data were collected through the survey by the Investigator personally from the selected schools. With the prior permission of the concerned school Principal, Thereafter, the investigator personally visited all the selected schools and explained the purpose of the study to the principals. The test was administered on the same days of visiting the schools in almost all the schools. But in few schools, the investigator had to visit the schools again for collecting the data because of the unavailability of the students in the first visit. While conducting the test,, firstly a brief introduction of the investigator was given to the students. After that, the test papers were distributed to the students. They were given clear instructions regarding filling in the primary details in the test papers such as their names, roll numbers and school names. The students asked the queries of the investigator while writing their responses in the test papers. Free space was provided in the test paper itself to write the answers. The time limit was not enforced for completion of the test by the students since the test did not aim at measuring the speed and accuracy of the students. Sufficient time was given to the students to complete their task. When the students completed the test, papers were collected back from the students and in this manner, the data was collected. Before leaving the school, the investigator again met the principals to deliver the vote of thanks for their cooperation and providing their valuable time.

3.12 DATA ANALYSIS

Looking at the nature of the collected data, they were analyzed qualitatively as well quantitatively. The data collected through the achievement test were analyzed in the school. Responses from the students were analyzed by using Frequency and Percentages.

The present study has been made to identify the Conceptual Understanding Approach in enhancing Learning Mathematics among Secondary School Students. The collected data were analyzed based on statical measures; the investigator has defined the following norms for the value judgment of the individual student score the investigator has defined the following three norms.

1) If the score of any student is Greater than or equal to mean +standard deviation it means the student is having high conceptual understanding.
2) If the score of any student is Less than or equal to mean -standard deviation it means the student is having law conceptual understanding.
3) If the score of any student is in-between mean +standard deviation and mean -standard deviation it means the student is having average conceptual understanding.

To analyze the objectives of the study, the investigator put "1" for each correct response, "0" for each incorrect response and to indicate no response while assessing the test papers. Based on these, the frequencies of correct, incorrect and no responses were counted for each test item under each competency. Also, the frequencies were converted in terms of percentage.

The investigator carefully examined all the responses of the students. Investigator noted down the errors committed by students in the incorrect responses. Investigator also kept a record of frequently occurring errors and noted down the competencies in which the errors occurred.

3.13 CONCLUSION

In this chapter on Research Methodology, 'Objectives of the study', 'Explanation of the terms', 'Operational definitions', 'Delimitations of the study', 'Population', 'Sample', 'Research Design', 'Plan and Procedure of the study', 'Tools and Techniques for data collection', 'Data Collection' and 'Data Analysis' have been described. Research methodology formed the basis for the descriptive study which is undertaken to achieve the objectives and provided vital information which would be further analyzed in the next chapter.

CHAPTER IV

DATA ANALYSIS AND INTERPRETATION

CHAPTER - IV
DATA ANALYSIS AND INTERPRETATION

4.1 INTRODUCTION

The organization, analysis and interpretation of data and formulation of conclusions are crucial steps to get a meaningful picture out of the raw data that is in the possession of the investigator. It is from this analysis that the results can be drawn. The present chapter provides the analysis and interpretation of the data concerning the objectives of the study. Analysis of the data means studying and tabulating materials to determine inherent facts or meaning. It involves the breaking up of complex factors into simpler parts and putting the parts together in a new arrangement for interpretations. The data are studied from as many angles as possible to explore the new facts. The interpretation of the data means arriving at what the result is, show its meaning, significance and answer to the original problem.

4.2 DATA ANALYSIS AND INTERPRETATION

For the systematic presentation of the results, the objective wise data analysis was done and interpretations were made based on the analyzed data under the present study.

This requires alert, flexible and open-minded skills for an investigator. Statistical techniques contribute a lot in gathering, organizing, analyzing and interpreting data. The collected data can be calculated individually and tabulated using the proper application of statistical techniques. The results are presented exactly and interpretation was given after verifying the formulated hypotheses. Interpretation refers to the task of drawing inferences from the collected facts after an analytical or experimental study. It is a search for a broader meaning of research findings. The task of interpretation has two major aspects viz., (i) the effort to establish continuity in research through linking the results of a given study with those of another, and (ii) the establishment of some explanatory concepts. Interpretation is concerned with relationships within the collected data and the extension of study beyond the collected data as well. Thus, interpretation is the device through which the factors that seem to explain what has been observed by the researcher in the course of the study can be better understood and it also provides a theoretical conception that can serve as a guide for further researches.

Data Analysis concerning Objectives, to achieve the Objectives (To study the current status of the use of conceptual understanding approach of standard ix mathematics in the Secondary Government schools of Naswadi Taluka.), the investigator collected the data related to conceptual understanding of standard ix mathematics.

Based on statical measures, the investigator has defined the following norms for the value judgment of the individual student score the investigator has defined the following three norms.

NORMS:

1) If the score of any student is Greater than or equal to mean +standard deviation it means the student is having high conceptual understanding.

2) If the score of any student is Less than or equal to mean -standard deviation it means the student is having law conceptual understanding.

3) If the score of any student is in-between mean +standard deviation and mean -standard deviation it means the student is having average conceptual understanding.

Investigator has analyzed students from five secondary government schools from Naswadi Taluka and below are the performed conceptual understanding analysis on their existing knowledge on mathematics.

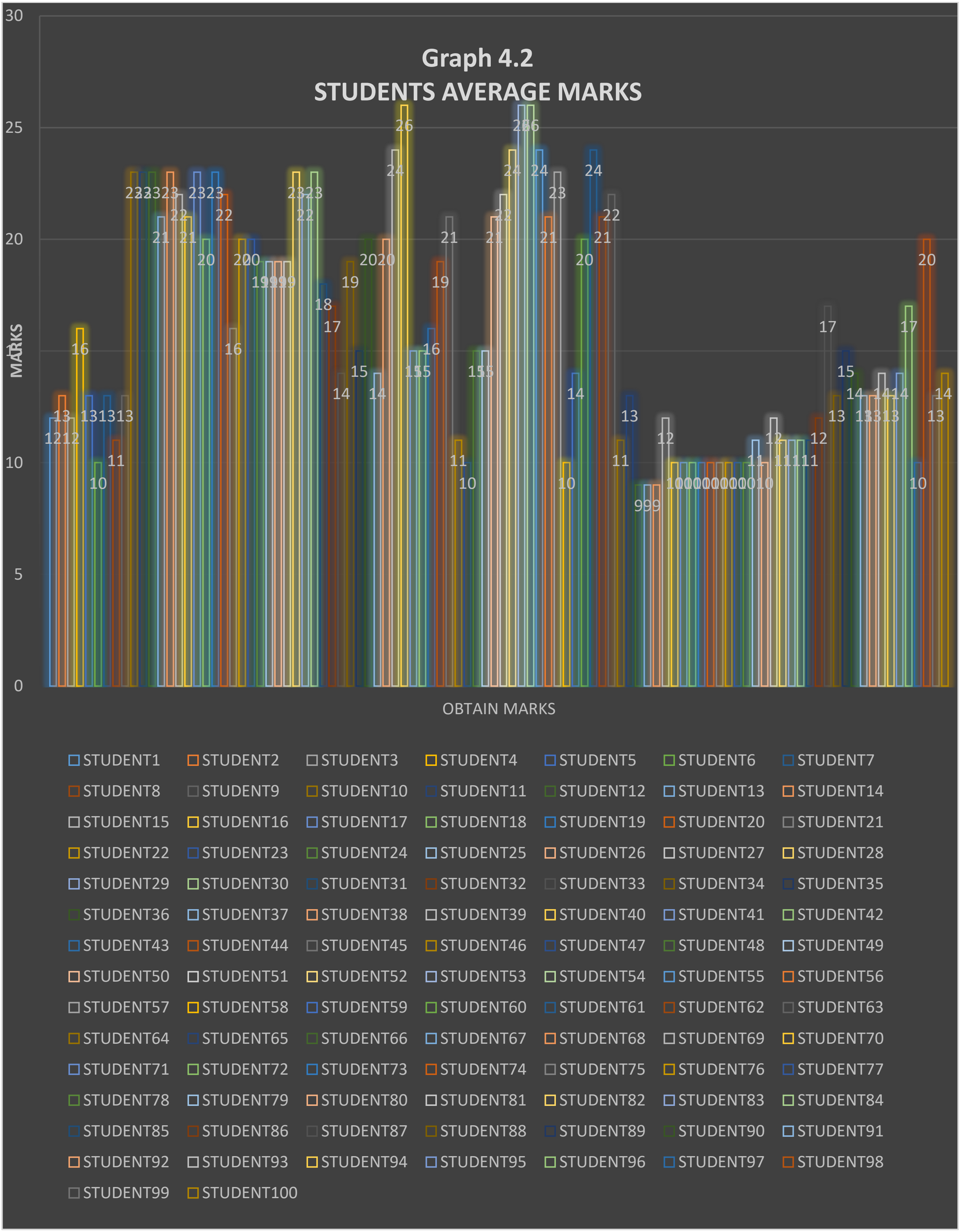
TABLE NO. 4.2

MARKS OF STUDENTS						
SR.NO.	OBTAIN MARKS	TOTAL MARKS		SR.NO.	OBTAIN MARKS	TOTAL MARKS
STUDENT1	12	30		STUDENT46	11	30
STUDENT2	13	30		STUDENT47	10	30
STUDENT3	12	30		STUDENT48	15	30
STUDENT4	16	30		STUDENT49	15	30
STUDENT5	13	30		STUDENT50	21	30
STUDENT6	10	30		STUDENT51	22	30
STUDENT7	13	30		STUDENT52	24	30
STUDENT8	11	30		STUDENT53	26	30
STUDENT9	13	30		STUDENT54	26	30
STUDENT10	23	30		STUDENT55	24	30
STUDENT11	23	30		STUDENT56	21	30
STUDENT12	23	30		STUDENT57	23	30
STUDENT13	21	30		STUDENT58	10	30
STUDENT14	23	30		STUDENT59	14	30
STUDENT15	22	30		STUDENT60	20	30
STUDENT16	21	30		STUDENT61	24	30
STUDENT17	23	30		STUDENT62	21	30
STUDENT18	20	30		STUDENT63	22	30
STUDENT19	23	30		STUDENT64	11	30
STUDENT20	22	30		STUDENT65	13	30
STUDENT21	16	30		STUDENT66	9	30
STUDENT22	20	30		STUDENT67	9	30
STUDENT23	20	30		STUDENT68	9	30
STUDENT24	19	30		STUDENT69	12	30
STUDENT25	19	30		STUDENT70	10	30
STUDENT26	19	30		STUDENT71	10	30
STUDENT27	19	30		STUDENT72	10	30
STUDENT28	23	30		STUDENT73	10	30
STUDENT29	22	30		STUDENT74	10	30
STUDENT30	23	30		STUDENT75	10	30
STUDENT31	18	30		STUDENT76	10	30
STUDENT32	17	30		STUDENT77	10	30
STUDENT33	14	30		STUDENT78	10	30
STUDENT34	19	30		STUDENT79	11	30
STUDENT35	15	30		STUDENT80	10	30
STUDENT36	20	30		STUDENT81	12	30
STUDENT37	14	30		STUDENT82	11	30
STUDENT38	20	30		STUDENT83	11	30

STUDENT39	24	30		STUDENT84	11	30
STUDENT40	26	30		STUDENT85	11	30
STUDENT41	15	30		STUDENT86	12	30
STUDENT42	15	30		STUDENT87	17	30
STUDENT43	16	30		STUDENT88	13	30
STUDENT44	19	30		STUDENT89	15	30
STUDENT45	21	30		STUDENT90	14	30

SR.NO.	**OBTAIN MARKS**	**TOTAL MARKS**
STUDENT91	13	30
STUDENT92	13	30
STUDENT93	14	30
STUDENT94	13	30
STUDENT95	14	30
STUDENT96	17	30
STUDENT97	10	30
STUDENT98	20	30
STUDENT99	13	30
STUDENT100	14	30
MEAN+SD	21.28	-
MEAN-SD	11.14	-

Table No. 4.2 Represents the achievement test score of students in Government Secondary school – Tal. Naswadi and also represent the value of mean + standard deviation and mean – standard deviation which helps the identifying norm values.



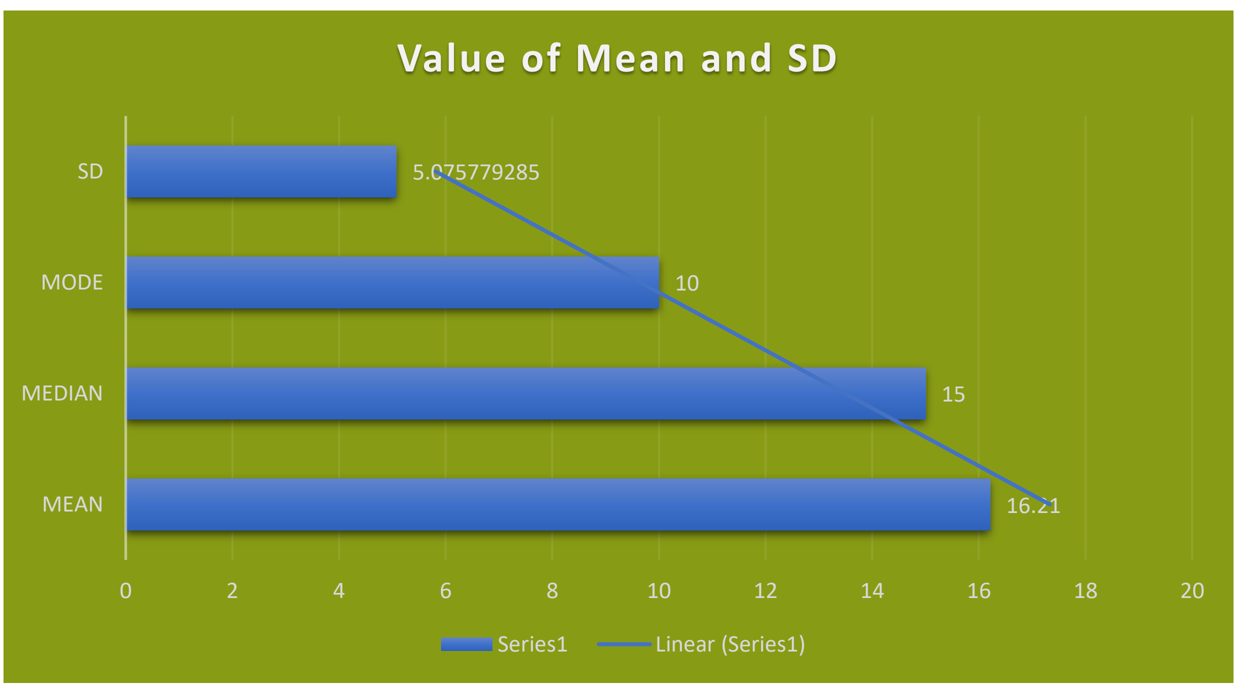
From Graph 4.2 it can be seen that the average score of the students.

Table No. 4.3

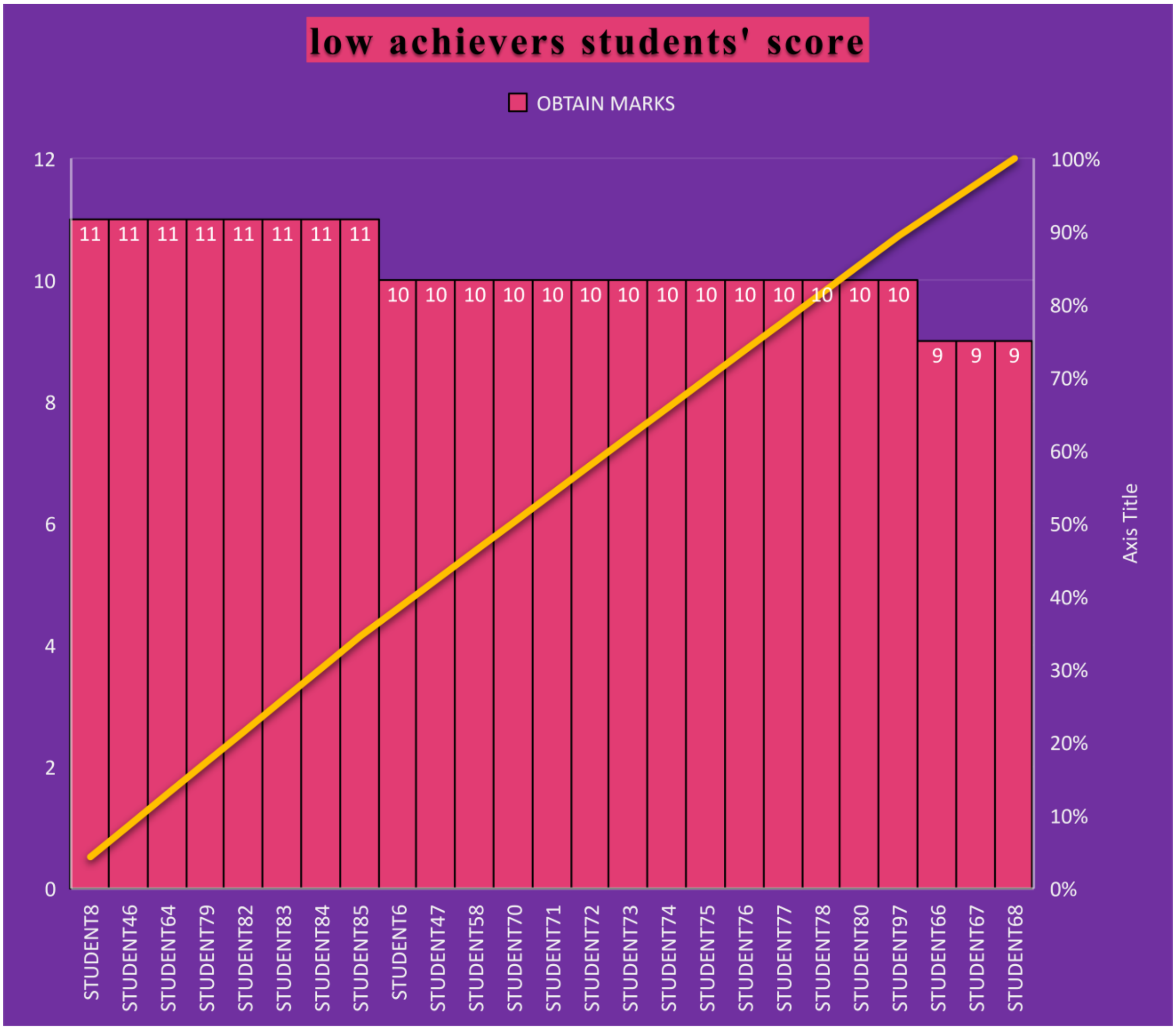
SUMMARY	VALUE
Mean	16.21
Standard Error	0.507578
Median	15
Mode	10
Standard Deviation	5.075779
Sample Variance	25.76354
Kurtosis	-1.32018
Skewness	0.25799
Range	17
Minimum	9
Maximum	26
Sum	1621
Count	100

Table No. 4.3 Represents the value of Mean, Standard Error, Median, Mode, Standard Deviation, Sample Variance, Kurtosis, Skewness, Range, Minimum, Maximum, Sum and Count of the collected data.

Graph No 4.3



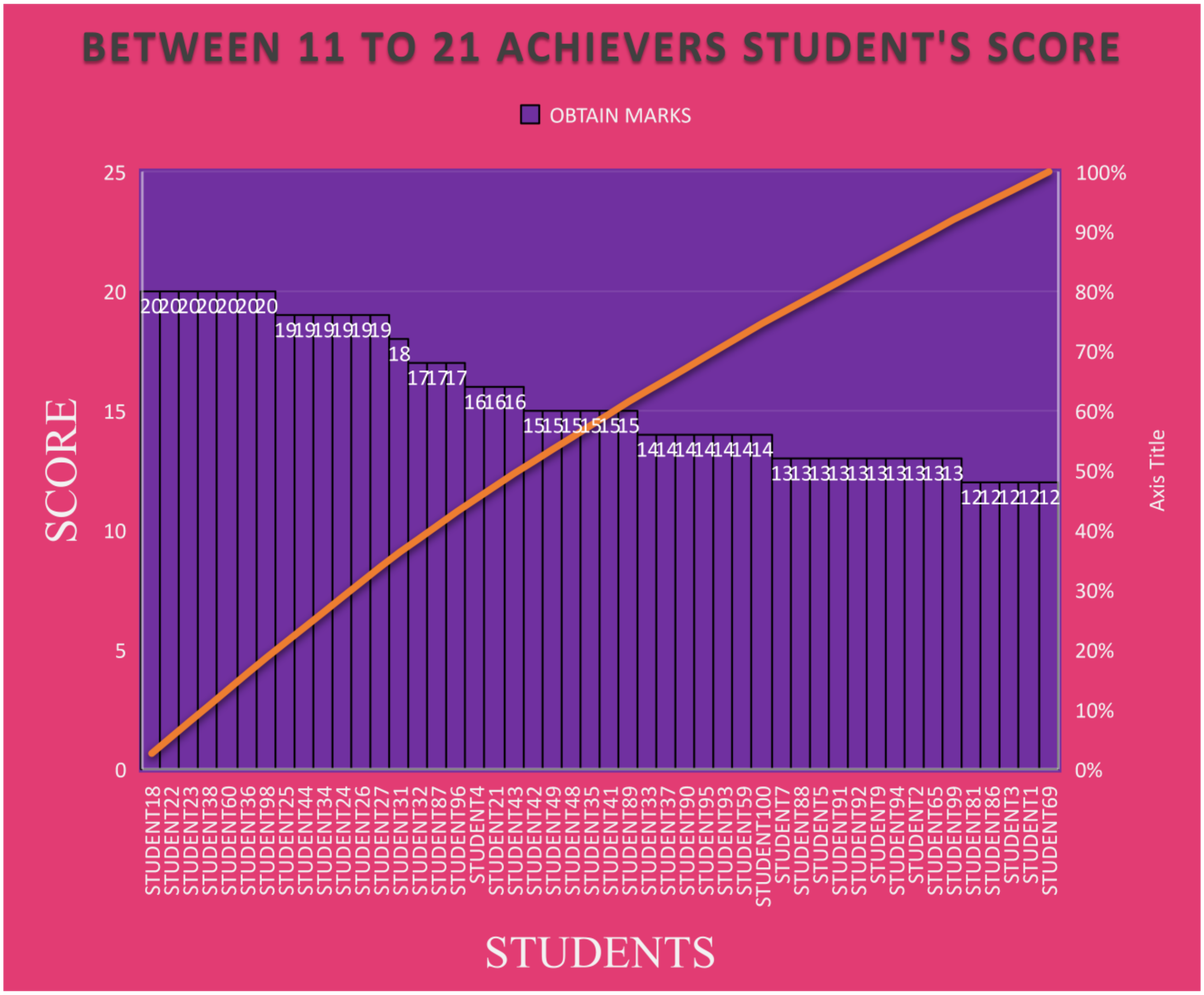
Graph No 4.4



From Graph 4.4 it can be seen that, 25 students have less than or equal to 11 marks. It means that 25 students low achievers score. It means that 25% students have scores low achievers.

As per defined norm 2. - If the score of any student is Less than or equal to mean -standard deviation it means student is having law conceptual understanding.

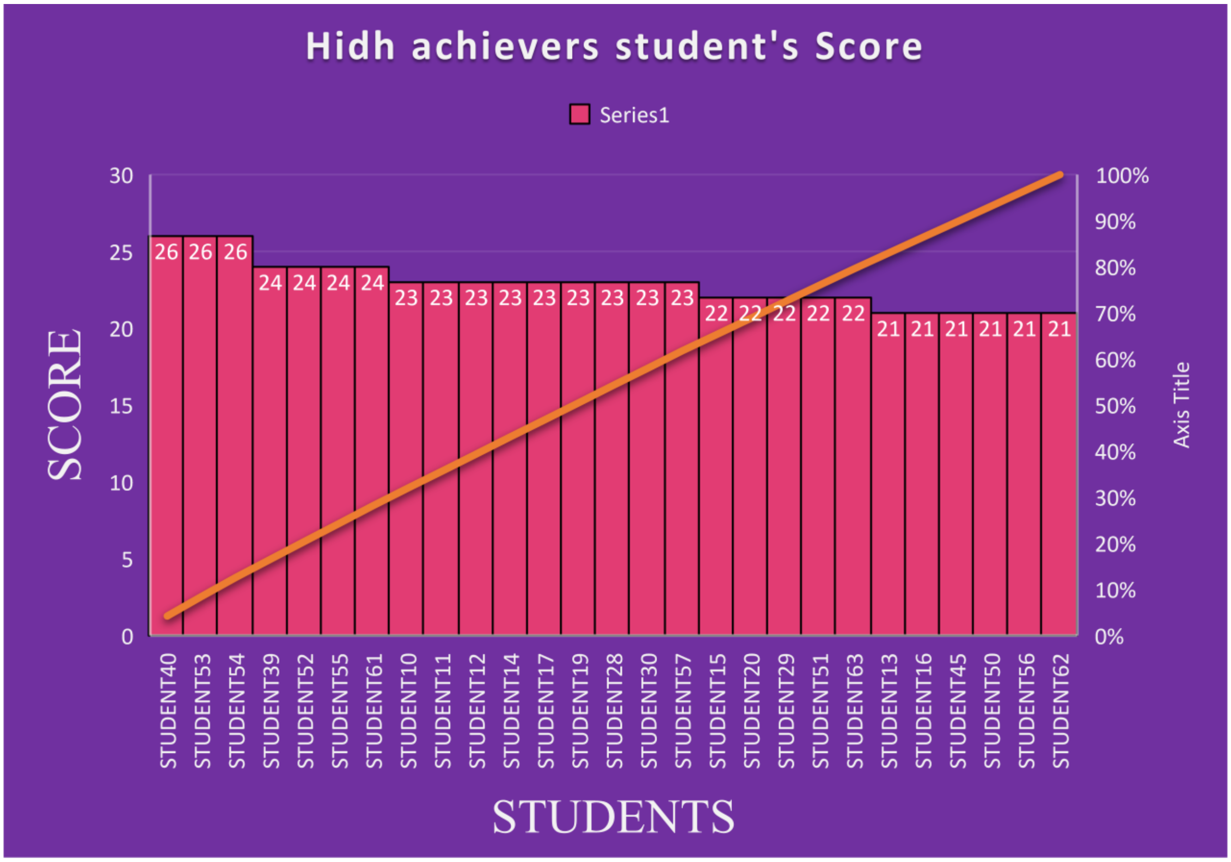
Graph No 4.5



From Graph 4.5 it can be seen that,48 students have between 11 to 21 marks. It means that 48 students average achievers score. It means that 50% students have between 11 to 21 scores.

As Per Norm 3. - If the score of any student is in-between mean + standard deviation and mean -standard deviation it means student is having average conceptual understanding.

Graph No 4.6



From Graph 4.6 it can be seen that,27 students have more than or equal to 21 marks. It means that 27 students high achievers score. It means that 25% students have high achievers scores.

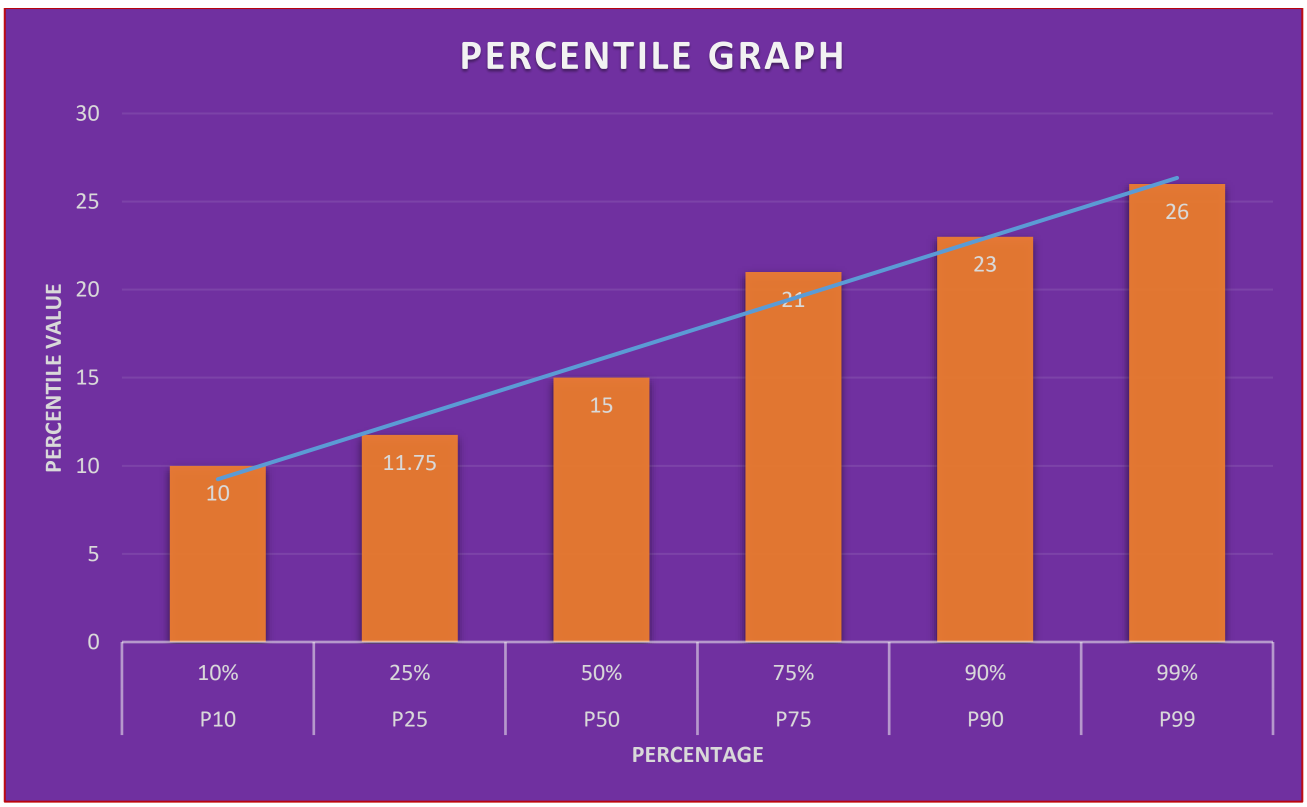
As per Norm 1. - If the score of any student is Greater than or equal to mean +standard deviation it means student is having high conceptual understanding.

Table No. 4.4

PERCENTILE TABLE		
PERCENTILE	PERCENTAGE	VALUE
P10	10%	10
P25	25%	11.75
P50	50%	15
P75	75%	21
P90	90%	23
P99	99%	26

Table No. 4.4 represents the percentile value of the collected data.

Graph No 4.7



From Graph 4.7 it can be seen that, 10% percentile is 10 it means that 90% students out of 100 have score more than or equal to 10 marks and 10% students out of 100 have score less than or equal to 10 marks.

Here, 25% percentile is 11.75 is equal to 11 it means that 75% students out of 100 have score more than or equal to 11 marks and 25% students out of 100 have score less than or equal to 11 marks.

Here, 50% percentile is 15 it means that 50% students out of 100 have score more than or equal to 15 marks and 50% students out of 100 have score less than or equal to 15 marks.

Here, 75% percentile is 21 it means that 25% students out of 100 have score more than or equal to 21 marks and 75% students out of 100 have score less than or equal to 21 marks.

Here, 90% percentile is 23 it means that 10% students out of 100 have score more than or equal to 23 marks and 90% students out of 100 have score less than or equal to 23 marks.

Here, 99% percentile is 26 it means that 1% students out of 100 have score more than or equal to 26 marks and 99% students out of 100 have score less than or equal to 26 marks.

Table No. 4.5

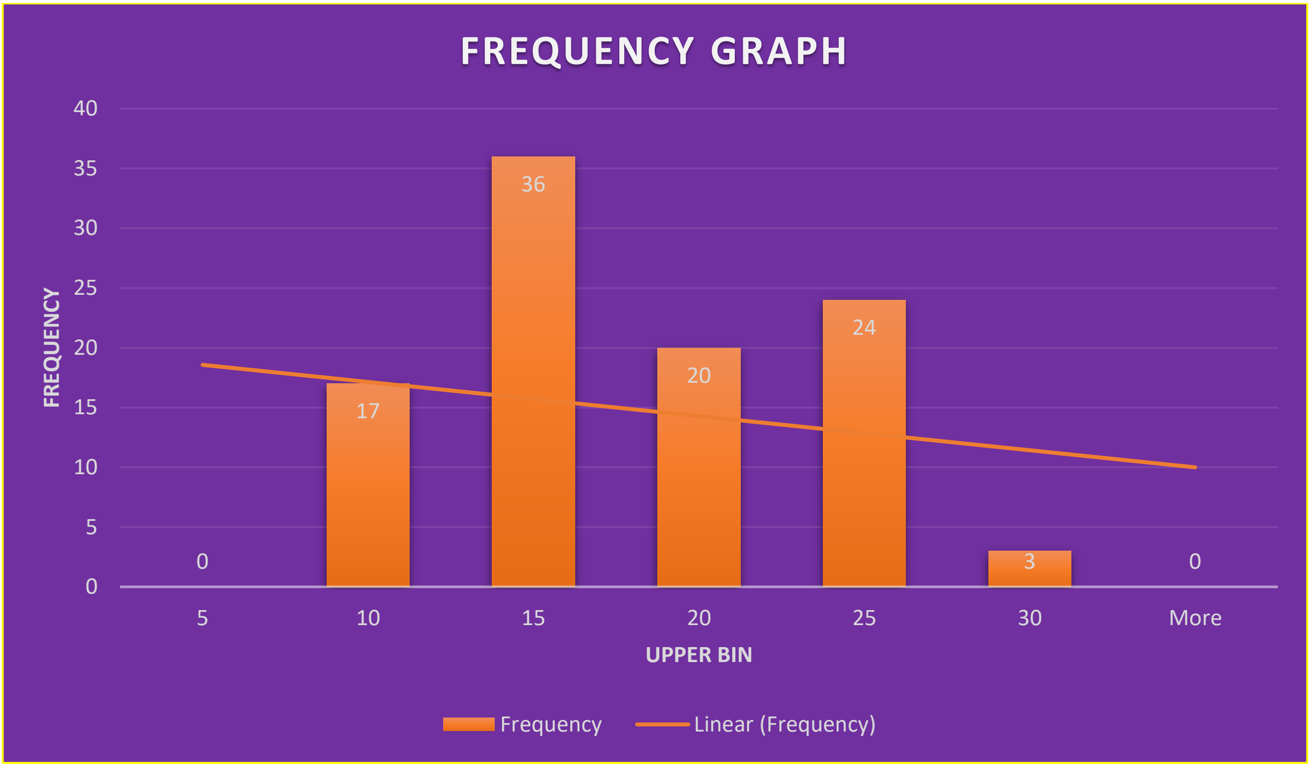
MARKS	LOWER BIN	UPPER BIN
0 TO 5	0	5
5 TO 10	5	10
10 TO 15	10	15
15 TO 20	15	20
20 TO 25	20	25
25 TO 30	25	30

Table No. 4.6

FREQUENCY TABLE	
UPPER BIN	FREQUENCY
5	0
10	17
15	36
20	20
25	24
30	3
More	0

Table 4.5 and 4.6 represents the frequency of the collected data.

Graph No 4.8



From Graph 4.8 it can be seen that,17 students have below or equal to 10 marks, 36 students have below or equal to 15 marks, 20 students have below or equal to 20 marks, 25 students have below or equal to 24 marks and only 3 students have below or equal to 30 marks.

4.3 CONCLUSION

The present chapter focuses on the analysis of the data looking to the nature of data and interpretations made on the basis of the analyzed data. The analysis done under this chapter helped the investigator for deriving the findings of the present study. Based on this, the major findings and conclusion have been made and discussed in the upcoming chapter.

CHAPTER V

SUMMARY, FINDINGS AND SUGGESTIONS

CHAPTER - V

SUMMARY, FINDINGS AND SUGGESTIONS

5.1 INTRODUCTION

Modern mathematics careers are now requiring conceptual skills such as critical thinking, modelling, and application of the content. This change in skillset needed for careers has strongly impacted mathematics curriculum and assessment. Meaningful assessment involves examining students' ability to inquire, to reason on targeted questions or tasks, and to promote conceptual understanding, not just focusing on discreet facts and principles. Mathematics assessment tools still focus solely on this procedural side of understanding mathematics instead of the equally important conceptual aspect of learning mathematics. Given that math is an active process that encourages higher-order thinking and problem solving, and assessment focusing on the growth of conceptual understanding is required. The proposed research focuses on the development of a tool that will be used to assess the student's ability to apply their conceptual understanding of a mathematic concept to scientific phenomena through modelling. The assessment using Netlogo would be very useful for math educators to have good tools to assess students' conceptual understanding, as well as to develop instructional Strategies used.

While these changes demand teachers and learners to transform, the curriculum does not remain isolated from being affected. Practically, the fundamental subjects such as Mathematics, Science and English have a tradition of strong dominance over other subjects in secondary schools. Both, Kothari Commission (1964-66) and National Policy on Education (NPE–1986) stressed the crucial need for Mathematics and Science in secondary education. It further suggested that "Mathematics should be visualized as the vehicle to train a child to think, reason, analyze and to articulate logically. Apart from being a specific subject, it should be treated as a concomitant to any subject involving analysis and reasoning.

The present study has been made to identify the Conceptual Understanding Approach in enhancing Learning Mathematics among Secondary School Students of Naswadi Taluka. The collected data were analyzed based on statical measures; the investigator has defined the following norms for the value judgment of the individual student score the investigator has defined the following three norms.

1) If the score of any student is Greater than or equal to mean +standard deviation it means the student is having high conceptual understanding.

2) If the score of any student is Less than or equal to mean -standard deviation it means the student is having law conceptual understanding.

3) If the score of any student is in-between mean +standard deviation and mean -standard deviation it means the student is having average conceptual understanding.

and interpreted in Chapter IV. This chapter summarizes the study in four sections. The first section deals with the summary of the findings of the study. The second section deals with the conclusions and discussions. In this section, the researcher explains to what extent the results of similar studies conducted in the past were verified by this study. The third section deals with the recommendations of the study for different stakeholders. This section includes the subjective opinions of the researcher. Section four deals with the possible topics to suggest for further investigation.

5.2 The implication of the study

The main goal of Mathematics education in schools is the Mathematization of the child's thinking. But, on the other hand, Mathematics education in our schools is beset with problems.

Due to the hierarchy of concepts and largely deductive and abstract nature of the subject. Mathematics is considered a very dull and difficult subject.

Only when the misconceptions are refined by deploying proper methods of conceptual change approach, the teaching process would yield its desired outcome. Students' misconceptions before or after formal instruction have become a major concern among researchers in mathematics education because they influence how students learn new mathematical knowledge, play an essential role in subsequent learning and become a hindrance in acquiring the correct body of knowledge.

To be successful in teaching, teachers should actively imbibe the core of the concepts into the minds of the students, so that the students clearly understand the conceptual linkages between new concepts and those they already possess. This process of elaborating personal, meaningful knowledge takes place by restructuring the already existing conceptual frameworks.

A phobia has been created in the minds of the children that Mathematics is tough to learn. As a result, most of the students are not taking interest in the subject and it has become one of the main causes of students' failure in Mathematics. Therefore, to remove this phobia, it is necessary to motivate the children by arousing and maintaining their interest in Mathematics. For this, Mathematics has to be learnt by doing rather than by reading. This doing of Mathematics gives rise to the need for a suitable place to perform mathematical activities.

In a study conducted by Brown and Kane, preschool children were likely to transfer skills across different situations when they were encouraged to use prior taught and shown solutions. They learned best when they saw examples of solutions rather than being given an explicit rule.

In this vein, when carried over to math or another academic subject, children should be able to make decisions based on an emerging understanding gained by witnessing example solutions, not an explicit rule that only covers one problem or one way of answering a problem.

The implications of this study are teachers should provide students with opportunities to discuss their prior conceptions and carefully compare them with the mathematical conceptions.

Career Readiness

When people perform in a workplace, they often act based on previous knowledge, assumptions and understandings they have about a particular situation. They intelligently make decisions on what to do, and this often has to be done in an exploratory, innovative way, especially if it's a novel situation. More often than not, people won't have all the necessary information they need to explicitly be told how to make the correct decision. This is where developing conceptual understanding and associations comes in.

If students aren't given the chance to experience this type of exploratory learning as young learners, they will lack the appropriate skills to develop situations to everyday problems. We can teach our students all the information they need, but if they're not building on, analyzing, evaluating or having the chance to be creative with this knowledge in a relevant way and making associations, they won't develop the ability to deeply understand and transfer knowledge to make educated assumptions about new situations.

When information isn't available, people need to use the conceptual understandings and associations they've formed about similar concepts to successfully execute decisions.

As Kaku foreshadowed, the fourth wave of technology is coming and is entirely new, so we must prepare our students to be able to make decisions and use deeper understanding to process new information.

As author Warren Berger discovered, children love having questions answered, and this lights a fire inside of them to want to know more. In the classroom, we can address this by encouraging curiosity. In a Maths unit, have your students explore a hypothesis as a mathematician. Ask them how mathematicians' approach new ideas - do they test them? What do they research? What do they need to know? Beyond knowing about the number system and what they do, have them develop an understanding of how number system work in our daily life. Making these connections early on will equip them with the critical thinking and investigative tools necessary to make informed assumptions.

When they ask great questions, they generate curiosity and more questions. As they ask more questions, they understand more deeply. We have to present students with situations with common threads so they can begin to learn patterns and underlying structures by asking questions themselves.

Promoting Equity through Conceptual Understanding

While information and facts are crucial to a student's success, what's more important—but often underdeveloped because testing does not typically assess this—is the ability to find connections. Standardized testing has traditionally measured a student's ability to memorize information and quickly plug-in formulas, and when students are unable to perform that way, they're placed lower than others and given special attention. In an actual workplace setting though, this memorization of skills and the specific score a student receives may not be indicative of his ability to perform or utilize prior knowledge to make an informed decision.

When we teach for understanding and not memorization, we're levelling the playing field and equipping students with the skills to succeed in the future. The ability to transfer skills and knowledge will be much more advantageous than information that might become irrelevant, and making this the primary focus will relieve the burden on students to try to memorize information separate from how it can be utilized in a project or real-world setting.

5.3 STATEMENT OF THE PROBLEM

"**A STUDY OF CONCEPTUAL UNDERSTANDING OF MATHEMATICS AMONG GOVERNMENT SECONDARY SCHOOL STUDENTS OF NASWADI TALUKA.**"

5.4 OBJECTIVE OF THE STUDY

1) To identify the major concepts in a selected unit of standard ix mathematics.
2) To study the conceptual understanding of the students in the identified concept in terms of their achievement.
3) To study the misconceptions in the identified concept prevalent among Students related to the mathematical concepts in terms of their achievement.
4) To construct a diagnostic test to logically identify misconceptions in learning Mathematics among Secondary School Students.

5.5 Explanation of the Term

In the statement of the problem chosen for the present study, the significant meanings of terms used in the title are given below: -

CONCEPT

A concept is an abstract idea or a mental symbol, typically associated with a corresponding representation in language or symbology, that denotes all of the objects in a given category or class of entities, interactions, phenomena, or relationships between them. Also, as per the definition in Dictionary, the concept means

- a general notion or idea; conception.
- an idea of something formed by mentally combining characteristics or particulars; a construct.
- a directly conceived or intuited object of thought.

Conceptual Understanding

Conceptual understanding, where children can grasp ideas in a transferrable way, can help students take what they learn in class and apply it across domains. It's a hot topic in the classroom today, as rote memorization and traditional methods of teaching math are becoming considered insufficient for real-world learning and application.

While teaching to the test is common for state accountability and measurement, these methods don't always arm students with the skills to complete tasks outside of the classroom.

MISCONCEPTIONS

The term 'misconceptions' has been used to refer to preconceived notions, non-scientific beliefs, theories, mixed conceptions, or conceptual misunderstandings that are not in agreement with accepted scientific ideas.

MATHEMATICS

"Mathematics" is the science that deals with the logic of shape, quantity and arrangement. Mathematics is all around us, in everything we do. It is the building block for everything in our daily lives, including mobile devices, architecture (ancient and modern), art, money, engineering, and even sports.

SECONDARY SCHOOL

In the study, "Secondary School" refers to Classes comprising Ninth Standards.

STUDENT

The term "Student" means an individual who is pursuing a full-time course at a qualified educational institution. Here in this study, High School students are studied.

5.6 DELIMITATIONS OF THE STUDY

- The present study was delimited to the Government Gujarati medium schools of Naswadi Taluka affiliated to the Gujarat Secondary and Higher Secondary Education Board (GSHSEB), for the academic year 2020–21.
- The study was delimited to identify the major concepts in a selected unit of standard ix mathematics.
- The study was delimited to evaluate students conceptual understanding of standard ix mathematics.

5.7 DESIGN OF THE STUDY

Once the problem and objectives of the study were decided; the next important and consequential matter in research to be determined was selecting an appropriate research design for the study. The present study was Descriptive survey research which was conducted for the description of a specific situation and studying opinions of a specific group of the participants (principals, teachers and students), which has allowed the researcher not only to present the prevailing situation but also to interpret and report the existing facts on the ground. According to Best and Kahn (2006), descriptive survey type studies are used to find out 'what is and therefore the detailed information is required for answering the research questions. So, looking at the study and its objectives, a descriptive survey design was found the most appropriate method to collect detailed information about achieving the stated objectives of the study.

5.8 POPULATION OF THE STUDY

The population for the present study consisted of 5 Gujarati medium schools of Naswadi Taluka affiliated to the GSHSEB. Thus, the Principal of the schools, teachers of Mathematics in all these schools and all of the students studying in Standard IX of these schools were the population of the study.

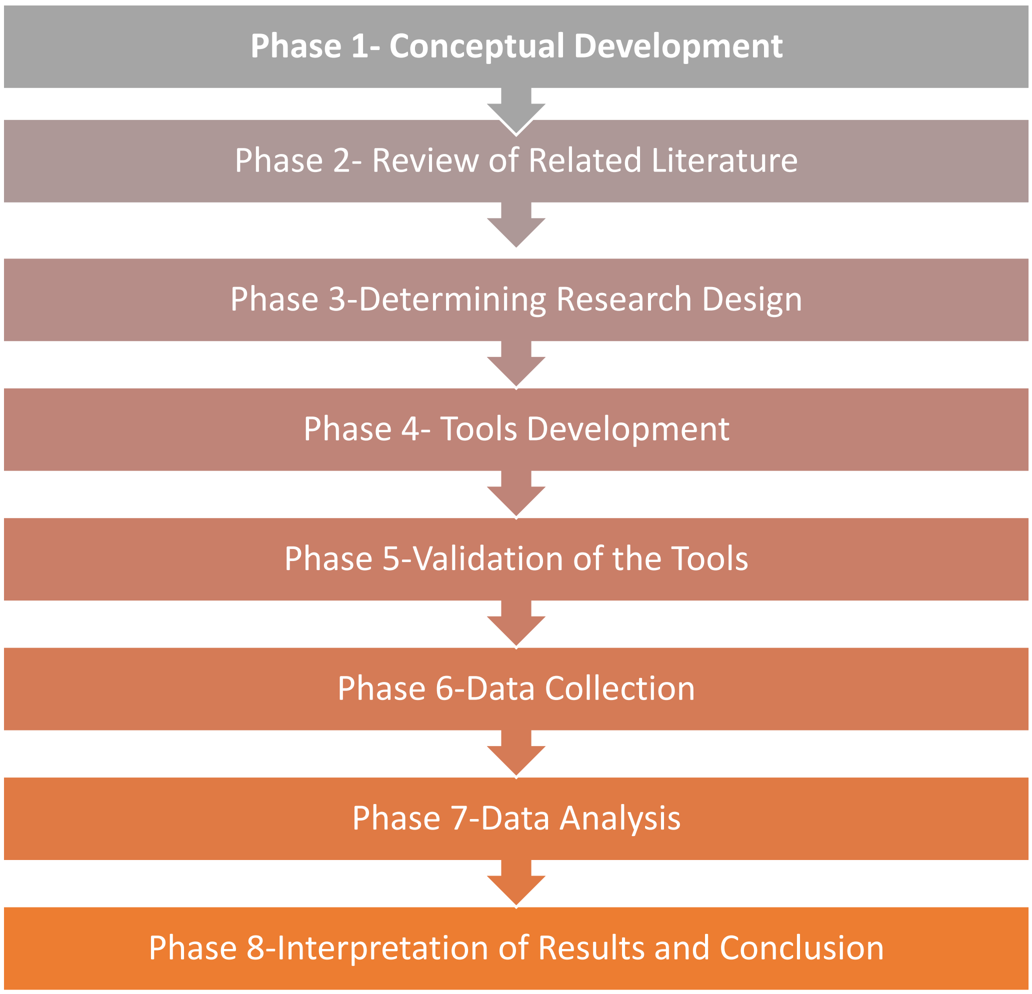
5.9 SAMPLE OF THE STUDY

To have a fair representation of the population, all schools were selected through the sampling technique. Across the selected schools, 5 Principals, 5 Mathematics teachers, and 20 students from the IXth grade from each school (total 100 students) constituted the sample for the study. The students were selected by using a random sampling technique. Thus, it was cluster sampling.

5.10 PLAN AND PROCEDURE OF THE STUDY

The study was planned in a phased manner as presented below in Figure 3.1:

Figure 3.1 Different Phases of the Study



As mentioned in Figure 3.1, the research study was planned in a phased manner with the initiation of the conceptual framework. The brainstorming exercise in the beginning about identifying the topic of research followed by the SWOT analysis helped to narrow down the domain of the area for the study. Once the topic was decided, a conceptual framework was built to understand the conceptual understanding about teaching Mathematics. In the second phase, the related literature was reviewed and analyzed to gain a better understanding of the study and to learn about the research gaps in connection with the present research. Further in the next phase deliberation on the appropriate research design was carried out. According to Best and Kahn (2006), the survey is an effective way to gather information about the status of the practices being executed in the educational institution and therefore Descriptive Research design was selected for the present study. Followed by it under Phase 4 and 5, the tools were developed by the investigator and were validated based on the experts' opinions. The next big task was the data collection which was carried out in Phase 6. The investigator collected the data personally with the help of tools and techniques developed under Phase 4. Once the data were collected, the major job of Data Analysis was carried out in Phase 7. In the last phase, that is Phase 8, results or findings were derived based on the interpretations made through analyzed data and the conclusions were arrived at.

5.11 TOOLS AND TECHNIQUES

Several studies on the topics related to the study were consulted to develop the tools required for achieving the objective of the present study.

To achieve the objective of the present study, an achievement test in Mathematics was constructed by the investigator.

Achievement test: The investigator an achievement in Mathematics for the study. The test included the items on the topics number systems, natural numbers, whole numbers, integers numbers rational numbers irrational numbers, real numbers, how numbers are interpreted on the graph, their decimal expansion and their addition, subtraction, multiplication and division. The Constructed test was validated with the help of experts.

5.11.1 CONSTRUCTION OF THE TOOL FOR DATA COLLECTION:

The investigator followed the below-mentioned steps for the construction of an achievement test which was used as the tool for the present study.

Step I: Content Analysis

The investigator had gone through the mathematics textbook of standard ix designed by the Gujarat State Board of School Textbooks (GSBST). There were two chapters on basic mathematical operations, one on addition and subtraction and the other on multiplication and division. main basic mathematical concepts were identified to design the achievement test.

Step II: Identification of Competencies

While going through the selected chapters of the mathematics textbooks, the investigator identified the competencies of basic mathematical operations based on which the content, examples and exercises have been prepared.

Step Ill: Preparation of Items for Each Competency

Based on the competencies identified in the previous step, the investigator prepared 30 test items for each competency. While preparing the test items the investigator kept in mind the criteria given by Rastogi (1991). At the end of this stage, 30 questions were prepared. so, a total of 30 items were prepared.

Step IV: Experts' Validation

The Investigator had prepared 30 test items keeping in mind the criteria given by Rastogi (1991) and it was given to the experts of mathematics subject to examine it. There were five experts selected for this purpose Overall experts were satisfied with the first draft itself in terms of the content of the items and the length of the test. so it was not needed to make any changes in it. The first draft itself was finalized as the tool for the present study.

Step V: Pilot Study

The pilot study was carried out further. A group of 5 class ix students was selected for the pilot study. The group contained high, average and low achievers which were considered based on their scores in the academic achievement test. Students having a percentage below 40 were considered as low achievers. Similarly, students having scores between 40 and 60 were average achievers and those having scores above 60 were high achievers. The minimum time taken by the students in responding to all the test items was 25 minutes and the maximum time was 30 minutes. Based on this, the average time required in writing the responses of all the test items came out to be nearly 30 minutes. Finally, there were 30 items in the test.

5.12 DATA COLLECTION

Before visiting the schools from which the data were to be collected, a formal permission letter on the letterhead of the Department of Education, Faculty of Education and Psychology duly signed by the authority was obtained. The data were collected through the survey by the

Investigator personally from the selected schools. With the prior permission of the concerned school Principal, Thereafter, the investigator personally visited all the selected schools and explained the purpose of the study to the principals. The test was administered on the same days of visiting the schools in almost all the schools. But in few schools, the investigator had to visit the schools again for collecting the data because of the unavailability of the students in the first visit. While conducting the test,, firstly a brief introduction of the investigator was given to the students. After that, the test papers were distributed to the students. They were given clear instructions regarding filling in the primary details in the test papers such as their names, roll numbers and school names. The students asked the queries of the investigator while writing their responses in the test papers. Free space was provided in the test paper itself to write the answers. The time limit was not enforced for completion of the test by the students since the test did not aim at measuring the speed and accuracy of the students. Sufficient time was given to the students to complete their task. When the students completed the test, papers were collected back from the students and in this manner, the data was collected. Before leaving the school, the investigator again met the principals to deliver the vote of thanks for their cooperation and providing their valuable time.

5.13 DATA ANALYSIS

Looking at the nature of the collected data, they were analyzed qualitatively as well quantitatively. The data collected through the achievement test were analyzed in the school. Responses from the students were analyzed by using Frequency and Percentages.

The present study has been made to identify the Conceptual Understanding Approach in enhancing Learning Mathematics among Secondary School Students of Naswadi Taluka. The collected data were analyzed based on statical measures; the investigator has defined the following norms for the value judgment of the individual student score the investigator has defined the following three norms.

1. If the score of any student is Greater than or equal to mean +standard deviation it means the student is having high conceptual understanding.
2. If the score of any student is Less than or equal to mean -standard deviation it means the student is having law conceptual understanding.

3. If the score of any student is in-between mean +standard deviation and mean -standard deviation it means the student is having average conceptual understanding.

To analyze the objectives of the study, the investigator put "1" for each correct response, "0" for each incorrect response and to indicate no response while assessing the test papers. Based on these, the frequencies of correct, incorrect and no responses were counted for each test item under each competency. Also, the frequencies were converted in terms of percentage.

The investigator carefully examined all the responses of the students. Investigator noted down the errors committed by students in the incorrect responses. Investigator also kept a record of frequently occurring errors and noted down the competencies in which the errors occurred.

5.14 MAJOR FINDINGS OF THE STUDY

The researcher studied the Conceptual Understanding Approach in enhancing learning mathematics among secondary school students studying in Government Schools in Naswadi Taluka. Many research studies in the past proved that variables like gender, age, the standard of study and nature of the institution, etc., contribute to differences in learning. so, to conduct the study in real research attitude and spirit, the researcher studied in detail the various factors involved in the process of learning mathematics.

A major reason for tribal students doing less well in school mathematics seems to lie in the way the subject is taught in schools at the primary level. Though tribal communities have extensive and rich knowledge of mathematics and everyday science, classroom teaching is completely divorced from their experiences. The National Curriculum Framework, 2005 appears to have failed in making an explicit commitment to adopt a cultural perspective on mathematics education that is necessary to protect the self-esteem of tribal students and impart to them a meaningful education.

After independence, policies have been revised several times to make education relevant for tribal students. Several print materials (though of doubtful quality) were developed by the State Councils of Educational Research and Training (SCERT) and Tribal Research Institutes (TRIs) in the tribal languages for primary classes, which were used only occasionally as supplementary readers in the schools. The culture and everyday cognitions of tribal children hardly influenced the main readers, e, textbooks. The textbooks and the classroom transactions continue to be predominantly monocultural and also monolingual in all subject areas.

Among different subject areas, mathematics teaching suffered most in Naswadi City's area schools because the tribal students have come to school with a very different number system (which is not often linked to written symbols). They use different heuristics and algorithms to solve day-to-day mathematical problems. In school, they are fed mercilessly, with a series of written symbols, notations and formulas without any effort at linking these to their past experiences.

The acceptance of the idea that mathematical knowledge is part of the culture has been fairly half-hearted among policy-makers and textbook writers. Through anthropological and sociohistorical research strengthens this view by revealing more and more of the rich tapestry of mathematical knowledge existing in hundreds of folk cultures around the world, there is a kind of in-built resistance to linking mathematics teaching to community knowledge.

5.15 RECOMMENDATIONS OF THE STUDY

In the light of the findings of the present study, the investigator has recommended the following: -

- All teachers are to be encouraged to identify the misconceptions prevailing among their students and make their students understand the concept of the subject without any ambiguity.
- All-out efforts to be taken to make mathematics an interesting subject. This could be achieved only when the teachers are conceptually sound in their subjects and are fully equipped with the latest trend in the field of educational technology.
- Students need to be rewarded for their queries, to make them involved in learning the subject.
- Students should not be encouraged for "Rote learning." Each concept should be explained to the students with lifetime examples so that the students do not forget the core concept.
- The use of Information Technology resources needs to be encouraged in teaching.
- Teaching would reach its finality only when Students and Teachers understand their desired output/result.

- The conceptual Understanding Approach should not be confined to Mathematics only. The Conceptual Understanding approach is useful in teaching any subjects irrespective of the field.

5.16 DISCUSSION AND IMPLICATIONS

A major reason for a tribal student doing less well in school mathematics seems to lie in the way the subject is taught in schools in India at the primary level. Many tribal communities have extensive and rich knowledge of mathematics and everyday science [Barber and Estrin 1995; Panda 2004a]. But the classroom teaching is completely divorced from their everyday experiences and knowledge. Many successful learning strategies employed by the members of these communities are not recognized in the formal classroom contexts [Lave 1988]. Non-tribal teachers, as well as educational administrators, devalue such strategies, popularly known as folk practices. In practice, tribal children are discouraged from using these strategies in class.

In the areas of mathematics and science teaching where several symbols and notations are used, it is important to establish a link between tribal children's past experiences and knowledge base derived from everyday cognition.

Mathematical Conceptual Understanding develop everywhere because people may live in different cultures, but they do similar things like arguing, comparing, searching, working to find food, enjoying themselves, fighting with each other and also carrying out other economic and commercial activities. Six operations that people engage in across all cultures are counting, measuring, designing, locating, playing and explaining [Dorfler 2000]. These activities involve an enormous amount of mathematics. Mathematical understanding is culturally conditioned and created across cultural contexts. However, unlike in many written cultures, in tribal cultures (most of which are oral) mathematics and science practices are not recorded, formalized and passed on beyond the context of their immediate usefulness. For this reason, this body of knowledge is not recognized by academia as a structured body of knowledge, but rather remains a set of ad hoc practices.

The other reason for which such potential mathematical knowledge is not used in the school is our fixation with modern mathematics and the Eurocentric approach. It is now time to acknowledge that mathematics is not just about sums, fractions and equations. In recent years, the feeling of exasperation at being entangled in such a narrow definition of mathematics has been noticed among pedagogues and textbook writers. But the fear of a grand paradigmatic shift that probably implied a larger societal change in the area of power relations among cultural groups kept the bottom line defined. The bottom line here is the ubiquitous "child" and the use of those examples from the society that is familiar to the majority of children but are "believed" to be shared by or are at least familiar to, the children of minority groups.

Economic and Political Weekly January 14, 2006, the beliefs that are held privately by teachers and parents from the majority communities that the children of majority groups may not gain much from the discussion of mathematics by minority groups have further reinforced existing classroom practices.

The NCF's (2000) submission that the multi-cultural complexion of society demands a multi-cultural approach to mathematics, however, remains at the level of rhetoric especially when translated into the development of print materials like textbooks, activities, etc, and pedagogic practices. According to this ethos, children should have been introduced to different number systems and also several measuring and counting devices used by the various cultural groups in this country. But the common fear across the masses – both common man and professionals – that such an approach may confuse the children and increase the cognitive burden on them brought the pendulum back to its original position.

The philosophic thrust of mathematics education as spelt out in NCF 2000 is aimed towards encouraging students to explore mathematical concepts and solve problems related to their everyday experiences. But the NCF 2000 document is silent on how to build symbolic and axiomatic knowledge on that foundation. Probably, instead of prescribing the methods and ways of doing it, the decision was left to the implementation agencies such as textbook writers and teacher trainers. This should have been ideal in a complex multicultural society like ours where each district, even the block, is unique in the multicultural composition of its population. But in the given circumstances of the teacher's negative attitude towards these knowledge systems as valid sources of knowledge and textbooks mirroring the dominant class's values, perceptions and cultures, very little could be expected from the teachers, teacher trainers and textbook writers.

Moreover, the existing attitude towards indigenous knowledge systems was grossly misconceived and patronizing. In the last 50 odd years, we have only satisfied ourselves by mentioning them in policy documents or our reactions to existing policy documents, that too in a sporadic manner. Even today, the emphasis in school mathematics is entirely on conceptual understanding, application of concepts, algorithmic performance, problem-solving processes, etc. The attitudinal and other affective aspects of mathematics learning are to a large extent undermined; leave aside the inclusion of the everyday mathematical cognitions of the tribal in textbooks and classroom transactions.

Mathematics and NCF 2005: A Critique

The recently formulated NCF 2005 appears to be philosophically a much more consistent document than NCF 2000. The new curriculum framework begins with an overview of our past experiences with the curriculum and sets out new goals for education in the first chapter. The first chapter discusses the social context of education and the guiding principles of the new national curriculum framework. The second chapter discusses threadbare the basic assumptions the NCF 2005 makes about the learner whose role has been rightly described as active, who is rooted in a specific cultural context and is a constructor of knowledge. It deals with most fundamental issues, like what is knowledge and understanding in general; how children's knowledge is integrally linked to local knowledge5and how knowledge is re-created, etc. It acknowledges local knowledge traditions and argues for making the experiences of the sociocultural world a part of the curriculum. In various places, the scientific knowledge embedded in the local cultures is discussed to establish a link between children's knowledge base as well as the natural learning processes. In each of these sections, various local knowledge traditions and their curricular and pedagogic relevance in the area of science teaching, social science teaching and teaching of ecology, etc, are discussed. But, local mathematical knowledge systems and the process of mathematics learning in communities do not find equivalent emphasis even once in the first two chapters. Therefore, the first impression one gets after going through the first two chapters is that the underlying assumptions of mathematics learning have not probably moved far from the pre-Kuhnian8 position that mathematics does not have much to do with communities, its knowledge and value systems. The following paragraph is taken from NCF 2005 dealing with "how mathematics is generally learnt" reinforces this doubt:

Mathematics has its distinctive concepts, such as prime number, square root, fraction, integral and function. It also has its validation procedure, namely, a step-by-step demonstration of the necessity of what is to be established. The validation procedure of mathematics is never empirical, never based on observation of the world or experiment, but are demonstrations internal to the system specified by the appropriate set of axioms and definitions.

The perspective of modern mathematics taught in present-day schools, which is to a large extent western in origin. It takes a particular position not only in terms of what constitutes mathematics but also in terms of mathematics as an ontological system, which is of modern western mathematics. Western mathematics is axiomatic whereas Indian mathematics found in the everyday practices of many cultural groups in India is not. Young Indian children come to school with mathematical knowledge rooted in the epistemic practices of their community. Such knowledge systems are not axiomatic, instead, they are governed by societal norms, values and also world views along with some pure mathematical considerations. Such fusion of societal or extra-mathematical considerations and the logico-deductive nature of this science are unique to oral traditions. Disregarding this knowledge system and the forms of knowing rooted in a particular epistemic practice of a community means disregarding children's past experiences and knowledge systems. From a purely academic and conceptual point of view, there is nothing wrong with the NCF paragraph cited above. But from a cultural perspective, the paragraph seems to have taken an epistemic position that is not ours.

The implicit rules of everyday mathematical cognitions in these communities are determined to a good extent by non-mathematical considerations like social values, beliefs, expectations, experiences, relations and social institutions [Lave 1988]. Panda (2004c) explored the cultural reasons why Sanora children reject certain kinds of mathematical propositions and discourses in the classrooms. If all these are true, the compelling truth is that unless tribal children's mathematical knowledge and experiences are integrated into classroom practices and, continuity established between their home and school, they will find mathematics education uninteresting, culturally barren and dead. When one examines NCF 2005 from a tribal child's perspective, the document appears to have failed in making an explicit commitment to adopt a cultural perspective on mathematics education. If we look at the whole document from a philosophical and theoretical perspective, the document adopts a pure cultural psychological perspective explicitly in all other curricular areas except mathematics.

5.17 SUGGESTIONS FOR FURTHER STUDY

A research study would be incomplete if it doesn't provide necessary guidelines as well as potential research topics, for further study. From the findings and the conclusion drawn from the study, the investigator realized the following areas where further study is possible:

- This study was limited to Government schools of Naswadi Taluka. It can be extended to other schools also and a comparative study could be carried out.
- The present study was conducted on Secondary school students. The same can be devised to cover Nursery, Higher-Secondary, College students etc.
- The present study was conducted in Mathematics. However, the same can be conducted in any of the Science/Arts subjects also.
- The investigator has taken variables for the study such as Gender, Type of School, Standard, Locality, Family Type, Parental Education, Parental Income. However, in the future, many additional variables may be considered for research.

5.18 CONCLUSION

From the analysis of the collected data, its interpretation and from the major findings the following conclusions can be drawn:

"**Conceptual Understanding Approach**" is a very important and fascinating part of educational psychology since it not only results in a positive impact on acquiring knowledge by the students but also results in developing the teaching skills of teachers.

Many of us who argue for culturizing mathematics pedagogy do so with a belief that such a "Conceptual Understanding approach" is necessary not only for protecting the self-esteem of tribal students but also for giving them a meaningful and culturally valued education. Indulgence in mathematical conventions and ways of speaking is partly an emotional willingness. The learners, be it a tribal student or any other, must indulge in mathematical discourse willingly and this participation cannot be forced on them by persuasion or cogent arguments [Dorfler 2000]. Presently, the mathematics curriculum, syllabus and textbooks do not represent tribal culture, their value system and knowledge. As a result, tribal children are forced to participate in a convention of mathematical discourse, which they neither own nor remotely identify with. This explains the research findings that the tribal children find mathematics textbooks and pedagogy culturally cold and barren and gradually lose interest in mathematics.

Therefore, speaking from an equity point of view, the new curriculum framework needs to identify some of these rough patches, which unless crossed or filled up may fail to address the needs of the tribal children. The document could be more emphatic and also explicit on the epistemological frame of the mathematics curriculum. Such a frame should take into account peoples' mathematics and its ontological aspects as well. Besides this, the document needs to go one step further by suggesting how to build symbolic and axiomatic knowledge on the everyday knowledge of students.

Nowadays, wide awareness in developing the curriculum of subjects with the aid of the current technological innovations is being propagated by the educationists with the able support of both the Central Government of India and the State Government of GUJARAT. Educationists emphasize that the involvement of parents and teachers is required for the all-round development of the child. NCERT, New Delhi recommends teachers follow the conceptual guidelines and exercises as enunciated in the relevant textbooks while teaching a new concept to the children. The study investigated by the investigator has yielded a positive impact on the effectiveness of the Conceptual Change Approach in enhancing Learning Mathematics among Secondary School Students. Many more types of research on the subject would throw light upon the various facets of the Conceptual Change Approach in the field of Education.

BIBLIOGRAPHY

BIBLIOGRAPHY

Acharya, R. (2017). *Factors Affecting Difficulties in Learning Mathematics by Mathematics Learners. .* Retrieved from International Journal of Elementary Education:article.sciencepublishinggroup.com/pdf/10.11648.j.ijeedu.20170602.11.pdf.

Ali, A. (2016). *Learning Problems and theirCauses in Mathematics.* Retrieved from http://www.rieajmer.ac.in: http://www.rieajmer.ac.in/Math_Conf_PPT/ANJUM%20ALI.pdf.

Benjamin C. Heddy, R. W. (2017). *Modifying Knowledge, Emotions, and Attitudes Regarding Genetically Modified Foods, .* The Journal Experimental Education.

Bora, A. (2019). *Factors responsible for academic achievement of secondary school students in mathematics. .* Retrieved from sodhganga: https://sg.inflibnet.ac.in/handle/10603/262655.

Chen, T. O. (2016). *What is Conceptual Understanding?* Retrieved from https://www.gettingsmart.com: https://www.gettingsmart.com/2016/08/what-is-conceptual-understanding/.

Geban, G. E. ((2016, 3 5)). *The Collaboration of CooperativeLearning and Conceptual Change: Enhancingthe Students'Understanding of Chemical BondingConcepts.* Retrieved from https://www.researchgate.net/: https://tinyurl.com/vudv6ye.

khedkar, L. (2016). *Ph. D. proposal on a study on status of teaching mathematics in the secondary schools of Vadodara city. .* An Unpublished Ph. D. proposal, The M. S. University of Baroda, CASE.

Kothari, R. (1987). *An investigation into efficiency of different instructional media in the teaching of Mathematics to the pupils of class IX in relation to certain variables in M.B. BUCH (Ed), Fourth survey of research in Education , (Vol.l) (1983-88).*

Leo J. Brueckner, F. E. (1957). *Develoing Mathematical Understandings - in the uper grades.* philadelphia: The John C. Winston Comany.

Manika, G. (1983). *Acquition of concept in Mathematics of pupils at primary school level and its Relation to some personal and environmental variables of the pupils. (Unpublished Ph.D. Thesis, Bombay University) In M.B. BUCH (Ed), Fourth survey of Resear.*

MHRD. (1986). *National Policy on Education.* New Delhi: Department of Education, MHRD, Govt. of India.

MHRD. (2009). *National Knowledge Commission.* New Delhi: Govt.of India.

Mishra, D. L. (2015). *Teaching of Mathematics.* New Delhi: S. B. Nanagia.

Moyer-Packenham, B. L. (2018, 1 8). *Components of Place Value Understanding: Targeting Mathematical Difficulties When Providing Interventions.* Retrieved from

Nair, A. (2017). *dissertation on a study on development and try out of laboratory approach in teaching mathematics for the students of standard vii of Vadodara city.* An Unpublished M. Ed dissertation, The M. S.University of Baroda, CASE.

Prabhu, R. (2018, 02 14). *Effectiveness Of Conceptual Change Approach In Enhancing Learning Mathematics Among Secondary School Students.* Retrieved from https://shodhganga.inflibnet.ac.in/: https://sg.inflibnet.ac.in/handle/10603/236293.

Prajapati, N. (. (2011). *Studied the Mathematical weakness that exist among the secondary school Students.*

Training, N. C. (2000). *National Curriculum Framework for school Education.* New Delhi. Training, N. C. (2005). National Curriculum Framework (2005). New Delhi: NCERT.

Zheng, A. R. (2020, 3 4). *Developing an understanding procedures observation rubric for mathematics intervention teachers.* Retrieved from https://www.researchgate.net/: https://www.researchgate.net/publication/339703682_Developing_an_understanding_procedu.

APPENDICES

Appendix A

ગણિત ની સમજણશક્તિ માટેની કસોટી

કુલ ગુણ:30 સમય:30 મિનિટ

ધોરણ:૯ તારીખ:

❖ નીચેના પ્રશ્નોના માગ્યા મુજબ જવાબ આપો. દરેક પ્રશ્નનો એક ગુણ છે.

A. નીચે આપેલા વાક્યો ખરા છે કે ખોટા જણાવો.

1. દરેક પૂર્ણાંક સંખ્યા એ વાસ્તવિક સંખ્યા છે.

2. દરેક સંમેય સંખ્યા એ વાસ્તવિક સંખ્યા છે.

3. √2 એ અસંમેય સંખ્યા છે.

4. -3૪ < –૫.

5. પૂર્ણાંક સંખ્યાનો ગણ, Z=N∪ {0} થાય.

6. ત્રિકોણ ABC માં ખૂણો B ની સામેની બાજુ AC છે.

B. નીચે આપેલા દાખલાઓ ગણો.

7. ૨૪ અને ૪૮ નો લ.સા.અ શોધો.

8. ૬ અને ૯ નો લ.સા.અ ૧૮ છે તો ગુ.સા.અ કેટલો થાય?

9. સાદું રૂપ આપો, $\frac{૬૨૫\times૧૮}{૨૫\times૬}$=

10. P(x)=3x+૧, x=$\frac{-૧}{3}$ આગળ કિમત શોધો.

11. OOOO.૫=

12. $\sqrt{૧૯૬}$ =

13. ૨૨ *૧O+૧૬-૮/૪ =

14. ૨૫^{૨} =

15. ઘન ને કેટલા પરિમાણ હોય?

16. ૪$\frac{૧}{૮}$ મિશ્ર સંખ્યાનું અપૂર્ણાંક રૂપ શું હોય શકે?

17. (3$^{૧/૫}$)^૪ નું સાદું રુપ આપો.

18. મેં એક પેન 3૫ રૂપિયામાં લીધી અને 1૭ રૂપિયામાં વેહચી તો મણે નફો થાય કે ખોટ?કેટલો?

19. ૨x + y =૭ હોય, જો x=૫ તો y=

20. (૨,૦) એ ક્યાં યામ પરનું બિંદુ છે.

21. બિંદુ (૦, -૬) નું ઉગમબિંદુથી અંતર કેટલું થાય?

22. ખૂણો BAC= ખૂણો   લખી શકાય.

23. $(૫^{૨})$^3 મોટા છે કે $૫^{૨^{3}}$ કહો.

24. સમતોલ પાસાને ઉછાળતા તેની પર અંક ૬ આવે તેની સંભાવના કેટલી થાય?

25. $૭^{૮} \times ૭^{૯} =$

26. $\frac{૬^{૭}}{૬^{૫}}=$

27. $a^{૨}-b^{૨} =$

28. ત્રિકોણનાં ક્ષેત્રફળનું સૂત્ર લખો.

29. ૬૫° ના માપના ખૂણાના પૂરકકોણનું માપ કેટલું થાય?

30. ચોરસનાં ક્ષેત્રફળનું સૂત્ર લખો.

Appendix B

List of Experts

Sr. No.	Name of Expert	Designation	Institute
1	Prof. Satish Pathak	Professor	The Maharaja Sayajirao University of Baroda, Vadodara
2	Mr. Vaibhav Patel	Teacher	Government secondary school Amroli, Naswadi.
3	Mr. Krunal Patel	Teacher	Government secondary school Ratanpur, Sankheda.
4	Ms. Trupti Rohit	Teacher	Government secondary school vankhala, Naswadi.
5	Mr. Sanjay Koli	Teacher	Government secondary school Khreda, Naswadi.