"THE EFFECTIVENESS OF MODEL TEACHING PROGRAM TO ACHIEVE PRACTICAL AND VISUAL DEVELOPMENT OF MATHEMATICS AMONG STUDENTS IN SECONDARY EDUCATION"

माध्यमिक शिक्षा में छात्रों के बीच गणित के व्यावहारिक और दृश्य विकास को प्राप्त करने के लिए मॉडल शिक्षण कार्यक्रम की प्रभावशीलता

A

Thesis

Submitted for the Award of the Ph.D. degree of

PACIFIC ACADEMY OF HIGHER EDUCATION AND RESEARCH UNIVERSITY

By

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DECLARATION

I, **Kalpit Pandya** S/o **Shri Mahesh Chandra Pandya** resident of 124-A Shrinath Nagar, Sector-9, Hiran Magri, Udaipur-313002, Rajasthan, hereby declare that the research work incorporated in the present thesis entitled **"The effectiveness of Model Teaching Program to achieve Practical and Visual Development of Mathematics among students in Secondary Education"** is my own work and is original. This work (in-part or in full) has not been submitted to any University for the award of a Degree or a Diploma. I have properly acknowledged the material collected from secondary sources wherever required. I solely own the responsibility for the originality of the entire content.

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ACKNOWLEDGEMENT

Firstly, I would like to express my sincere gratitude to my research guides **Dr. NARESH MENARIA,** Associate Professor, Faculty of Science, PAHER University, Udaipurfor their continuous support of my Ph.D. study and related research, for their patience, motivation, and immense knowledge. Their guidance helped me in all the time of research and writing of this thesis. I could not have imagined having better advisors and mentors for my Ph.D. study.

I am also thankful of **Prof. (Dr.) HEMANT KOTHARI,** Dean PG Studies, Pacific Universityfor his valuable support and corporation.

Special thanks to my wife **Ms. NEHA PANDYA** It was her dream that I should pursue doctorate degree and today I am very much indebted to her that I couldnot have initiated and completed it if she would not have encouraged and supported methroughout this journey.

Also, thanks to my son **HITARTH PANDYA** & daughter **MISHA PANDYA** who werealways kind to me to give me enough space so that I can complete this research work.

I am obliged to staff members of the University, for the valuable information provided by them in their respective fields. I am grateful for their cooperation during the period of my course work and thesis.

I am grateful to my parents and family to help me always with the carrying and safe hand. I always feel their blessings in my heart in hard times.

I am very grateful to **Dr. RAJESH KANJA**, Assistant Professor, Faculty of Computer Science, PAHER University, Udaipur and friend for his valuable suggestions and encouragement throughout theperiod of my research.

I extend my sincere thanks to all my senior Professors, who have played a vital role during my research work and who rendered their full cooperation to me in completing this work in time.

I would like to thank each of them, who directly or indirectly rendered their help to me in the completion of this work, but whose names could not be mentioned.

Last but not the least, my distinctive thanks to **M/s Shorya Thesis Prinitng & Binding, Udaipur** for their role in shaping the matter, creative design work and bringing out this document meticulously, neatly and timely.

KALPIT PANDYA

ABSTRACT

The goal of the study was to ascertain how successfully a brain habits-based math learning programme promoted academic success and original thought in secondary level students. The researchers used the academic achievement encouragement scale and the creativity in mathematics test to collect the data (Prepared by the Researcher). Utilizing a study technique based on a semi-experimental approach and the statistical programme SPSS, the collected data were analysed. The sample was chosen at random from the mathematics department. The results show that there are statistically significant differences between the post-application scores for creativity and academic achievement encouragement at the (0.01) level, indicating that the programme has aided secondary students in improving their mathematical creativity and academic achievement encouragement.

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INTRODUCTION

1.1 INTRODUCTION

The standard of education offered to the future generation at all levels has a significant impact on the prosperity, progress, and development of a country. Education is the sole means of bringing about the required change, and it aids the younger generation in becoming used to the science and technological advancements that have transformed modern society in all spheres of life. Additionally, education supports overcoming obstacles and advancing in life. In this sense, Bill Clinton, the President of the United States, stated that in the beginning, we are required to modernise education for the twenty-first century, guided by our belief that every kid can learn, while discussing the national goals of education in his state in January 2000. Education is the key to our children's future since it is more crucial than ever. Since it keeps a person alive and helps them succeed in today's ideal and fiercely competitive world, education is the essence of life.

Today, the entire globe is viewed as a global village, with many doors leading to knowledge in all directions and exposing people to a wide range of experiences. These encounters help one advance human civilization. The capacity to select the appropriate experiences and take advantage of appropriate chances that benefit both the person and society at large is something that must be developed urgently.

Showing the value of education According to John Dewey, education is the process of fostering in a person all the abilities that will allow him to exert control over his environment and meet his requirements. Rig Veda says, Education is the source of all light in a straightforward manner (Abbott 2004)[1]. Education is the one that, promotes capabilities such as spirit of enquiry, creativity, entrepreneurship and moral leadership which are important to nation building in a democracy, says Abdul Kalam, the former second president of India. All of these justifications and several additional definitions emphasize how complicated, dynamic, and forward-thinking education is.

India is a growing nation, and because of the significance of education to its development, it is believed that every Indian should have the chance to further their education. Education is considered to be a fundamental right of every Indian. In this regard, the Indian Constitution guarantees all children under the age of 14 access to free and required elementary and secondary education.

A significant commission in the history of Indian education, the Indian Education Commission (1964–1966), states that education must serve as a potent tool of social, economic, and cultural transformation essential for the realization of national goals. In a similar vein, National Policy on Education (NPE) (1992), another significant milestone in Indian education, notes that Education gives individuals the chance to think on vital social, economic, cultural, moral, and spiritual concerns facing mankind. It promotes the growth of the nation by disseminating specialized information and abilities. Therefore, it is essential for survival.

In addition, N.P.E. (1992) emphasizes the significance of quality education by asserting that quality is the need of the hour and it comprises all the characteristics of education which surely contribute towards the growth of a person and eventually the nation.

All facets of education are directly impacted by today's scenario of knowledge explosion, advancements in ICT, commerce, ideas, economics, shifting values, etc. beyond national boundaries. With regard to improvement in the areas of activities, educational programmers, policies, and strategies, etc., the role of education is enhanced in this context. Critical concerns like the use of technology in curriculum, resource development, and other areas should be investigated, added to, changed, or removed as soon as possible in light of the evolving, fresh viewpoints. To address the difficulties facing the world, all facets of education at all levels must be changed and improved.

Education is the only answer that can fulfil everyone's demands while addressing the current global concerns (Angrist 2002)[2]. In this regard, the Kothari Education Commission suggests a number of national education goals, including education for productivity, enhancing social and racial integration, promoting democracy as a system of government and a way of life, modernizing education, and developing moral character by balancing social, moral, and spiritual objectives.

The Kothari Education Commission's stated national goals serve as the foundation for the whole Indian educational system (1964-66). They give the instructional programmers for students in elementary and secondary schools the much-needed direction. At these levels, every topic is connected to the national objectives.

The Prime Minister Rajiv Gandhi also outlined a New Education Policy (N.E.P.) in 1986, emphasizing that Education would have to be simplified to build enterprise aptitude, and they must be exposed to challenges of new ideas. The resource constraint and input dynamism must be solved through the use of new concepts in place of outdated ones.

The National Policy on Instruction (1986) and the POA (1992) had a significant impact on how school education was changed, emphasizing four areas in science and mathematics. The recommendations provided made mathematics study realistic, fascinating, practical, and pleasant.

1.1.1 Activity Based Mathematics

Students study arithmetic to pass exams, and lecturers emphasise passing concerning manipulation of numbers classes or, in irregular class, doing well on exams. This manifests by what method the makeup of exams influences two together the education and education of arithmetic. In paper-and-pencil exams, pupils are necessary to answer concerning manipulation of numbers questions. The basic purpose of education arithmetic is to support pupils' capabilities to answer concerning mathematics baffles. Use the "Do as I have approved" approach to resolve these issues. Students in the twenty-first century are folds barriers on account of this system of education and education. For instance, the current view of the teaching and knowledge process has existed raised doubt for one use of news and ideas science (ICT).

It is well known that teenagers the one study arithmetic at some level will wait with expectation the era. (Bauer 2005)[3]. In India, mathematics is generally instructed and well-informed in a habit that helps juniors prepare for twenty-first-of one hundred years abilities. We must appreciate that the arithmetic syllabuses from 1900, 1950, or even 1980 cannot sufficiently gird contemporary's kids. (Kennedy 1991)[4]. This manifests that this method of education and understanding arithmetic is not present advantageous than passing exams the antiquated approach. The growth of 21st-of one hundred years talents

must allow for possibility the views of earlier instructed academic regimens. Although not contained in the educational program, these matters might be included into each of the cases below the current syllabus.

The progressive educational ethos advanced by John Dewey serves as the foundation for activity-based mathematics instruction (ABMI). This type of education emphasises active learning. At the turn of the century, India was a pioneer in the use of activity-based learning.

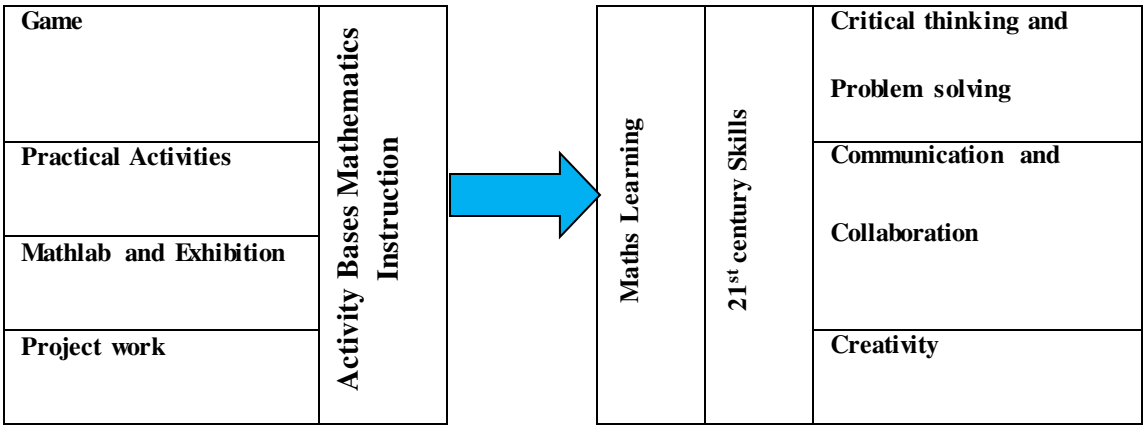

Fig. 1.1: Conceptual framework

The Activity Based Mathematics (ABMI) approach transcends the conventional lecture format and the dogmatic method of learning. John Dewey's idea of "learning by doing" serves as the foundation for ABMI. The learning process involves learners actively. (Salami 2014)[5] and the emphasis on the student has increased. Activity-based tactics for learning include activity/learning centers, panel discussions, carousels, repetition and practice exercises, debates, retellings, field trips, simulations, games, surveys, and oral presentations. (Ministry of Education, 2002). Additionally, ABMI is activity-based and involves students in reading, writing, discussions, hands-on activities, problem-solving, analysis, synthesis, and evaluation. (Festus 2013)[6]. Festus (2013) listed a few of the activities, including the discovery approach to teaching, appropriate practical work, the use of teaching aids, cooperative learning, and small group instruction.

Despite the fact that ABMI employs a variety of methodologies, project-based learning, games, and practical exercises were chosen. The easiest way to learn mathematics while

having fun is through games. Younger students, in particular, enjoy playing games. (Way 2011)[7]. Studies on games demonstrate that they are the best tools for fostering brain development. Basic mental capabilities such as visual processing, attention and alertness, executive functioning, and job-related skills are all improved by playing video games. (Gray 2015)[8]. Physical sports are the most effective for both mental and psychosocial growth in addition to physical development. Games can be used to educate and learn a variety of mathematical ideas, including games that promote factual knowledge, skill development, conceptual comprehension, and strategy development. Practical exercises are skill-based methods for learning mathematics and gaining practical abilities. The location and circumstances determine how these skills change. Some of the skills include estimate, direction-finding, and practical calculations. Measuring length, weight, height, capacity, and other physical attributes are examples of practical tasks. It's beneficial to engage in practical activities to get first-hand knowledge. Different elements of mathematics, such as graphs, transformations, trigonometry, geometry, calculator skills, locus, geometry, etc., can all be taught while fostering practical abilities. In (Conlon's 2003)[9].

The school's mathematics laboratory, or simply "Math lab," is a space where students can experiment and investigate patterns and concepts. (Homi Bhabha Centre for Science Education, n. d.). With the use of games, puzzles, and other specialised materials, various activities are carried out to investigate and validate mathematical linkages. Math labs are typically used to explicitly examine and test mathematical concepts. Paper folding and cutting are also utilised as lab exercises for concretely testing mathematical ideas. The best way to learn here is through guided or independent discovery. Students also create various models to depict mathematical relationships and objects. One of the programmes that students put together to share their thoughts, creations, etc. is the exhibition.

Project-based mathematics instruction breathes life into the classroom environment. In the same vein, students must complete a variety of assignments, puzzles, and investigations in order to develop their ability to think and work mathematically. A project is just a plan to perform a sequence of activities, and project-based learning is learning through doing the tasks. A project is also a sincere, intentional activity that takes place in a group setting. Therefore, a project is a collection of learning-focused actions that are intended to achieve one or more specific understanding goals. It entails problem-

solving and problem-investigation, typically involving the use of and manipulation of physical items, organised and carried out by students and teachers in a natural manner.

1.1.2 Visual and Practical Learning of Mathematics

The interplay and alter of information through representations is famous as able to be seen with eyes knowledge. This comprises sketches, pictures, drawings, maps, and added optic sexually transmitted disease. Teachers can help students discover and remind what they visualize by effecting visual material on chalkboards, whiteboards, screens, projectors, and additional able to be seen with eyes display maneuvers to attack visual learners. Although they can gain in additional habits, ocular learners benefit most from a show me arrangement. For instance, they mostly determine by what method to change a flat tire better by watching other person invite to do battle than by version inscribed directions. When distinguished to look at a print, even spoken directions maybe disputing for a optic beginner to comprehend.

In a study written in the Journal of Applied and Computational Mathematics, investigators displayed that optic processing is the bedrock of analytical concept. The Stanford Graduate School of Education educator and study's principal investigator, Dr. Jo Boaler, claims that when you attempt to answer a analytical issue, your intelligence activates abundant different extents. The first and back routes, that are visual pathways, are two of these points. And two together men and babies are subject to this operation.

The communication is that even when we aren't intentionally achievement it, our brains will softly establish representations from guideline we see. This develops our understanding of two together bulk and space. As a result, when kids are education arithmetic, their intellects are active under the hood difficult to anticipate the movements.

Another study erects that when we consider numerical computations, our understanding is followed by exercise in the area of the intelligence had connection with finger likeness, or relying our fingers. When doing arithmetic, many adolescents seemingly use their fingers as optical aids. The research told that, outside our knowledge, our mind performs this somewhat finger considering by visualising the computations as fingers.

This plainly displays that for many kids, visuals can entirely change the mathematics meeting. Some pupil's ability changes their perspective later observing a explicit, that helps them understand arithmetic issues fresh. A companion may need to visualize the unchanging arithmetic troubles visually before they can adequately accept the reason behind the trouble, whereas individual undergraduate grant permission within financial means hears numbers and mathematics questions being noticed in a spoken voice and grasp the underlying arithmetic plans. In order to act pace accompanying their non-visual matches, these optical learners remodel these optic representations, in the way that the six spheres, back into numbers in their intellects.

1.2 IMPORTANCE OF MATHEMATICS

Given its significance, mathematics is rightfully referred to as the Queen of Sciences. It is a well-organized and systematized field of study. It deals with quantitative facts and correlations and is logical in character. According to the National Policy on Education (NPE, 1986), mathematics should be seen as a tool for teaching a kid to reason, analyses, and speak coherently. It should be viewed as a concomitant to any subject involving analysis and interpretation rather than as a separate subject.

Although mathematics has been around for more than 5000 years, its significance only recently rose due to developments in the scientific and technology fields, which heavily rely on mathematics.

Howard F. Fehr (1966) highlights the value of mathematics by stating that if mathematics had not been beneficial, it would long since have gone... Moreover, highlighting the inevitable nature of mathematics Mathematics is the necessary instrument of all physical inquiries, according to Kant (1956). Bacon (1967), who asserts that Mathematics is the doorway to all disciplines, supports this interpretation of Kant. We cannot overstate the significance of mathematics in connection to scientific education research, according to Kothari Education Commission of India (1966), which also supports this viewpoint by noting that it should be taught as a required subject. This has always been the case, but never has mathematics importance been higher than it is now.

Shaw, J.B. (1988) elaborates on the idea of mathematics by claiming that it is scientific since it leads to generalizations, which in turn greatly expand the subject's horizons. It is

intuitive because it offers a thorough insight into the topic being studied. Additionally, it is deductive since it results in unchanging statements. Finally, it is undeniable that it is intuitive since it culminates in an ideal component and ushers in a new period that allows for the exploration of hitherto unexplored territory. Additionally, it makes predictions and suggests fresh lines of inquiry.

The topic has been defined and explained in many ways by eminent experts. Though each definition and explanation of mathematics describes the subject in one way or another, taken collectively, they provide a thorough description of its nature and traits.

1.3 NATURE OF MATHEMATICS

Mathematics varies from other academic disciplines due to various distinctive qualities, some of which include correctness, logical sequencing, application, abstractness, generalizations, and its link with other academic disciplines, among others.

It has a variety of uses. No area of knowledge can function without calculations and predictions, both of which fall under the purview of mathematics. It is heavily utilized in the fields of physics, chemistry, biology, and other physical sciences. In the social sciences, such as geography, sociology, economics, psychology, etc., mathematics is used to analyses social phenomena, quantify, generalize laws regulating diverse policies, trace the growth, and make forecasts. Mathematics are used in all languages. Only with the aid of mathematics do the symbols of a language become understandable, practical, and universal. The only way to use grammar and organize thoughts is through mathematics. When works of art and architecture have symmetry and characteristics, they become significant and admired. Because the notes and rhythm follow a predetermined course, even music is mathematical.

The nature of mathematics is abstract. All mathematical procedures are founded on assumptions that turn out to be true. Since there are no such physical items to experiment with, mathematics comes at its final conclusions by relying on assumptions that cannot be verified (Parsons 2005)[10]. However, the ultimate result is concrete. Furthermore, the validity of the results might be confirmed. Finally, it offers generalizations that may be used everywhere and whenever necessary in the form of laws, rules, postulates, theorems, etc. (Mulaik 1987)[11].

The study of mathematics is multidisciplinary in the sense that all of its subfields, such as arithmetic, algebra, trigonometry, geometry, statistics, etc., are interconnected in some way.

It employs the inductive or deductive approach to establish the truth. Both approaches include logical stages. The requirement dictates which postulates, laws, rules, definitions (Mangal 2013)[12], axioms, etc. are used in the logical sequencing. It progresses sequentially and logically from the known to the unknown and from the simple to the complex, or maybe vice versa.

The discipline of mathematics is highly valued. The outcomes are specific and measurable, making them reliable. Before drawing final findings, the process incorporates logical consideration, reasoning, and verification. Inferences drawn from mathematics cannot include any subjectivity. The entire procedure proceeds exactly as expected and preplanned (Goldin 2008)[13]. Only true, authentic, and definite facts are discussed in mathematics. It basically follows rules, encourages honesty, and ensures that every decision is clear before continuing. Because it is methodical, it encourages patience and hard effort.

Mathematics not only highlights change in all spheres of life, but it also provides a concise and exact explanation for the change. Additionally, it anticipates improvement. Furthermore, mathematics promotes accountability and openness by precisely measuring outcomes using well recognized numerical symbols (MacBeath 2001)[14].

Mathematics develops a person's capacity for systematic thought, which makes it easier to apply previously learned information to the acquisition of new knowledge. Thinking rationally, reasoning, organizing, organizing, observing, analyzing, visualizing, synthesizing, and coming to conclusions are all parts of this process. According to Plato, Mathematics is a topic that gives a chance for training, to chase thinking, waking up a sleeping and undisciplined soul, in this regard. Hubsch (1960) asserts that studying mathematics teaches one to think clearly, sequentially, and deliberately.

Encyclopedia Cambridge states that it is a mental process that progresses through a sequence of phases from existing knowledge to a new circumstance, to new judgments.

All of them demonstrate how mathematics aids in developing a person's mental skills (Salkind 2005)[15].

The facts are communicated clearly and with support using mathematics, which helps people build their power of speech. By expressing the results quantitatively in the form of numerical symbols, it simplifies the explanations. Error-free reasoning keeps you from making mistakes (Yang 2006)[16]. It directs and steers thought in the appropriate direction.

It promotes a scientific mindset, an open mind, critical observation, self-reliance, and self-assurance. Schellbach (1908) correctly noted that ... who does not comprehend mathematics and the findings of modern scientific inquiries dies without understanding truth in this regard.

Therefore, mathematics aids in appreciating and enjoying the harmony, symmetry, beauty, completeness, and regularity with which nature operates. It improves one's quality of life by assisting in the stress-free resolution of everyday issues.

1.4 THE VALUE OF MATHEMATICS IN EDUCATION

According to educators, it is impossible to envision education without the study of mathematics. From pre-primary through primary school and high school, formal math instruction should be a part of the curriculum. Arithmetic is one of the three Rs that are taught in elementary school; the other two Rs stand for language learning. They get instruction until they graduate from high school. One benefits from it as a foundation for higher education in particular, while another benefits from its application or usefulness in daily life generally.

Mathematical skills learned in elementary and middle school will stick with a person and be helpful throughout their lifetime. Actually, the need for mathematics is felt, and as the demand grows, so does the requirement for mathematical understanding (Zaslavsky 1994)[17].

Studying mathematics at the secondary school level is crucial since it facilitates learning other courses studied there, such as physics, chemistry, economics, geography, etc. Mathematical symbols have a global aspect, which means that people from all different

countries accept them. These typical mathematical symbols are part of the shared human heritage. Additionally, it fosters intercultural understanding (Schmidt 2005)[18].

Mathematics helps to focus thoughts in a positive and creative way. Children's mental development is aided by it. It promotes the capacity to reason out, synthesize, and analyses in order to reach the proper conclusions. Additionally, it develops the practice of systematic thinking, which in turn fosters the abilities of expression, attention, and concentration. Mathematical techniques might be used to provide precise and accurate findings. Clarity is provided by the results being validated before being generalized. Such validated generalizations assist in applying previously learned information. It promotes imagination. Students that study mathematics become more engaged, independent, and self-assured, and they also become better at self-evaluation.

Because it encourages traits like focus, organization, diligence, sincerity, seriousness, as well as timeliness, fairness, and self-control, among others, it has disciplinary significance. All of these traits assist in overcoming undesirable traits like hostility, apathy, and other such traits, which promotes good mental health and a balanced personality. Mathematics has a practical importance compared to other academic topics since it is employed in daily life. It also serves as a foundation for further education. The inclusion of mathematics in the secondary school curriculum is justified by all these benefits of math instruction.

1.5 MATHEMATICS AND CURRICULUM

Education is a deliberate activity with clear goals and objectives. Therefore, it is necessary to arrange all of the experiences and activities offered in schools (Polu 2022)[19]. Given its importance, mathematics is given a major place in the elementary and secondary school curricula (Coxford 1998)[20]. It gives both the teaching and learning processes the much-needed direction. In this regard, the Kothari Education Commission (1966) and the Secondary Education Commission (1952–1953) recommend that both the primary and secondary curricula be activity-based, which should promote exploration, problem-solving, decision-making, the development of positive attitudes, social behavior, etc. The National Education Policy (NEP, 1986) emphasized the requirement for a significant overhaul of the current curriculum.

The National Council of Educational Research and Training (N.C.E.R.T.) developed the first curriculum based on all the proposals, combining several recommendations made by the various commissions and educational policies (Aithal 2019)[21]. The 10-year National Curriculum Framework was later revisited in the landmark years of Indian education, 2000 and 2005. Regarding the instruction of mathematics in elementary and secondary schools, it has provided insightful advice. It was emphasized that there should be a change from curriculum that is only information-heavy to curriculum that is activity-based, integrated, and learner-centered.

Major recommendations have been made by P.O.A. (Programmed of Action) (1992) to make studying mathematics relevant, simple, and entertaining. It is advised that the curriculum contain hands-on activities, projects that are activity-based, child-centered, light on the load, and stress-free, as well as engaging and effective teaching-learning techniques.

For secondary school pupils, the National Curriculum Framework's (N.C.F., 2005) recommendations for mathematics curricula include constructivism and problem-solving techniques. The Right to Education Act (R.T.E.) also suggests learning via activities in the year 2009. It was advised to use child-centered and kid-friendly strategies for inquiry and discovery. A powerful advisory committee was established later in 2011 to create the school curriculum (APSCF). This committee, whose members were specialists from universities, NGOs, and other organizations, examined the mathematics curriculum. Finally, it was advised that the curriculum be focused on teaching techniques that are activity-based and problem-solving.

When they are used in a classroom, all committee recommendations, rules, research papers, etc. take on new significance. In the end, it is the duty of the instructors to satisfy all of the demands of the students and guide them in the best interests of all parties.

The needs in today's society are diverse and difficult, and teachers play a crucial role in meeting these requirements. To do this, teachers must be effective at their jobs and competent enough to handle the burden of meeting the needs of both individuals and the community as a whole.

Learning is a mental activity. To ensure that learning is effective, the instructor must provide the student a variety of experiences. It is essential to understand the cognitive talents and skills of learners in order to tailor the learning experiences that should be provided to them in order to make the study of mathematics relevant. Making the right decision while choosing a learning technique for mathematics is difficult. Planning is necessary since teaching and mastering a single idea may need for a variety of approaches to meet the needs of each learner. Similar to this, problem-solving aptitude is a crucial component of learning mathematics. It is a higher-level cognitive process that relies on prior understanding of many ideas, axioms, principles, laws, theories, etc. that are necessary in order to solve any problem. Additionally, it requires observation, identification, logical analysis, assessment, synthesis, verification of the findings, and reaching of conclusions. Failure at any step causes confusion, which makes it impossible to tackle any problems. As a result, it is a complicated process, and students should receive particular instruction in building problem-solving capacity at the secondary school level so that they would be able to solve a variety of difficulties. It supports both higher education and problem-solving in daily life.

Furthermore, the age of secondary school students is roughly between 11 and 15 years, which according to Piaget (1956) is the Formal operational stage and according to Bruner (1966) is the point at which children would be able to use logic to solve various problems, be able to clarify, analyses, synthesize, and meet multiple demands at once, etc. Therefore, secondary school pupils need to strengthen their problem-solving skills.

Modern pedagogical elements in the realm of teaching-learning processes where students actively engage are required by the changing environment of today. To boost learning and advance diverse skills compared to traditional teaching approaches, teachers must embrace instructional practices that have been experimentally proven. Teachers must motivate students with the appropriate instructional tools, such as activity-based learning methodologies, to make learning engaging and pleasurable (Ahmad 2016)[22].

1.6 NEED OF THE STUDY

Education is crucial in preparing the next generation to meet the difficulties of contemporary society and to contribute to the advancement of humanity. The level of

education a country's population get determines how quickly and how far that country develops. A comprehensive idea, quality education encompasses all facets of education while keeping in mind the potential growth of students. According to National Educational Policy (Bharat 1986), education gives individuals the chance to consider important social, economic, cultural, and spiritual concerns that the world is currently experiencing it aids in the growth of the country by disseminating specialized information and abilities. The methods developed for education need to be strengthened and improved in order to maximize our resources, knowledge, priorities, and concerns for everyone involved at all educational levels.

Keeping in mind the significance of education at the secondary school level, various curriculum changes were implemented where the subjects of mathematics and science were given emphasis in the National Policy on Education (NPE, 1986) and a revised version of the same Programmed of Action (POA, 1992). They were actively encouraged to be taught as required topics at the secondary school level of education.

The study of mathematics is significant because it has several applications in both the physical and social sciences. It is helpful to measure the outcomes in the first and explain social phenomena in the second so that they may be confirmed and generalized. It is distinctive in nature and provides precise and accurate results. No area of knowledge can function without calculations and predictions, both of which fall under the purview of mathematics. Structures, connections, clarity, regulation, and prediction are all explained by mathematics. As a result, it helps not only in daily life but also in the solution of challenging problems in the humanities, pure sciences, and applied sciences.

It is the only topic that begins with an assumption that cannot be tested but leads to concrete outcomes that can then be validated and transform into rules, laws, postulates, etc. before becoming facts that are eventually acknowledged by everyone.

Because it works with real, logical, concrete, and rule-bound facts and affirms clarity at every step, mathematics is disciplinary in character. One gains strength of expression and open-mindedness from it. He gains the ability to organize, plan, and be methodical. As a result, it fosters self-assurance, independence, sincerity, and judgement. Working out mathematical problems improves cognitive talents such as logical reasoning,

analysis, synthesis, and conclusion-making. It stimulates inventive and productive thinking. Additionally, it aids in applying and learning in such circumstances.

It's interdisciplinarity facilitates the study of other disciplines. Mathematical symbols are widely understood, making communication simple. Such cognitive talents are necessary to comprehend, connect, and interpret various concepts from the appropriate angle. The base for greater learning in any discipline is the ability for students to memories various concepts and link the knowledge they have learned to be applied for all practical purposes.

The benefit of active learning techniques is that students are physically and cognitively engaged in the learning activities, which encourages methodical exploration of in-depth knowledge (Bean 2021)[23]. These techniques encourage students to think critically and creatively about the issue, which results in meaningful learning. Additionally, active learning techniques at the secondary school level provide pupils the chance to be self-directed, recognize their potential, and exert themselves to the fullest extent in order to achieve the greatest outcomes (Bolhuis 2003)[24]. Several active learning strategies have arisen and are being researched globally as a result of the advantages of active learning strategies over traditional learning methods. Active learning methodologies have arisen and are widely employed, including peer learning, inquiry-based learning, problem-based learning, project-based learning, collaborative learning (DeFillippi 2009)[25]. As a result, it is possible to say that active learning techniques make learning simple, straightforward, and engaging.

Many times (Sweller 1985)[26], it's assumed that traditional teaching techniques are used to teach the topic of mathematics (Wenglinsky 1998)[27], At the school level, a high failure rate in mathematics courses has been noted

Their incapacity to analyses critically and logically as a result of poor math performance reduces their productivity. According to Hamid, Shastrill, Matzin, Mahall, and Mundia (2013), school kids' performance in mathematics is subpar compared to other disciplines. The use of traditional instructional tactics and a student-centered teaching approach, which gives the students the chance to learn more effectively, may be the cause of the students' poor performance in the mathematics course. This unquestionably raises

interest in the beneficial characteristics that make studying mathematics exciting, straightforward, and uncomplicated.

Active learning tactics should be adopted since they are better for the students than the traditional methods of instruction used by the majority of mathematics teachers now employed at the school level (Zakaria 2007)[28]. In contrast to traditional classrooms, which were uninteresting, that students loved and had fun learning mathematics in active-learning classes. Additionally, it was shown that active learning teaching methods were more engaging, relevant, produced better results, boosted return rates, and sparked curiosity. Common learning techniques were also seen to have instructional value and learning efficacy.

After realizing the value of active learning techniques, it was decided to research the use of particular or niche techniques in relation to several fields of mathematics.

Major recommendations have been made by P.O.A. (Programmed of Action) (1992) to make studying mathematics relevant, simple, and entertaining. It is advised that the curriculum contain hands-on activities, projects that are activity-based, child-centered, light on the load, and stress-free, as well as engaging and effective teaching-learning techniques.

For secondary school pupils, the National Curriculum Framework's (N.C.F., 2005) recommendations for mathematics curricula include constructivism and problem-solving techniques. The Right to Education Act (R.T.E.) (Batra 2005) also suggests learning via activities in the year 2009. It was advised to use child-centered and kid-friendly strategies for inquiry and discovery. A powerful advisory committee was established later in 2011 to create the school curriculum (APSCF). This committee, whose members were specialists from universities, NGOs, and other organizations, examined the mathematics curriculum. Finally, it was advised that the curriculum be focused on teaching techniques that are activity-based and problem-solving.

Learning mathematics requires a variety of cognitive talents and skills, necessitating active participation from the student throughout the learning process. Active learning techniques should be used instead of conventional teacher-centered learning pedagogies to make learning more efficient and goal-oriented (Comacho2015)[29]. Recently, various

initiatives to spread learning pedagogies over the globe have been made (UNESCO, 1960; United Nations, etc.) (Finnemore 1993)[30]. The renowned Indian Education Commission (1964) and NPE (1986) both advocated for the use of activity-based teaching and learning techniques at the school level in India. Additionally, N.C.F. (2005) and R.T.E. (2009) urge that secondary school curricula be child-centered, child-friendly, and filled with appropriate activities. Additionally, they urge that the pedagogic medium implement active-based education with creative and avant-garde resource inputs.

'Active learning' is a method used in the classroom that makes use of various types of interaction to change the learning environment from passive to active (Al-Ghamdi 2006)[31]. Unlike in a regular classroom where they are merely passive listeners, the students have opportunity to be involved in the 17 classroom thanks to the active learning pedagogies used there.

Prinee (2004) defined active learning as any teaching strategy other than lectures that involves students in the learning process. During active learning processes, students create their own concepts, rules, principles, etc. by participating in various activities. Direct encounters act as a catalyst for subsequent learning in these learning processes. It serves as inspiration.

In an activity-based class, the teacher just serves as a facilitator or supplier while the students actively participate throughout the lesson. In addition to encouraging attitudes like curiosity and investigation, these strategies foster the development of many abilities.

In an activity-based class, the teacher just serves as a facilitator or supplier while the students actively participate throughout the lesson. In addition to encouraging attitudes like curiosity and investigation, these strategies foster the development of many abilities.

All of these research show that active learning techniques have a favourable impact on students' academic performance overall and on mathematics accomplishment in particular. But in the current environment, particularly in the field of mathematics, this has to be tested. 18 Therefore, an effort is made in the current study to look at how active learning tactics affect mathematical accomplishment.

Being able to solve mathematical problems is a major aim of learning mathematics. In order to solve any issue, one must possess the capacity to do so. This skill is known as problem solving ability, and it has taken center stage in the teaching-learning process of mathematics education (Cockcraft1982; Dede2005)[32,33]. In this sense, the National Council of Teachers of Mathematics (NTCM, 1980) emphasised the necessity for students to approach any mathematical topic in a variety of ways. In general, addressing problems entails finding a solution to any issue, including a mathematical one.

Logic, observation, identification, hypothesizing, analysis, assessment, identification of relationships and cause and effect, synthesis, and reaching final conclusions after verification are all components of the higher order cognitive process known as problem solving (Jonassen1997; Hendriana2017; Solihah2018; Surya 2017)[34,35,36,37]. To recognize the relationships in a mathematical issue in an organized manner, a student has to be familiar with a variety of ideas, axioms, rules, laws, etc. As a result, it is referred to as the mathematical heart (Cockcraft1982; Dede 2005)[32,33]. One needs information and talent to solve an issue. As a result, it calls for both operational and conceptual expertise. According to Van Dewell, J.H. (1994), when pupils are unaware of the many ideas involved in addressing an issue, they are unable to comprehend how to carry out the process of solving that specific problem.

In this regard, (Hendriana 2018)[35] suggests four steps in problem-solving, which are: (1) understanding the problem, which entails identifying known facts, asked facts, and 19 the facts that are required to solve the asked problem; (2) chalking out a plan to relate the known facts to that of unknown ones and plan a mathematical model; (3) carrying out the plan, which involves selecting an appropriate strategy, and executing the chalked-out plan; and (4) looking back to interpret the obtained results

The ability to solve problems makes one more self-assured (Hendriana2014)[38]. Everyone goes through the process of learning how to solve problems throughout their lives, not just in school. Memory and curiosity play key roles in problem-solving when using prior information and experience (Pintroich 2003)[39].

To a considerable extent, problem solving is an essential component of mastering the topic of mathematics. Students of mathematics should be able to comprehend a particular learning idea, remember previously learned concepts that could be related to that

problem, and then create connections to interpret outcomes. Additionally, when studying mathematics and solving problems, Students should be able to recognize and use the connections between various concepts in order to come up with a solution that promotes deep comprehension, memory, and meaningful learning (Rismawati 2016)[40].

According to Polya, G. (1973), it is difficult to solve a mathematical issue. Additionally, he notes that kids at the secondary school level are not accustomed to the methodical problem-solving approach. Math success is directly and favorably impacted by problem-solving ability (Guven 2012)[41]. Therefore, it is important for secondary school pupils to enhance their problem-solving skills, particularly in the study of the topic of mathematics.

Problem solving, which aids in finding several solutions to a problem, is regarded as the core of mathematical education. Because it involves a higher order cognitive process that requires both conceptual and operational expertise, there has been relatively little research done in this area. Consequently, it requires a thorough and detailed study. It has been noted that teaching kids to solve problems effectively is a seriously underutilized skill. Additionally, secondary school kids need to acquire problem-solving skills since they are able to exert effort in problem-solving tasks due to their cognitive ability. Piaget and Bruner, 1956; 1966

Analysis of research studies with respect to problem solving ability carried out so for in foreign countries (Gallagher 2000)[42] indicated that, problem solving ability positively effect on achievement in mathematics. However, the number of such studies conducted in India is quite low in comparison to those conducted abroad. Furthermore, these studies are not common in Karnataka. Therefore, our research has demonstrated that active learning practices have a good influence on mathematical success (focuses, a few studies as shown the contradictory result also) According to certain research investigations, active learning improves problem-solving skills. But the majority of studies are carried out elsewhere. Therefore, the purpose of the current study is to investigate the impact of active learning methodologies on mathematical accomplishment and problem-solving skills.

1.7 COMPONENTS TO EFFECTIVENESS VISUAL MATHEMATICS

Effective visual mathematics training must include these three factors:

1. Educating for conceptual comprehension.
2. Increasing the procedural literacy of students.
3. Fostering strategic competence by engaging in visual problem-solving studies.

Middle school students are approaching a crucial turning point in their mathematical education. They are coming to understandings about their mathematical aptitude, curiosity, and drive that will affect how they approach mathematics in the future.

The most fruitful classroom observations take the form of clinical supervision. The conditions of the classroom observation are decided upon during a preconference between the instructor or the classroom observer before the cycle of observations begins. The observer in the classroom negotiates entrance into the teacher's classroom and chooses a focusing question. Focusing questions can be derived from big idea questions like: What instructional technique are you aiming to expand? Focusing questions give a focus for classroom observation and data collecting.

What results should be anticipated from the classroom observation?

An observer should find the instructor in a classroom with a successful MTP for mathematics.

1.7.1 Accepting various viewpoints from students while challenging - them to think critically about the issues they are tackling goes beyond the methods and algorithms that are necessary to find a solution. This makes sure that students are articulating both how they arrived at their solution and why they selected a particular approach.

1.7.2 Having an impact on learning by offering difficult and intriguing questions - The teacher asks questions that pique students' natural curiosity and motivate them to learn more.

1.7.3 Displaying an optimistic outlook towards mathematics and pupils' aptitude for it - The teacher consistently increases pupils' sense of efficacy and instills in them a belief that they are both capable of and capable of accomplishing the aim of learning mathematics. It is not implied that mathematics is a magical or mysterious subject.

An observer in an excellent mathematics classroom ought to notice that students are

1.7.4 Actively engaged in doing mathematics - Instead of seeing others perform mathematical operations for them or in front of them, students should metaphorically pull up their sleeves and perform the operations themselves.

1.7.5 Solving challenging problems - Whenever feasible, students should be researching important real-world issues. Mathematics is a dynamic technique of creating meaning about the world around us, producing new information and understanding about the real world every day. It is not a static discipline of textbook problems.

1.7.6 Making interdisciplinary connections - The study of mathematics is not a solitary endeavour. Connecting mathematics to other fields of study, such as art, architecture, science, health, and literature, helps students learn mathematics more effectively. Teachers might present problem solving scenarios that might have messy outcomes by using literature as a jumping off point for mathematics research. These associations assist students connect the language of mathematical ideas with numerical representations and build a knowledge of the academic vocabulary needed to accomplish mathematics.

1.7.7 Sharing mathematical ideas - It is crucial that students have the chance to converse about mathematics with one another, developing and challenging one another's concepts. Work in pairs, small groups, or in front of the class all provide opportunities for communication.

1.7.8 Using multiple representations to communicate mathematical ideas - Students should have several opportunities to express their mathematical concepts using a range of representations, such as drawing a picture, writing in a diary, or participating in fruitful class discussions.

1.7.9 Using manipulative and other tools - Particularly in the intermediate grades, students are just starting to develop an understanding of abstract reasoning. Students may

find it helpful to transition from the tangible mathematical understandings they have from elementary school to the abstract understandings they will need to master algebra in high school by using concrete models, such as manipulatives. Teachers demonstrate how to utilise manipulatives to solve problems, and they encourage their usage in ways that are consistent with the goals of the lesson.

1.8 STATEMENT OF THE STUDY

The effectiveness of Model Teaching Program to achieve Practical and Visual Development of Mathematics among students in Secondary Education.

1.9 OBJECTIVE

The objective of this study is to develop logical thinking and to visualize the working of mathematics among learner. This study will investigate the effects of MTP based on learner's achievement in mathematics.

The objectives are as follows:

- To construct the Model Teaching Program of Mathematics in secondary classes.
- To implement the Model Teaching Program and to study its effects on pupil's achievement in Mathematics.
- To study the main effect of factors like sex, intelligence, and social economic status on the achievement.

1.10 HYPOTHESIS

1. Make it hands-on
    - Elementary math can be difficult because it involves learning new, abstract concepts that can be tricky for students to visualize.
    - Try to imagine what it's like for a ten-year-old to see an addition problem for the very first time. Since it's a totally new concept to them, it can be hard for them to visualize a scenario where one quantity is added to another.

- Manipulative are hands-on tools that make math a lot easier for young children to understand. Tools like Lego, clay, and wooden blocks can all be used in the classroom to demonstrate how math ideas work.

- For example, Lego is a great way to demonstrate number building, operations, fractions, sorting, patterns, 3D shapes, and more.

2. Use apparatus, visuals and images

- While students will come across countless graphs and visuals in their math textbooks, research shows this isn't the only place they should be utilized.

- According to the National Council of Teachers of Mathematics, the most powerful way to use graphics in elementary math is in conjunction with specific practice or guidance, either from a teacher or another classroom tool such as Math seeds**.**

3. Find opportunities to differentiate learning

- It's important that students feel comfortable and are given the opportunity to learn new math ideas at their own pace, without feeling rushed. But while the idea that 'given enough time, every student will learn' is nothing new, it's easier said than done.

- Technology-based classroom tools offer a powerful way to differentiate learning while teaching elementary math, which is an effective way to help students in mixed-ability classrooms to succeed.

4. Ask students to explain their ideas

- Have you ever noticed how much more confident you feel about a concept after explaining it to someone else?

- Meta-cognition is the process of thinking about your options, choices, and results, and it has a big impact on the way students learn.

- Before assigning a math problem, ask students to brainstorm problem-solving strategies they can use. Encourage students to work together to suggest different strategies in a respectful way.

- This process can be carried out at every stage of problem solving when teaching elementary math. Once students have offered an answer, ask them to verbalize step-by-step how they got that answer.

5. Incorporate storytelling to make connections to real-world scenarios

- When it comes to igniting the interest of young minds, not much comes close to a good story.

- Incorporate story problems into your classroom lessons allow students to see how certain math concepts can apply to real life. Story problems are also a good way to help students understand how to use math in everyday life, and see the relevance of math.

- A math seed provides colorful end-of-lesson books as part of its online program. Many of these are designed so students read the problem, work through it independently, and then turn to the next page to see the solution.

6. Show and tell new concepts

- Elementary math teachers should normally begin each lesson with a 'show and tell.' Telling is the process of sharing information and knowledge with students, while showing involves modeling how to do something.

- These days, teachers can really kick 'show and tell' up a notch with an interactive whiteboard, using animations, and videos to clearly show and tell specific math concepts in an engaging and interesting way.

7. Let your students regularly know how they're doing

- Feedback is an important part of teaching elementary math and improving students' results.

- Let your students know how they have performed on a specific task, along with helpful ways that they can further improve and extend their skills.

Importance of proposed investigation:

Research has highlighted the importance of "Model Teaching Program" both for teachers and students in their teaching and learning of mathematics. The use of visual representations in general is an important part of teachers' knowledge of mathematics and they can play an important role in the explanation of mathematical ideas.

The "Model Teaching Program" can highlight specific aspects of a mathematical concept (e.g., the array representation illustrating the commutative and distributive nature of multiplication, explanation of various theorems), therefore supporting this process of explanation. Visual model representations enable students to make connections between their own experience and mathematical concepts, and therefore gain insight into these abstract mathematical ideas.

Scope of the proposed study:

Number of problems occurred to the students during mathematics learning.

It includes:

1. Structure teaching of mathematical concepts and skills around problems to be solved.
2. Encourage students to work cooperatively with others during learning with fun.
3. Use group problem-solving to stimulate students to apply their mathematical thinking skills.
4. Student's interaction in ways that both support and challenge one another's strategic thinking.
5. Activities structured in ways allowing students to explore, explain, extend, and evaluate their progress.

There are three critical components to effectiveness visual mathematics instruction:

1. Teaching for conceptual understanding.
2. Developing student's procedural literacy.
3. Promoting strategic competence through meaningful problem-solving investigations using visual aids.

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Chapter – 02

Literature Review

CHAPTER - 2

REVIEW OF LITERATURE

2.1 MEANING OF REVIEW:

The review of the literature is one of the key components of the study because it aids in developing the methodology, determining the cause-and-effect relationship of the study, and identifying any gaps in the literature that need to be filled. Reviews of the literature serve as versatile guides for a certain subject. A critical and in-depth analysis of prior research is what is done in a literature review. Anyone reading the document will be able to understand why we are pursuing this particular study development because it is an overview and synopsis of a certain research topic. In order to understand what contributions can be offered and to build a suitable study strategy, it is also helpful to review the literature.

2.1.1 Importance of Review of Literature:

There are several purposes to writing a literature review:

- Why to force researchers to synthesize, assess, and compare original research in that particular area, giving them a great place to start when conducting research in a new field.
- To inform the design and methodology of the proposed study.
- To be able to detect conflicting points of view expressed by different authors.
- To form Basis of forthcoming research work.
- To discuss relevant research carried out on the same topic.
- To provide summary of the research area.

2.2 MAIN REVIEWS ARE

Tan, May; Lan, Ong Saw (2019) investigates the stances and opinions of upper subordinate arithmetic and science faculty members (MST) whose undergraduates are the first and second cohorts to study arithmetic and wisdom in English. The findings of surveys, scholar interviews, and hall observations illustrate MST stances and beliefs influence teaching game plans. The information manifests by virtue of what exam tactics, professor attitudes, and theories communicate to promote interpretation use and a devote effort to something keywords during education (Tan 2019)[1].

Lim, Chap Sam; Presmeg, Norma (2018) When examining in what way or manner to educate arithmetic in two expressions: According to a study named A Teaching Dilemma of Malaysian Chinese Primary Schools, arithmetic is instructed in two together Mandarin and English in Malaysian Chinese basic schools on account of the difficult sociocultural needs of the Malaysian Chinese society. Particularly in depressed-operating courses, coaches knowledgeable the challenge of transitioning 'tween English and Mandarin (Lim 2018)[2].

Doganay, Ahmet; Bal, Ayten Pinar (2017) When developing traditional and alternative measuring instruments, teachers regularly took their students' levels and levels of acquisition into account, according to a study on the measurement of students' accomplishment in teaching fifth-year mathematics classes in primary schools. They disregarded the level of analysis-synthesis, though. In this regard, it might be suggested that attention be made to measuring students' higher order thinking skills and the usage of additional alternative assessment tools while developing traditional and alternative assessment tools (Doganay 2017)[3].

Jo Boaler, Lang Chen, Cathy Williams, and Montserrat Cordero (2016) A study on the value of visual mathematics discovered that studying mathematics visually also has an impact on the brain. Finally, they provide three suggestions for parents and teachers[4].

Encourage visual approaches in students' and celebrate this by removing an idea that strong mathematics learners are only those who can calculate fast and memorize.

1. Encourage students to use their figures while calculations and solving problems.

2. The teaching and learning of mathematics require to become more visual - there is no idea or concept that cannot be illustrated or thought visually.

Furkan özdemir, Murat Duran, Abdullah Kaplan (2016) researched on Middle School Students for their self-efficacy perceptions of Visual Mathematics Literacy. The motive was also to find their perceptions of Problem-Solving Skill[5].

Singh et al (2016) examined the factors having an impact on students' academic achievement. Ex post facto research design was used in the study. Further, an instrument, designed for the measurement of students' educational attainment, was used to collect data on management students. The outcome disclosed a statistically positive influence of training facilities, proper guidance, and communication skills on the performance of students in their learning (Singh 2016)[6].

Shera fat and Venkatesh Murthy (2016) in their study, tried to comprehend whether study habits had an impact on secondary and senior secondary school students' performance or not. In the study, a sample of 625 students of Mysore was taken using stratified random sampling technique. The outcomes showed study habits enhance academic achievement and secondary school students did better than senior secondary students (Shera fat 2016)[7].

Dzever (2015) in his study, evaluated the effect of home environment factors on educational attainment of students studying in public schools in Abuja, Nigeria. He took samples of 300 students from six public schools. In the study, random sampling method was used to supervise the questionnaire. In his study, he used a descriptive survey research, designed for the study. The data for the study was taken from the obtained scores from the selected four school subjects. The analyzation of data was done using inferential and descriptive statistical techniques; ANOVA (Pearson Product Moment Correlation and Multiple Regression Analysis. The outcomes disclosed a remarkable positive correlation between academic achievement permissive parenting styles. Further, the result showed that economic status, occupational level, parents' educational background as the primary predictive variables leaving impact on learners' educational performance (Dzever 2015)[8].

Ghosh (2014) in his study, found a correlation between emotional intelligence and academic achievement. The results of his study disclosed a noteworthy and positive relationship between educational attainment and emotional intelligence. Further, the study revealed that learners with low to high socio-economic conditions differ from each other on academic achievement and emotional intelligence (Ghosh 2014)[9].

Korir and Kipkemboi (2014) in their study of The Impact of School Environment and Peer Influences on Students' Academic Performance in Vihiga County, Kenya, analyzed the effect of school atmosphere and peer influence on students' educational performance. In their research, they found that school environment and peer influence had a crucial role in students' academic achievement (Korir 2014)[10].

Roy et al (2013) in their study of Emotional intelligence and academic achievement motivation among adolescents: a relationship study, also found a considerable positive relationship between educational attainment, emotions, and intelligence. They observed that the students having low, average, and high educational attainment differentiated each other on intelligence and emotion, in their study of Internal factors Affecting Academic Performance among Pharmacy Students in Malaysian Public Institutions of Higher Learning, examined the effect of internal factors of pharmacy students' educational performance to find out whether these factors influenced their average cumulative grade points and the year of study. The outcomes 58 disclosed that there was a significant association of academic achievement with time management skills, academic competency, test anxiety, neuroticism, and test competency. The difference was significant among students studying in 2nd, 3rd and 4th year of pharmacy course. Post-hoc explanation disclosed that there was a remarkable difference in the conscientious level between the students of second and 4th year (Roy 2013)[11].

Alkhutaba (2013) in his study the influence of socio-economic factors on the performance of students in education at the secondary level, found that there was a remarkable influence of socioeconomic factors on students' academic achievement. Further, he observed that socio-economic factors had greater influence on female students (Alkhutaba 2013)[12].

Anees (2013) in his study on the relation of intelligence with academic achievement among students of class 8 dealt with the relationship of the identification of magnitude

between educational attainment and intelligence. The study was conducted over 180 students from AMU girl high school and high school. R.B. Cattell conducted the culture faire intelligent test. Major outcomes of the study were; there was a positive correlation between academic achievement and intelligence and no any remarkable difference between boys and girls (Anees 2013)[13].

Kanti, K.S. (2013) in this study titled A Study of the Value Preferences of Prospective Secondary School Teachers, went through the observation of 650 probable secondary school teachers from 10 colleges of Nagarjuna University. The valuation of the prospective teachers was done by Dr. S. P. Ahluwalia, L Singh, and Dr. (Mrs.) Harbhajan. Major results of the study were; the participants gave first priority to social value and the least priority to political value, there was a significant difference between male and female prospective teachers over value preferences, the difference on value preferences was also remarkable among graduate and postgraduate prospective teachers (Kanti 2013)[14].

Kumari and Garita (2012) in their study of the relationship between anxiety and academic achievement among senior secondary school students carried out on the students studying in North-western Delhi schools, tested three null hypotheses with the use of data collected from research instruments. The instrument used in the study was Stress Inventory, designed and developed by Nagina (1990). The achievement of students was taken from the previously held exams. Results showed a significant relation between performance and stress. The difference was found on three stress 57 levels - low, moderate, and high. Learners with moderate stress had higher academic achievement than one with less stress. The study also disclosed gender had no mediation in stress and performance (Kumari 2012)[15].

Abukar and Adegboyega (2012) in their study, found age and gender as determinants of educational attainment among students of mathematics. There was a low positive relationship between gender and age in regards with performance at schools (Abukar 2012)[16].

Shekhar and Devi (2012) in their study of the influence of gender on academic achievement of college students, found that there was a remarkable difference in educational attainment of students studying arts and science subjects. The difference was

also found among male and female students. The difference showed that gender had a major role in the performance of arts and science students (Shekhar 2012)[17].

Mittal (2008) A sample of 640 secondary school students were used in his study, Academic achievement of secondary level pupils in connection to their mental health and area. He discovered that students from various areas had very varying educational levels. The students residing in urban area were better in performance in comparison with one of rural areas. Further, he found that the students of urban areas had better learn atmosphere at home apart from the school 56 than the rural students. He found a remarkable correlation between academic achievement and mental health of students (Mittal 2008)[18].

Edward and Allen (2008) in their study titled as Value Clarification, Used as Intervention for Urban, Delinquent, Pregnant Adolescents, and Young Mothers, framed a questionnaire to map the changes in social views, attitudes, and desired behaviors that could disclose personal values. Their team of social workers stayed at the school for pregnant, young mothers, and delinquent adolescents. They found that the participants built several values including the permission for alcoholic beverages, appreciation of family usage of illicit drugs, future planning, honesty, and permission for violence (Edward 2008)[19].

Babu et al. (2008) in their study named as A Study on Higher Secondary Students Achievement in Accountancy and their Parental Encouragement, explained whether any remarkable difference in gender, locality and family was or not in students of secondary schools. Major findings of the study were; remarkable low relationship between performance and parental encouragement in terms of subject like accountancy (Babu 2008)[20].

Suneetha et al. (2001) Researchers concluded that gender was a more important factor than IQ in predicting performance in their study, A Study on Age and Gender Differences on the Factors Affecting High Academic Achievement. Female students were on the top, had better concentration and interaction than boys. Male students were better than female students in reasoning, drilling dimension, and reasoning (Suneetha 2001)[21].

2.3 DISCUSSION

The results of the review of literature on teaching with model give a clear idea that there are a few researches conducted in the area of teaching with model in mathematics. The reviewed studies include experimental research and survey studies etc., most of the studies are experimental nature. The review of literature revealed that the jurisprudential inquiry model of teaching social science benefitting than the traditional way of teaching social science. Some of the studies are suggested that jurisprudential inquiry model of teaching would be better choice to enhance academic achievement in social science among secondary school students.

Majority of the studies were conducted effectiveness of jurisprudential inquiry model of teaching on languages, biology, ecology, law etc. So, for there is no studies on Model Teaching Program to achieve Practical and Visual Development of Mathematics, value preferences and academic achievement in Mathematics. So, the researcher wanted to conduct the study on this topic. The study of review of related literature provided an insight into the variables as mentioned. It is helped the researcher to found research gaps identified from the review. The present study aims to find the effectiveness of Model Teaching Program to achieve Practical and Visual Development of Mathematics among students in Secondary Education. Study of review of literature gave depth of knowledge about research questions, defining the variables, selecting the statistical method, design of the study.

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Chapter – 03

Planning and Program Development

CHAPTER - 3

PLANNING AND PROGRAM DEVELOPMENT

3.1 INTRODUCTION

When designing a arithmetic educational program that supports the ideal environment for all graduates to maximise their analytical education, scholars allow for possibility a assortment of tests. In order to build effective and all-embracing arithmetic programs, school administrators and instructors bear allow for possibility the main plans and approaches emphasize in this place section. The division named "Considerations for Program Planning" holds further news and offers recommendation that is to say having to do with all curricula (Fink 2011)[1].

There are many definitions of the term "educational program" that have happened projected by miscellaneous educators. Curriculum is delimited as "all the knowledge or educational programmes anticipated scholars under the protections of the school" in individual of these by Okunrotifa in Longe (1984). This writing of educational program states that it involves academic course contributions, programmes of activities containing unfaithful and interior projects, and course growth. (Festus 2015). Planning these knowledge experiences accompanying the goal of provoking few derivative changes in the pupils is unspoken by syllabus growth, as is judging the strength at which point these changes have happen. One concedes possibility perhaps form the case that educational program development is just individual type of correct proposed at changeful the instructional arrangement in this place situation (Romiszowski 2016)[2]. The achievement of instruction's final purpose, the complete happening of the junior, depends exceptionally on a receptive syllabus. In terms of new instruction, the educational program at the school is containing all the knowledge that a undergraduate has while being led for one institution. In addition, the current description of educational program covers the study plan, the procedure of command secondhand in each course, the school's counseling program, and the unfaithful activities programme (Offorma 2016)[3]. The type of the organization, the figure of the trainee, and the type of the subject must be overthrown by an enemy into concern while determining on the curriculum's content and the methods used to educate it. According to Hosford in Badmus (2002), a syllabus is an

accumulation of happenings devised to influence pupils to support an organisation's objectives. When we discuss arranging, we're speaking about two together schools and the many differing frameworks in which courses maybe presented. Both folk and mammals are learners. Animals discover, and they accompany schools. Consider a dog type of educational institution.

According to Hosford in Badmus (2002), consensus on the crucial components of the assignment is a part of the curriculum planning and development process.

1. Statement of goals and purpose
2. Selection of content
3. Organisation of learning opportunities, and choice of sequencing
4. Materials and facility selection
5. Evaluations. (i.e., purpose, content, sequences, materials and evaluation)

Festus (2015) claims that curriculum development design is a step in a larger process of curriculum renewal. "A set of intentions about opportunities for engagement of people to be educated with other people and with things (all bearers of information, processes, techniques and values) in certain arrangements of time and space" is what a curriculum is, according to Wikipedia.

- The history of organised knowledge,
- Modes of mind
- A planned learning environment
- Cognitive and emotional content and processes
- An instructional plan
- Instructional and/or end results

The other elements of experiential learning include a technical manufacturing system. To the contrary, Saylor, Alexander, and Lewis (Akangbou1984)[4] view the curriculum as consisting of "the subjects and subject matter therein to be taught by teachers and learned by students." Planning was defined by Anderson and Bowman, who were cited by Akangbou, as "a process of preparing a set of decisions for actions in the future." The compilation of a set of decisions regarding the subject and subject matter that teachers are to teach individuals who will be educated in the future is thus the focus of curriculum planning. (Akangbou 1984)[4]. The curriculum plan must go through specific phases in this regard. According to Lewy, who was mentioned in Akangbou (1984), these are:

(a) The readiness of the summary of the matters which are essentially distinctly explain of the theme;

(b) The result of teaching materials; and

(c) The exercise of the syllabus in bureaucracy.

3.1.1 Instructional Approaches in Mathematics

All offspring concede possibility receive arithmetic education that helps bureaucracy develop the news, skills, and psychology necessary to meet curriculum necessities and touch hold and participate in arithmetic education for age to come (Resnick 1998)[5]. Reliable arithmetic Knowing the kids' names and sketches, bearing high anticipations for and of all pupils, and trusting that all pupils can learn and manage arithmetic are the first steps in instruction. (Conley 2007)[6]. It creates use of diversified education event and with regard to the welfare of mankind appropriate and responsive practices to pamper the education weaknesses and needs of each individual student. It emphasises the bettering of ideas, logical, procedural fluency, ability incident, and abstract comprehension. (Moses 1989)[7]. All pupils feel esteemed, authorized, busy, and free to take chances and approach the study of mathematics optimistically because it takes place in a secure, bright, and inclusive education atmosphere. In order to instigate and engage undergraduates intentionally and to implant positive insane practices, to a degree interest and open-mindedness, a readiness to anticipate, to question, to challenge and be disputed, and an awareness of the advantage of hearing closely, reading helpfully, and corresponding accompanying clarity, information that is to say graduate-centered what

builds on juniors' substances is productive. All students' lived knowledge concede possibility be the stimulus for learning, and genuine (Moses 1989)[7], authentic-realm situations endure be used to help scholars discover the essential mathematical plans and abilities in addition to appreciate the advantage and extent of arithmetic. Students can utilise numerical reasoning to form links in their regularly lives thanks to this system.

3.1.2 High-Impact Practices

- Teachers are informed about latest trends by virtue of what important it is to identify accompanying the names and sketches of each undergraduate and to select the teaching approaches that will best advance juniors' education. Teachers pick and implement a variety of approachable, impartial extreme-impact teaching practices, and their designs vary contingent upon the education aims and the necessities of the juniors (Hollingsworth 1989)[8]. Effective math command must contain the deliberate request of these high-impact teaching game plans, containing aware when to use bureaucracy and how they may be linked to best advance the capability of sure math aims. According to research, the following practices usually have a meaningful affect how arithmetic is instructed and well-informed (Hong 2012)[9]:

- Learning Goals, Success Criteria, and Descriptive Feedback. The purpose of knowledge aims and success tests search out guarantee that educators and scholars have a clear and shared information of what is being well-informed and what profit looks like. They more explain the goal for the gathering and by virtue of what this goal will be achieved. Giving pupils the specific facts, they demand so that pull off the focus learning aim is one the custom of explanatory feedback. By engaging this method, all added methods enhance more efficient (Robertson 2009)[10].

- Direct Instruction. This is a brief, deliberate pattern of instruction that starts accompanying additional knowledge objective. It is not a speech or a manifestation. Direct command, in another way, engages inquiry, ventures, or brief shows to lead knowledge, check for information, and purify concepts. It is a means that is to say fully contemplate and closely targeted. The knowledge process is prioritised by direct information, that emphasises response and formative evaluation during the whole of (Klahr 2004)[11].

- Problem-Solving Tasks and Experiences. Using a issue that has happened correctly selected apiece instructor or graduates to present, describe, or apply an idea or ability is a profitable practice (Biggs 1991)[12]. Students have the chance to show their instrumentality through this practice by representing, pertaining, and upholding their plans. In order to emphasise key plans, help understanding, do away with useless methods, and advance education, undergraduates converse with one another, reason between themselves, and supply plans that the coach connects (Hmelo 2004)[13].

- Teaching about Problem Solving. Making clear the detracting thinking that question answering necessitates through education scholars the logical process. It includes instructing pupils on which is known and what is mysterious in addition to in what way or manner to equate and contrast miscellaneous types of positions. Using representations to model the issue-answering synopsis is a key component of education question resolving. This method of question resolving advances the need for steadfastness and the understanding that education can ultimately advance through making mistakes.

- Tools and Representations. At all grade levels, abstract understanding of arithmetic is by means of the use of a difference of appropriate tools and likenesses. Math fields maybe implicit by a sort of learners when representations and forms, to a degree manipulative, are prudently preferred and used. Teachers can more gain insight into their scholars' thinking and knowledge through their interplays accompanying likenesses and tools.

- Math Conversations. All juniors have various chances to take part in significant concerning manipulation of numbers discourse by listening to and answering to the plans of possible choice all the while persuasive math discourses. As undergraduates expand their analytical understanding, assurance, and sense of self, these talks include reasoning, trying, construction on the think of possible choice, maintaining and supporting their own thinking, and changing their views.

- Small-Group Instruction. Small-group command is an active pattern for advancing graduate education because it supports analytical instruction namely appropriate, point or direct at a goal, and tailor-made to the necessities of individual juniors. Teachers can personalise learning by occupied accompanying narrow, flexible

groups, either they are homogeneous or miscellaneous, so that stop break from making, close break that already endure, or longer thinking. As an establishment for their arithmetic education, teachers can engage limited-group command to help bureaucracy accept more about the identities, occurrences, and societies of their pupils.

- Deliberate Practice. Practice is more direct when it is projected and open over time. It must continually come to pass understanding. This guarantees unending, trustworthy, and pertinent response, allowing pupils experience they are practicing suitably. A profitable mathematics programme must combine practice.

- Flexible Groupings. A rich mathematical learning environment can be created by purposefully combining large-group, small-group, paired, and autonomous working arrangements in response to student and class learning demands. Students can work independently of the teacher but with the support of their colleagues when flexible groupings are created in a mathematics class. This improves teamwork and communication skills. It is crucial that each student is responsible for and takes responsibility of their learning, regardless of the size of the group.

  Even while one of these high-impact practices might be the focus of a class, other practices will unavoidably also be used. There isn't a single technique that works best for teaching, and the techniques are rarely utilised separately. In order to provide every student with the best learning opportunity possible, teachers select the appropriate practice for the appropriate time. In order to decide which high-impact instructional approach, or combination of practices, best serves the students, educators use their knowledge of the students, a thorough understanding of the curriculum and the mathematics that underpins the goals, and a number of evaluation strategies. Throughout a lesson, choices are made on a regular basis. The effective application of high-impact practices is crucial for promoting student learning.

3.2 RESEARCH METHOD

Every research has its own method. Selection of appropriate method in context to the problem is essential. Borg, Gall and Borg divided the research methods into three categories.

1. Historical Research Method.

2. Descriptive Research Method

3. Experimental Research Method

If the study pertains to past, if some monuments are to be studied or some historical past events are to be studied then Historical Research Method is used (Roediger 2008)[14]. In researches were in present is studied and certain conclusions about present status are made Descriptive Research Method is used. While in researches where in some conditions are altered in present to find that what would be its results it is an experimental research. In this method some variables are introduced and under certain controlled conditions its effect is studied. These effects can be used in future to improvise certain conditions. In the present study the effectiveness of Concept Attainment Model of Instruction is to be checked in reference to achievement among learners with different achievement levels, so It employed experimental research methodology. According to Best (1963), experimentation is the traditional method used in a mathematics laboratory since it allows for the manipulation of the elements and the control of the consequences that are seen. It is the most advanced, rigorous, and potent technique for finding and creating a structured body of information. (Gorman 2005)[15].

3.2.1 Selection of Experimental

Design There are various types of designs available. It is important to select appropriate method. Dave (1994) says Experimental method is a scientific pre decided tool to test the hypothesis and collecting data. According to Shah (2004) experimental design is blue print prepared to evaluate hypotheses that are made for developing relations between independent and dependent variables. There are mainly three types of experimental designs which can be classified as follows:

1. Pre-Experimental Design.

Pre experimental designs are very less effective as they have minimal control. No control group is present in such designs. There is no method for equalizing groups.

2. True Experimental Design.

These designs are mostly used in scientific laboratory study. Randomization is used for equalizing groups. These types of designs have equalized groups.

3. Quasi Experimental design.

Quasi experimental design provides a less degree of control. Randomization is not possible. This design is mostly used in educational experiment. The investigator used Quasi-experimental design. The investigator used 'Three groups only posttest design'.

The logical thinking of this study provides strong basis for it.

1. This design is according to the objectives/process of experiment of the study.
2. This is the best design when randomization of subjects is not possible.
3. Number of subjects in the groups is unequal.
4. This method has internal and external validity.

3.3 THE ROLE OF INFORMATION AND COMMUNICATION TECHNOLOGY IN MATHEMATICS

- An equalized arithmetic programme includes the contemplative request of electronics, that was taken into concern when expanding the arithmetic educational program. To promote all juniors' education in arithmetic, technology can supplement and extend coaches' existent education methods. Technology can help and boost the progress of analytical thinking, problem resolving, and ideas when utilised tenderly (Zakaria 2016; Temur 2020)[16,17]. Teachers allow for possibility the concerns of student security, solitude, righteous trustworthiness, fairness and addition, and prosperity while utilising electronics to support the teaching and education of arithmetic. An all-encompassing understanding of the following should for the strategic use of electronics to promote the fulfilment of the educational program's beliefs:

- The mathematical ideas being covered
- High-impact teaching strategies that can be applied as necessary to meet the learning objectives
- The ability of the selected technology to support learning, as well as how to use it.

- Technology maybe used to support the practice of arithmetic usually (e.g., mathematical finishes, computing finishes, calculators, dossier gathering programmes), or to form news more approachable and enhance communication and collaboration. (Such as, cooperative documents and netting-located content that enable scholars to buy and sell masters and added graduates, near or far) (Kiru 2018; Mendoza 2018)[18,19]. Technology can help English sound learners attain to analytical agreements and techniques secondhand in their native language. In order to guarantee that all juniors accompanying special education needs have approach to the educational program and are backed in their education, useful technologies must ought handy similarly each graduate's Individual Education Plan (IEP). Teachers are informed about latest trends the value of electronics and in what way or manner possibly used to help instruction and guarantee that all juniors are smart to meet the necessities of the arithmetic educational program. The subsection of considerations for Program Planning named "The Role of Information and Communications Technology" holds more facts.

3.4 PLANNING MATHEMATICS PROGRAMS FOR STUDENTS WITH SPECIAL EDUCATION NEEDS

The basic instructors of scholars accompanying education for those with special needs are hall educators. They are accountable for helping all kids in their knowledge, and when essential, they participate accompanying education for those with special needs scholar's commotion this. Teachers in the hall promise to help each undergraduate prepare for liberated living to the greatest extent attainable. The planning for teenagers accompanying special education needs portion of considerations for program planning

holds more facts on fitting for and judging youth accompanying education for those with special needs.

3.4.1 Principles for Supporting Students with Special Education Needs

- In order to correctly assemble and teach arithmetic communication to teenagers with education for those with special needs while together enhancing different students, supervisors concede possibility accept the following principles:
    - The gain of pupils in arithmetic is greatly affected by their scholars.
    - It's critical for educators to gain an inexact understanding of how arithmetic is well-informed by kids.
- The education expectations illustrate pertain and basic essential concepts and abilities in arithmetic that are developmentally appropriate for all of the ropes.
    - The relationship betwixt procedural understanding and abstract understanding of mathematics is important.
    - Using real finishes and representations is owned by learning arithmetic as a whole grade because it gives supervisors a habit to ideas both ideas and undergraduate understanding.
- The process of education and learning contains perpetual amount. The opportunity for scholars accompanying education for those with special needs to exhibit their knowledge and thinking in various habits endure should available to bureaucracy on a normal footing. With the concepts of Universal Design for Learning in mind, an active arithmetic education surroundings and programme that meets the mathematical knowledge needs of scholars accompanying special education needs involves the following elements:
    - appreciate of the undergraduate's areas of substance, adorations, and needs in order to change information and determine the necessary rooms and modifications as depicted in the IEP;

- promoting the student's confidence and good self-countenance as a mathematics beginner;
- regarding the beginner's past knowledge and making networks middle from two points what the student earlier sees and what the scholar needs to learn;
- emphasising the connections betwixt abstract numerical notions;
- conceiving rich and charming learning backgrounds by pertaining arithmetic to common, current, and appropriate issues;
- advancing a favourable outlook towards arithmetic and a possession of arithmetic using an assortment of forms, such as utilizing functional science and carrying out evident-planet tasks; achieving research-informed teaching approaches (like, Concrete – Semi-Concrete – Representational – Abstract) when introducing new ideas to advance abstract understanding, procedural accuracy, and eloquence;
- attaining a balance between individual knowledge, education stubborn groupings, and explicit direction. While restrain mind that few children ability need more orderly and extensive counseling, more specific and direct command before participating in free education, each mode of education endure happen in a safe, auxiliary, and exciting scene;
- implementing the material, appraisal, and instructional modifications defined in the scholar's IEP in consideration of maximise learning (for instance, making manipulatives, money, adapted game pieces, bulky tangrams, and calculators possible; guaranteeing access to functional electronics);
- constituting a welcoming knowledge surroundings where scholars accompanying education for those with special needs are encouraged to affiliate with organization an assortment of math-connected class projects and ventures;

- generating partnerships accompanying administrators and added educators, especially education for those with special needs supervisors, where feasible, to share knowledge and information of the curriculum anticipations (Campbell 2007)[20]; co-expanding content in the IEP that is particular to arithmetic; and accurately achieving intervention blueprints, as unavoidable, while creating significant networks 'tween school and home to ensure that what the undergraduate is education in the school is kept at home (Garrison 1999)[21].

3.5 HUMAN RIGHTS, EQUITY, AND INCLUSIVE EDUCATION IN MATHEMATICS

According to research, few scholar groups still encounter structural barriers to examining arithmetic. Inequitable consequences, to a degree continuous underachievement and depressed confidence in arithmetic, maybe the result of fundamental impediments. For all juniors to gain in arithmetic, educators must be aware of these hurdles and in what way or manner the power overlap and communicate, amplifying their impact. Teachers confirm that pupils have access to advancement support when wanted, and they consume the diverse enlightening information, knowledge, and skills that all junior causes to their study of mathematics. The freedom for all undergraduates to discover is maximised when educators design differentiated, with regard to the welfare of mankind appropriate, and sensitive pedagogical practices and set extreme and appropriate anticipations for undergraduates. They also demonstrate the environments unavoidable to guarantee that students have a beneficial correspondence as arithmetic learners and can succeed in arithmetic as well additional subjects.

Recognizing that graduates produce a resource of mathematical information, facts, occurrences, and skills to the school room—often in vocabularies apart from the language of instruction—it is important to evolve practices that gain and build on undergraduates' educational abilities and linguistic possessions. By binding arithmetic education to scholars' societies and everyday lives, respecting and utilising their forethought, occurrences, substances, and interests, and actively trying and eliminating the intrinsic barriers that few scholars face, educators promote authentic arithmetic happenings. Students the one learns arithmetic in an undergraduate-focused environment

can link what they are education to actual-world positions and find aim in what they are education (Costley 2015)[22].

Additionally, cross-curricular learning and the education of civil rights can happen in mathematics classes. Teachers must stand by egalitarianism and addition for all children in addition to maintaining and advancing human rights so that support secure, inclusive, and charming knowledge atmospheres. Every student has the right to approach arithmetic excuse that enable bureaucracy to realize two together socially and academically, however their backdrop, similarity, or personal dowry. It is detracting to recognise undergraduates' various friendly identities and the habits at which point they interact accompanying the outside planet in some mathematics hall. It is the blame of educators to forge and support learning atmospheres that are thoughtful of and sensitive to the needs, cultures, and various growth occurrences of students, and to hold all of ruling class to extreme principles.

3.6 CULTURALLY RELEVANT AND RESPONSIVE PEDAGOGY IN MATHEMATICS

The linchpin of with regard to the welfare of mankind relevant and receptive education (CRRP) in arithmetic is rich, finest instruction and questions. Teachers that take part in the CRRP study their own identities and grant how they influence their education, their faith, and their prejudices. In order to promote the growth of an alive arithmetic study hall society, teachers endure more make inquiries the identities, identifications, and/or affiliations of their scholars and imagine their plans, questions, and interests (Leonard, 2010)[23].

Students actively take part in crafty much of the knowledge in arithmetic classrooms that use CRRP, giving ruling class analytical instrumentality and a stake in the outcomes. Students gain instrumentality, that stimulates them to care for their analytical knowledge and progress. Students can learn about remainder of something and common people habits mathematics is present comprehensively aspects of their atmosphere by education about diverse analytical figures from annals and from differing global frameworks (Ortiz, 2021)[24]. This is main for allowance students expand their sense of self.

Teachers that are with regard to the welfare of mankind knowledgeable and impressionable are aware that skilled are diversified approaches to expanding a solution. Students are unprotected to differing forms of information and are encouraged to inspect miscellaneous approaches to answering questions. As an illustration, an Indigenous teaching game plan places a devote effort to something holistic, practical knowledge, educator modeling, and the utilisation of charming, cooperative exercises. (Griner 2013). In order to advance a respect for and awareness of the differing and different habits of knowing that create our classrooms, schools, and the experience (Zeichner 1987)[25], professors change instruction and estimate hope. This admits all students to gain and in a group. Teachers grant permission collaborate accompanying Indigenous groups to co-educate when pertaining arithmetic to practical requests. Indigenous with regard to the welfare of mankind particular examples maybe deferentially organized by teachers as a habit to intentionally include Indigenous information into the mathematical syllabus. This avoids enlightening allocation while using instances that are with regard to the welfare of mankind particular.

3.7 THE PROCESSES OF PLANNING AND DEVELOPMENT OF CURRICULUM

The planning and development of a curriculum involves five stages of activity. These include setting the aim, carrying out technical operations (technology), applying it, putting it into practice, and evaluating it.

(1) Goal Determination (Aims and Objectives)

This task entails figuring out the overarching educational goals and outlining key goals. Politics should take into consideration the broad objectives of education. They are typically articulated in general terms in order to win the support of the vast majority of society. They serve as the foundation for decisions regarding the structure of school life and the content that should be taught there, but they do not in and of themselves make up or directly decide the day-to-day operations of school life. These political objectives include things like "increase the supply of high-level manpower," "develop a more complex thinking in children," and "make education a preparation for life." Governmental or legislative measures formally

state the goals of general education.

Three fundamental elements influence the choices made while deciding on curriculum objectives. They are the student, the community, and the topic. (discipline).

The demands, ideals, and other elements of society exert pressure on educational institutions. The social environment is constantly evolving. As a result, the curriculum designer should choose educational goals that take these modifications into account. When choosing a new course of study for the school, the curriculum planner's job is to consider the effects of societal changes. Since schools are required to teach fundamental skills, one change in society that must be taken into account is the employment pattern. Another change is the requirements brought on by the emergence of new health-related behaviours. ICT, HIV/AIDS education, and quantitative reasoning were all included to the mathematics curriculum for Basic Education in 2006.

the learner's requirements. This comprises the learner's traits and learning style. The employment and occupational demands of the learner should be taken into account while creating the curriculum, just as they would be in a society. This is so because the goal of education is to make students liveable and sociable.

Here, we take into account the natural world, philosophy, and specialised branches of study. The subject matter is constantly changing, much like society is. In this regard, the curriculum that will be developed must take into account the introduction of fresh ideas, relevant subject matter, modern topic frameworks, etc.

Typically, the major educational objectives (MEO) that are inherent in or that can be attained through their study needs to be defined when the educational programme is organised according to subject matter, with specific curricular materials prepared for each subject. The MEO outline general spheres of human behaviour and should initially be converted into more detailed instructions for creating educational resources.

For instance, the redesigned Nigerian National Mathematics Curriculum, which

spans nine years, aims to provide students with the opportunity to:

i. Develop the understanding and application of mathematics skills and concepts necessary to thrive in the constantly evolving technological world;

ii. Develop the crucial elements of problem solving, communication, reasoning, and connection within their study of mathematics;

iii. Develop the major ideas of mathematics while keeping in mind how the world has changed and is continuing to change since the first time; and

iv. Understand the major ideas of mathematics while keeping in mind how the world has changed since the first time.

- Although the aforementioned three factors are the ones that have the greatest direct impact on judgements about the objectives of the school curriculum, the curriculum planner must also take the nature of the educational system into account. This can be viewed as including the system's organisational components and overall educational goals.

- **General educational aims and objectives**

The National Policy on Education's general educational goals and objectives are derived from the nation's top priorities, which are the development of:

(**a**) Free and democratic society;

(**b**) A just egalitarian society;

(**c**) A great and dynamic society; and

(**d**) Al and full of bright opportunities for all citizens

- **The National educational goals are:**

(a) The inculcation of national consciousness and national unity;

(b) The inculcation of the type of values and attitudes for the survival; of the

individual and the Nigerian society;

(c) The training of the mind in the understanding of the word around; and

(d) The acquisition of appropriate skills and the development of mental, physical and social abilities and competencies as equipment for the individual to live in and contribute to the development of the society.

- **Organizational Features of the School system**

Here, we examine whether the educational system combines academics and vocational training. The course's structure and duration in years must also be taken into account. These would have an impact on the curriculum's goals.

(2) Technology (Selecting and organizing learner experience)

After confirming the broad instructional objectives, these expert planners start to change ruling class into particular educational program activities. The educational program crew would conceive the beginning draught of the teaching material expected utilised in the class previously resolutions were made concerning the aims of the course of study, the content, the education-education, and the syllabus. This contains creating communication plans for the scholars, letter the passage, assembling the demonstration fabrics, and more a necessity that knowledge occurrences link to goals;

Must be such that learners obtain satisfaction from carrying on the kind of behavior implied in the objectives;

(a) Must be within the range of possibility of the learners;

(b) Must be such that many of them relate to a particular objective; and

(c) Must be such that a learning experience could have several outcomes.

(3) Application (Try on)

In general, little concern is likely to the plan of combining or completing professional insight accompanying practical evidence for the task of fabrics

preparation. The request stage refers to "test" and rewriting by which instructional programmes would be tentatively proven before they are certified for use on a big base. Due to a lack of testing before maintenance, various educational programs have abandoned earlier. The approval of many of ruling class is established the emotional estimate of the instructional authorities. At this point, the educational program crew endure pay consolidation of effort to the teaching-knowledge process happening in the hall and use a difference of influential assessment finishes, in the way that exams and scholar work sheets. The stick concede possibility encourage instructors and juniors to consider some issues and challenges they have accompanying the programme. The programme concede possibility also reveal to miscellaneous types of masters the one will judge the content and point out some particular modifications that are necessary. A number of implications for attractive changes to the programme's original edition hopeful created established the consequences of two together the empirical test run and the masters' amounts.

(4) Implementation

An open usage of the curriculum across the entire educational system is referred to as implementation. The educational system would need to undergo a lot of modifications as a result. The provision of teaching-learning and in-service training for principals, teachers, and school supervisors is one of the activities.

Any curriculum's success hinges on having the necessary teaching resources available and having school administrators, instructors, and inspectors who are prepared. In Nigeria, numerous curricula have failed because of a lack of adherence to this implementation technique. In addition, it is necessary to keep an eye on how the curriculum is being used to ensure that its goals are being met. Every finding would need to be corrected.

(5) Evaluation

According to Tyler, the evaluation method primarily involves figuring out to what extent the curriculum and teaching programme is genuinely realising the educational objectives. In other words, the programme's objectives serve as both

the benchmark against which it is evaluated and the basis for the selection and arrangement of learning experiences. Tyler views evaluation as a process by which one achieves behavioural goals without deviating from initial expectations. Such a view of curriculum planning appeals to common sense, and it especially looks like a wonderfully prudent and useful way to gauge the effectiveness when reinforced by models from business and systems management.

3.8 MODELS FOR CURRICULUM DEVELOPMENT

Some of the Models for curriculum development are shown below:

3.8.1 Tyler's Model

Tylerin Badmus (2002) based his work on four fundamental questions:

1. What educational goals must the school to pursue?
2. What educational opportunities can be offered that are likely to accomplish this goal?
3. How can these educational opportunities be set up in an efficient manner? and
4. How can we tell if these goals have been accomplished?

Tyler did not seek to provide answers; instead, he contends that they will differ depending on the educational level, provides ways to research these ways, and diagrams his model as follows:

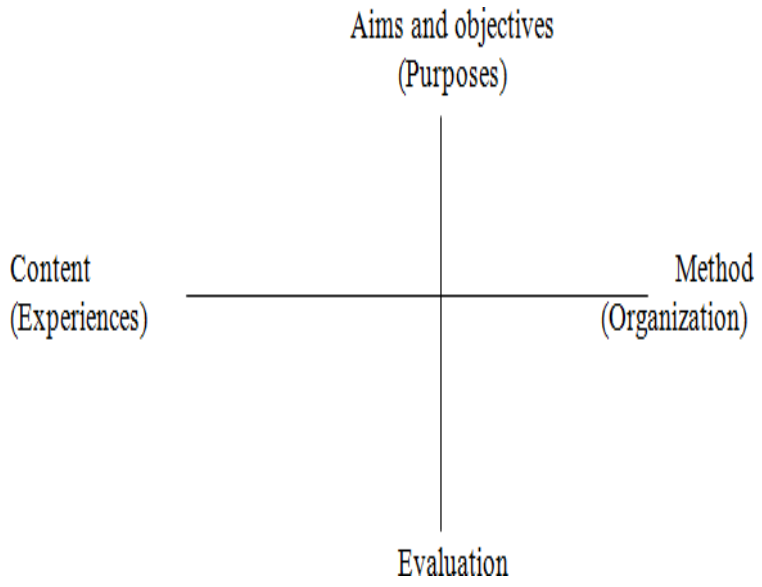

Fig. 3.1: Tyler's Model

3.8.2 Wheeler's Model

Some claim that the Tyler model is very simplistic and say that evaluation doesn't necessarily need to be a final step but rather should occur at each level instead. According to Wheeler in Badmus, Tyler's original concepts were transformed into a cyclic structure with five phases. (2002)

Wheeler's Model

3.8.3 Planning for Mathematics Instruction

When teachers make choices that ultimately affect students' learning chances, planning is a crucial but frequently overlooked component of teaching practice. The time teachers spend creating and planning activities for their students is frequently referred to as planning. Before students even reach the classroom, teachers need to think about a range of areas of their education, from assignments and activities to instructional practices used throughout sessions. Effective instructors are aware that designing lessons takes a lot of work, thus teachers need to pay close attention to how they are designing their lessons. Such a design is frequently referred to as planning, which many teachers consider to be a fundamental aspect of teaching.

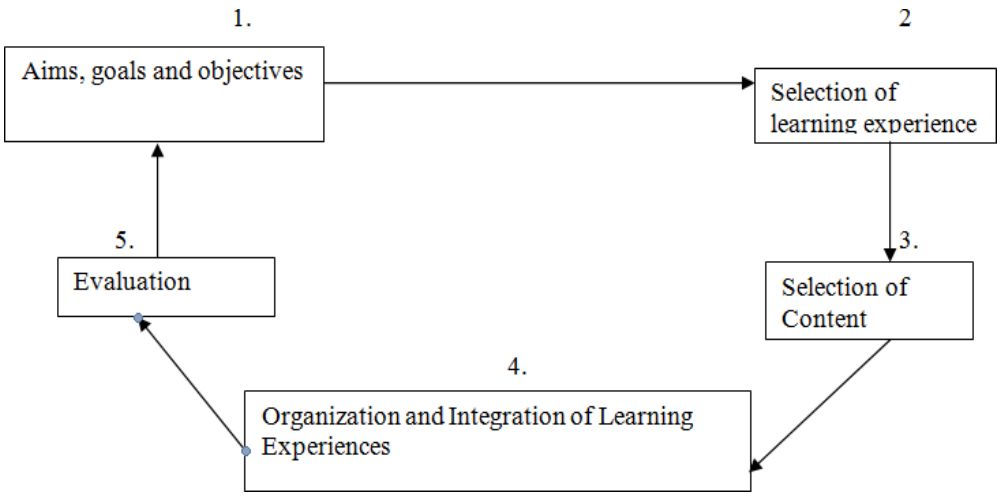

Fig. 3.2: Wheeler's Model

The many lesson components that instructors often take into account when planning their lessons were outlined in earlier studies on teacher planning, which established a linear or logical model of teacher planning. In accordance with this approach, teachers first think about the learning activities that take into account the interests and skills of the students, then the session's learning goals and objectives, and finally the evaluation techniques to be employed during the lesson. Later, several studies contended that linear models of teacher planning do not accurately capture the planning processes of experienced instructors and do not take into account the complexity of teaching mathematics. Instead, a number of additional elements, such as the experiences and ideas that teachers have about how mathematics been taught and learned, also have an impact on how teachers arrange their classes.

The level to which teachers use curricular materials when making planning decisions is not clearly shown by more recent research on teachers' planning. Even less study has been done specifically on teachers' planning in the context of reform mathematics curricula, which make up a large portion of teachers' instructional design. These reform curricula, which represent innovative forms of instruction, are becoming more common in American classrooms. Planning classes with such curricula may present some unique difficulties not present when utilising more traditional mathematical curriculum. Thus, if mathematics educators wish to comprehend this crucial stage of teaching, they must examine how teachers plan in the specific context of reform curriculum.

A Model of Teacher Planning: A model of teacher planning in the particular context of reform-oriented mathematics instruction must include a number of components. These components include the methods for teaching and learning mathematics that are incorporated into reform curriculum as well as the diverse experiences and concepts that instructors bring to their planning decisions. Particular attention must be paid to how these factors interact with one another and ultimately affect teachers' planning choices. Because it takes into account the influence of these various components, the idea of planning problems is well suited for creating a conceptualization of planning. The model created in this study makes extensive use of the concept of planning problems and emphasises the different factors that contribute to the development of such planning issues in instructors' daily practices.

As was previously mentioned, enabling and encouraging students' understanding in a way that won't limit their opportunities to learn or impair their thinking is a key component of reform-oriented mathematics instruction. As a result, teachers must prepare for doing this kind of job while teaching. In order to influence students' thinking about the material without providing them with too much information and to encourage them to articulate their ideas, teachers must prepare questions in advance. In order to encourage students' learning and discussion of these tactics in ways that foster a shared knowledge of the, teachers need to be prepared for the various solutions that students may propose as well as other ways of thinking about a task. Finally, teachers must be ready to alter or adapt a task in a way that maintains the complexity of the original assignment while still allowing students to benefit from working on it. Teachers need to carefully prepare their courses and predict how students will engage with the content during implementation in order to increase students' grasp of various mathematical topics, even when their intended plans frequently diverge from actual performed plans. Planning issues might be seen as the foreshadowing of teaching issues in this way. Every teacher has unique planning issues based on their experiences, conceptions, and beliefs, as well as the curriculum they are using. For teachers who see the use of such questions as enhancing student knowledge, for example, asking higher-order questions that force students to defend and explain their ideas is just a planning issue. For a teacher who adheres to a more standard idea of mathematics instruction, planning challenges can also be very

different. A teacher in this situation might need to figure out how to include opportunities for students to practice using particular skills and procedures within a curriculum the instructor feels is lacking. A teacher who has expertise implementing several curriculum programmes should also think about how to incorporate what they are aware of from other mathematical curricula into their planning for a particular Standards-based curriculum.

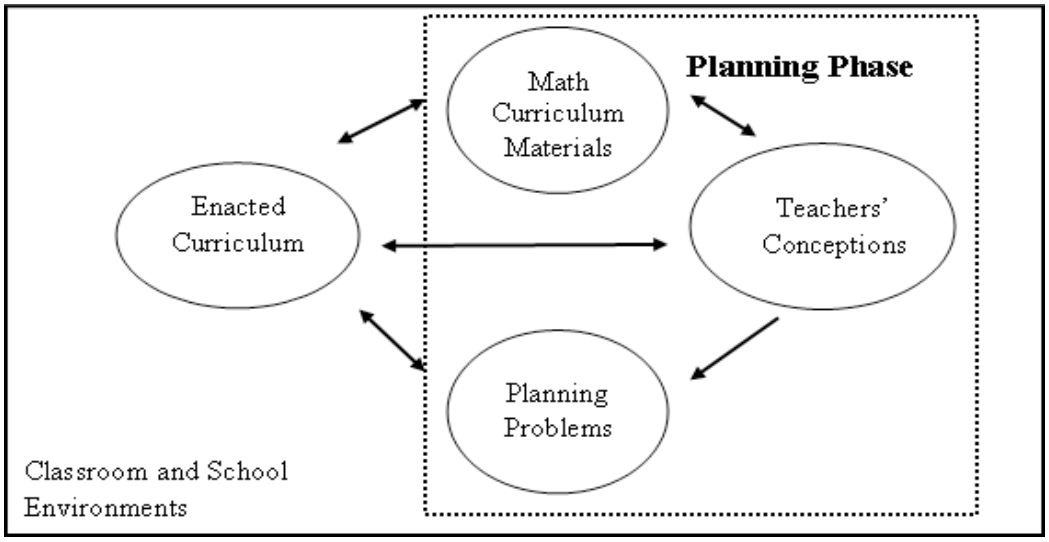

Fig. 3.3: Planning for Mathematics Instruction Model

Teachers' diverse conceptions serve as a resource for handling planning challenges that arise throughout their planning, just as their conceptions aid to frame the planning problems they experience. Teachers make options about how to handle these various planning challenges when they are presented with them based on their prior experiences with the work and their conceptions of what it means to learn and teach mathematics. Teachers sometimes also make use of the data and assistance found in the actual mathematics curriculum materials.

Notably, the CMP teacher guide gives teachers the tools they need to deal with specific planning issues, like anticipating the kinds of solutions students can come up with, questions to pose to them, and mistakes and misunderstandings they might have in relation to a job. However, how much teachers rely on curriculum materials to guide their planning choices is greatly influenced by how they view the curriculum.

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Chapter – 04

Experimental Design and Execution of MTP

CHAPTER - 4

EXPERIMENTAL DESIGN AND EXECUTION OF MTP

4.1 INTRODUCTION

For many years, behavioural psychology supplied the predominant paradigm of learning and, as a result, the direction for instruction. This was based on the notion that effective learning required creating a mental replica of the material being taught. It was a persuasive model for the learning of skills in situations where a thorough grasp of transfer to other contexts wasn't actually required, such as in the normal use of a piece of equipment (Rayner 2001)[1]. However, it was unable to explain the wide range of results from traditional classroom instruction, where it is necessary for students to have a context-transferable understanding of prevailing knowledge, but this understanding is not always reached and frequently results in students picking up "misconceptions." In recent decades, both official and informal educational systems have come to increasingly rely on the collection of psychological theories known as "constructivist." It is assumed that prior knowledge serves as a barrier to, a crucial filter for, and a basis for assimilating new information. The two main forms of constructivism are the "personal" type, in which the centre of learning is the person acting alone, and the "social" variation, in which the locus of learning is believed to be interpersonal interactions (Subotnik 2001)[2].

The premise that thinking progresses for one intellect pursuing news as if it were a stream of "bodies"—that is to say, as if it had object-like properties—underlies all of the major hypotheses of education. By illustrating ideas, belongings, arrangements, occurrences, and processes as what maybe about refer to as "likenesses," these entities support exact facts about the theme substitute. (Gilbert 2010)[3]. Although likenesses are any of all thinking, they are specifically main in learning and, thus, in real wisdom instruction. Here, the main focus act planning indicators about the behaviour of open experiences that are situated real research and are established hypotheses about the individuals they are collected of and the fresh means working in ruling class. The type of these likenesses, their use in erudition education, and the consequences of their use for wisdom educational program design and demand are the issues concerning this study (Linell 1988)[4].

4.2 MODELLING, MODELSAND VISUALIZATION

The experienced universe is too complicated to fully comprehend at once. Science "cuts it up" into phenomena that are deemed significant and understandable. The phenomena of movement are typical. Then, simplified representations of a given example of movement are developed in an effort to illustrate its characteristics, its constituent parts, and how those parts explain the characteristics presented. (Gilbert 2010)[5]. This is the modelling process, and the results are models. For example, in the case of movement, Aristotle, Newton, and Einstein all constructed general models in chronological order. Representations are the ways in which we show the models that we have developed so that the person in question may understand what has been done and can communicate that with others.

There are two ontological types of visual representations. The first of these are internal representations, often known as mental images, which are a person's unique mental creations. The second of these is as visible external representations for others to examine. Unfortunately, both of these modalities are referred to as visualisation in the literature. I find it less confusing to reserve the term "visualization" for internal representation and to use the term "external representation" for that which individuals share (Russell 2003)[6].

People create three different forms of visualisations when learning anything, but notably when learning science (internal representations). The first of them is the macro type, which is based on Johnstone's theories and is illustrated in the study of chemistry. This shows the empirical characteristics of the phenomena that are of interest to chemists and that may be studied using the tools that are now available, including solid, liquid (including solution), colloid, gaseous, and aerosol phenomena. Thus, macro representations enable the creation of descriptive explanations, including the naming of phenomena, vocal output, and the development of measurements of their attributes that can be visually displayed (Gilbert 2009; Levy 2009)[7,8].

The second type is the sub-micro type, which shows the bonding inside and between those objects that are too small to be observed under an optical microscope (such as atoms, ions, molecules, and free radicals). These make it possible to create interpretive

and causal explanations. That is, the causes of the attributes that are measured and what the model (and, of course, the phenomenon) are thought to consist of (Gilbert 2014)[9].

The third of these is the symbolic type, which uses symbols to represent sub-micro entities. These symbols include letters for elements, signs for electrical charges, subscripts for the number of atoms in a particular species, and subscripts for physical state. These symbols are then incorporated into chemical equations that are quantitatively balanced to represent macro phenomena and any chemical changes that occur within them. As stated in the definition, the symbolic style of representation allows for the production of quantitative explanations, i.e., those that display the numbers of entities involved (Gilbert 2014)[9].

Similar definitions for the categories of biology, physics, earth science, etc. can be established, whether they are three or more in number. At any moment in the historical history of a field of inquiry, a comprehensive comprehension of every occurrence that falls under the purview of a science requires the ability to create visualisations of these types and the ability to "move" mentally between them. This is a key objective of science education, as we will see, and it has been found to be a significant barrier for many pupils.

While it is possible to create visualisations that make no overt allusion to the outside world (this is an act of extreme or unique creativity), many visualisations start (in the way outlined by Paivio) with the perception of outside representations. The function, focus, and level of attention given to the stimulus will determine the relationship between an external representation and a visualisation (Richardson 2009)[10]. There will inevitably be considerable discrepancies between the final visualisation and an external representation. Similar to the generation of an external representation from a visualization, this process may involve modifications to what the person initially believed to be the original. The producer's assumptions of the target audience for the external representation and the desired response from that audience do appear to influence the character of the stated concepts. When considering anything new, we frequently compare it to an existing concept. Thus, the function of metaphor and analogy—concepts that are frequently confused—is essential to the existence of all visualisation (Boudry, 2020)[11].

4.3 MATHEMATICS MODEL

The first applications of mathematical models were in the many domains of science and engineering. It is also significant in fields like economics and social sciences. These models are most frequently used by those who operate in these fields. Mathematical models are used to simulate real-world scenarios. Typically, algebraic problems are used as the basis for these mathematical models. Models aid in the development of our logical and analytical thinking. Models are based on how mathematics is used in real-world situations in everyday life (Backhouse, 2010)[12].

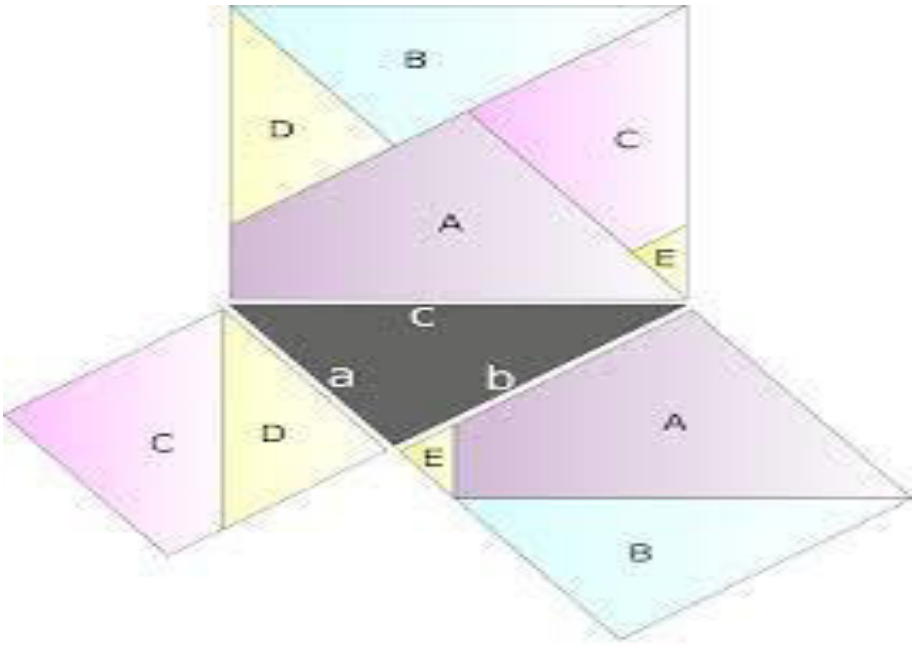

Fig. 4.1: Mathematics Model

Most schools hold exhibitions for various subjects where students can display their original projects and ideas in order to study the material in an engaging manner. Students create mathematical models for school exhibitions based on various mathematical concepts in the form of still models, such as the application of calculus and trigonometry in daily life. The mathematical model that is still in use means that the figures are fixed in place while the topic is being explained.

4.4 MODEL TEACHING PROGRAM EXAMPLES

Example-1: Pythagoras Theorem Model: The Pythagorean Theorem is a very helpful formula for figuring out how long a right triangle's side should be. In the geometrical derivations and applications, this formula has numerous direct and indirect uses. The hypotenuse is the longest side in a triangle. By gazing across at the appropriate angle, we may quickly identify the longest side. Base and perpendicular, which form a 90-degree angle, will be the other two legs. To determine whether a side is base or perpendicular, there is no set rule. It is irrelevant in any way (Ungar 1999).

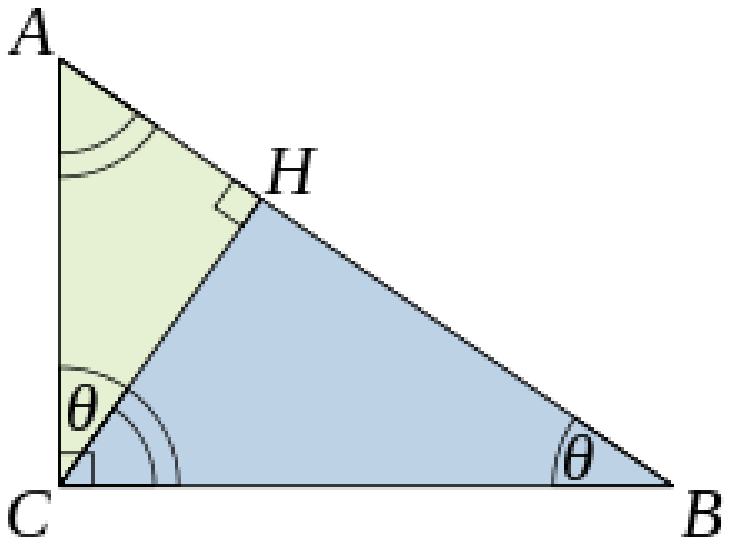

Fig. 4.2: Pythagoras Theorem Model

Example-2: Congruency of Triangles Model: The ranges of the edges and angles of two or more triangles decide either they are agreeable. A trio's amount and shape are determined by allure three parts and three angles, individually. If pairing of matching parts and equivalent angles are equal, two triangles are pronounced expected agreeable. They are the exact alike capacity and form. Triangles can assuage a wide difference of agreement necessities. Let's discuss ruling class exhaustive. (Sadiki 2016).

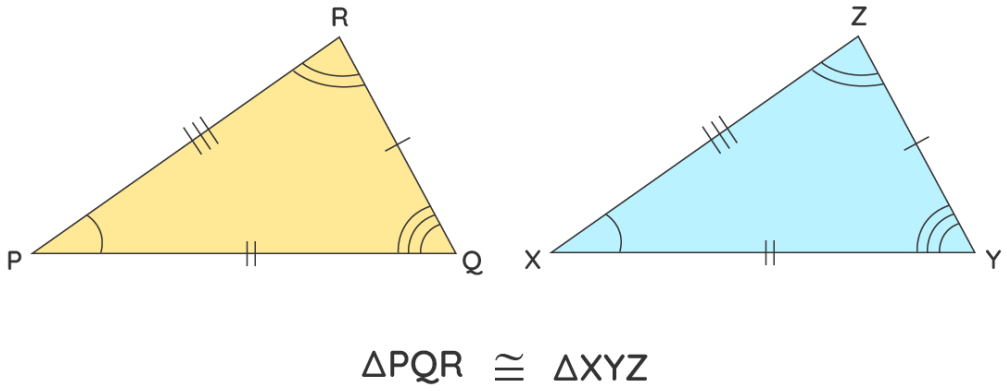

Fig. 4.3: Congruency of Triangles Model

Example-3: Circumcenter of different types of triangles Model: The crossroads of the standing bisectors of a trio's edges is popular as the circumcenter of that particular trio. In added conditions, the circumcenter is the point at that the bisector of a trio's hands coincides. P means it. (X, Y). The circumcenter, that maybe erect inside or outside the trio (Lal 1998)[13], is again the centre of the trio's circumcircle.

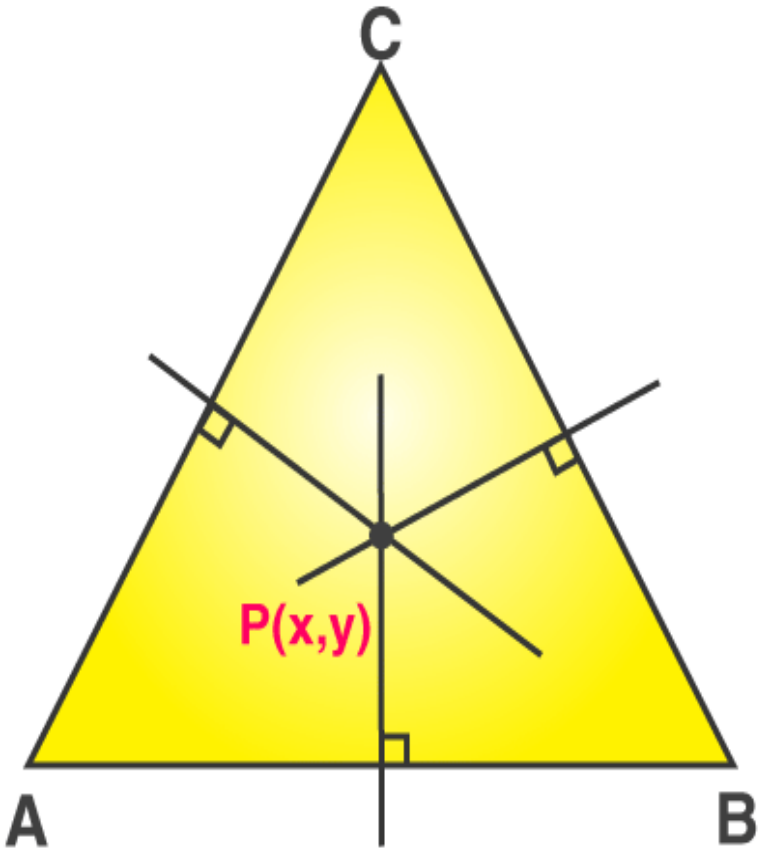

Fig. 4.4: Circumcenter of different types of triangles Model

Example-4: Venn Diagram of sets Model: Venn drawings are the drawings used to visually define sets, connections 'tween sets, and operations completed activity on ruling class. John Venn (1834–1883) fictitious the Venn drawing, which create use of circles (coinciding, converging, and non–intersecting) to show the connection betwixt sets. A Venn drawing can also be referring to as a set drawing or a rationale diagram that decorates miscellaneous set movements containing the intersection, merger, and dissimilarity of sets. Subsets of a set are more represented utilizing it (Qiu 2022)[14].

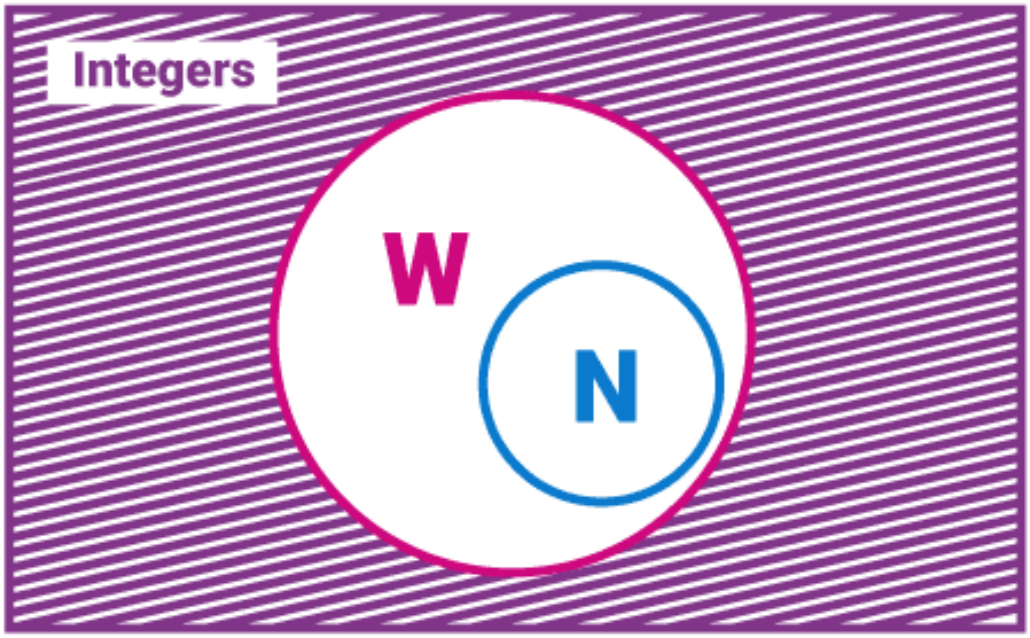

Fig. 4.5: Venn Diagram of sets Model

Example-5: Representation of Circles: Tangents, a circle's radius, a secant, a chord, and a sector: A secant line is a straight line that passes through two points on a circle. The section of the line that connects two separate circle points is known as a chord. Every secant line defines a distinct chord, and each chord is in its own unique secant line. A line in geometry known as a secant is one that intersects any curve at least twice. Secant, derived from the Latin word secure, implies "to cut." A chord is the line segment described by these two locations, which is the interval on a secant whose endpoints are these two points, and a secant will touch the circle exactly twice while in a circle.

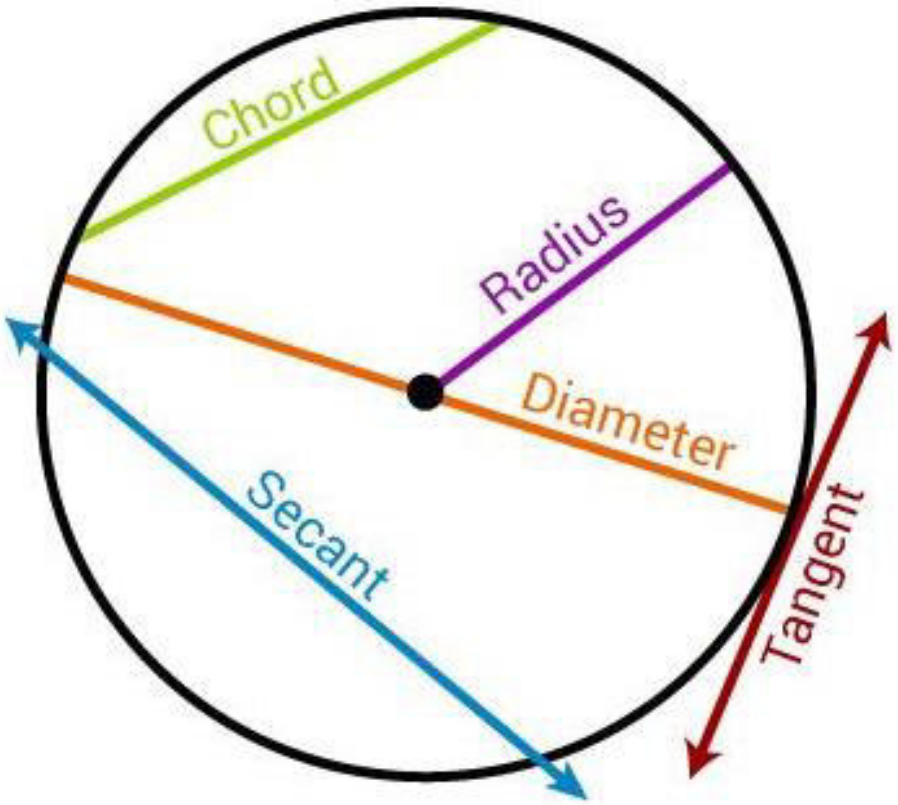

Fig. 4.6: Representation of Circles

Example-6: Comparison of areas of two similar triangles Model: Triangles accompanying the unchanging shape but different sizes are pronounced expected similar triangles. Squares accompanying some side time and all four-sided triangles are instances of related objects. In other words, if two triangles are complementary, their matching edges are proportionately equal and their equivalent angles are harmonious. Triangle resemblance is designated present for one symbol '~' (Doyle 2022)[15].

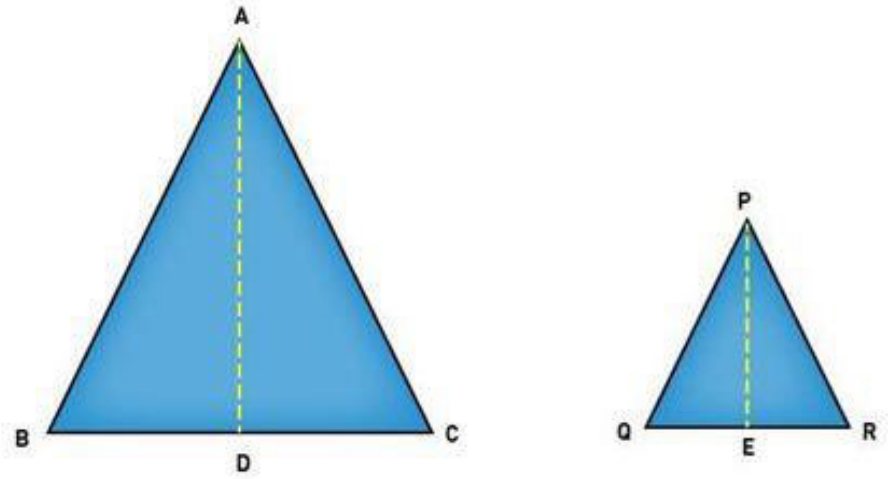

Fig. 4.7: Comparison of areas of two similar triangles Model

Example-7: Finding the angles with the help of trigonometric ratios Model: Trigonometric by definition, percentages are the principles of all concerning manipulation of numbers functions established the four-sided trio's side percentage. The concerning manipulation of numbers percentages of a likely severe angle are the percentages of the hands of a four-sided trio concerning that angle (Adler 1999)[16]. The three edges of the right trio are:

- Hypotenuse (the longest side)
- Perpendicular (opposite side to the angle)
- Base (Adjacent side to the angle)

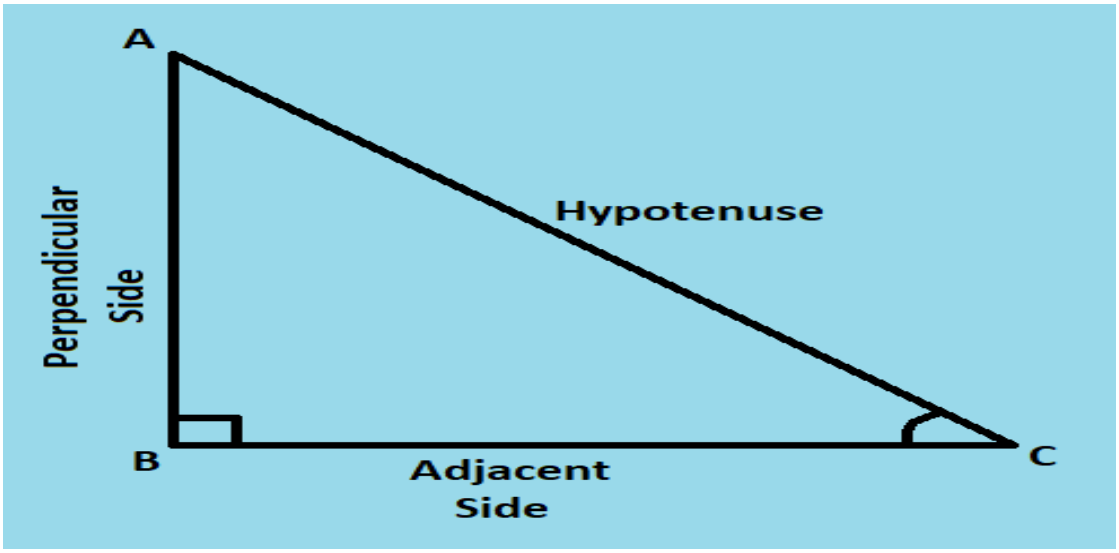

Fig. 4.8: Finding the angles with the help of trigonometric ratios Model

Example-8: Mean values of given data Model: The descriptive summary of a data set is known as the central tendency in statistics. Through the single value from the dataset, it reflects the center of the data distribution. Additionally, it only provides a summary of the dataset rather than information on specific data within the dataset. The central tendency of a dataset may typically be determined using several statistical measures (Kourti 2003)[17].

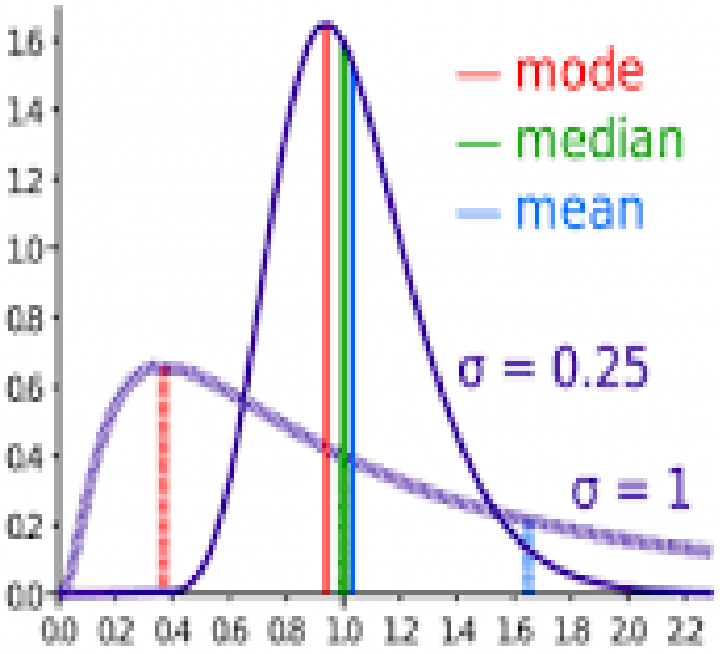

Fig. 4.9: Mean values of given data Model

Example-9: Probability of random experiments Model: Probability refers to potential. A chance occurrence's incident is the subject concerning this area of arithmetic. The range of the advantage is 0 to 1. To forecast by means of what likely occurrences search out happen, anticipation has been received in arithmetic (Liu 2005)[18]. The scope at which point entity is inclined occur is basically what expectation resources. You will comprehend the potential effects for a chance experiment utilizing this fundamental belief of probability, that is more used to the frequency distribution. Knowing the total number of consequences should before we can reckon the likelihood that a particular occurrence will happen. The seedling drawing form it smooth to organise and see all of the potential. The sapling's arms and ends are allure two basic points. On each arm is inscribed the probability, and situation of devastation hold the results finally. To decide when to increase and when to increase, use timber drawings. Below is a tree likeness of the coin:

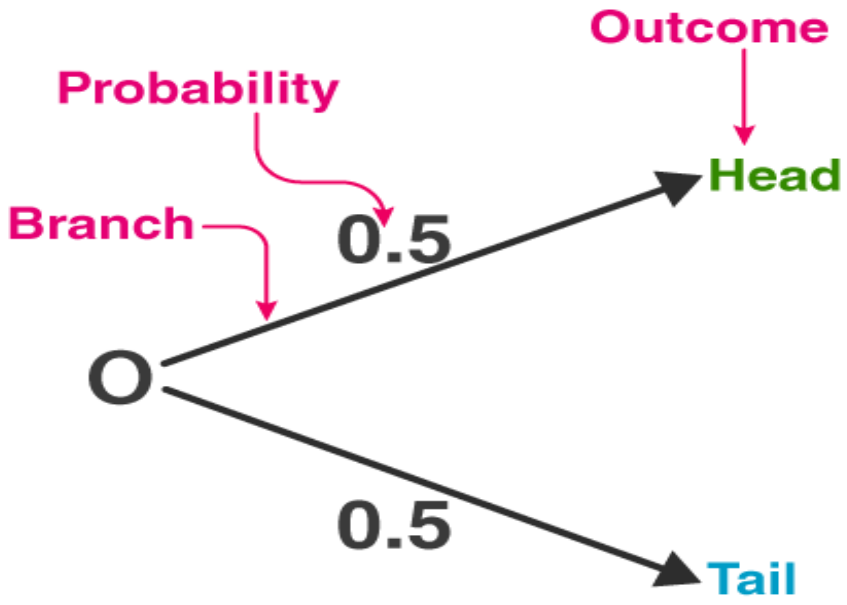

Fig. 4.10: Probability of random experiments Model

Example-10: Conic Sections Model: The term "conical" refers to a curve made apiece crossroads of a right circular circular-shaped object with pointed end accompanying a plane. In Euclidean arithmetic, it has different looks. The pyramid is split into two nappes, the above nappe and the lower nappe, at allure top.

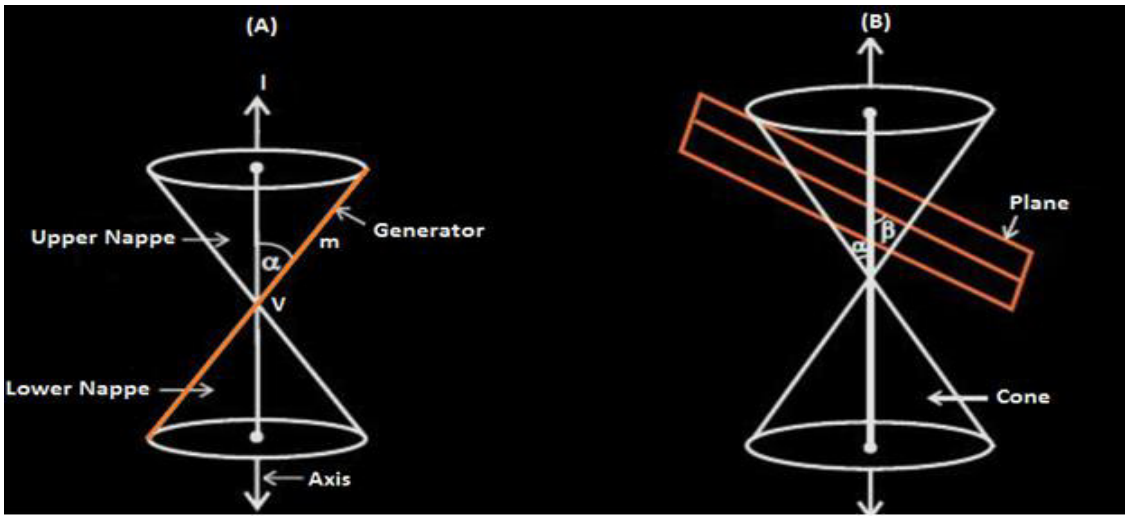

Fig. 4.11: Conic Sections Model

4.4.1 Visual Mathematics Models Made for Model Teaching Program:

Model 1: Construct a model to explain Pythagoras Theorem.

Materials Required: Card Board, Brown Sheet, Straws, Scissor, Pen, Ruler, Glue-stick and Beans.

Model Construction:

1. We mark Right Triangle Shape on a brown sheet with the help of pen and ruler.
2. Mark side **a = 3** units, side **b = 4** units and side **c = 5** units.
3. Now, we cut this shape with the help of scissor and paste it on Card Board.
4. Using straws, we construct **3x3**, **4x4** and **5x5** squares on sides **a, b** and **c** respectively.
5. Now, we put some beans in **a=3x3** unit square box, some beans in **b=4x4** unit square box.

Procedure:

1. When we move this card board upside down, all the beans from square box **a** and **b** flow downwards to square box **c**, which fills the whole square box **c**.

2. When we move some beans from square box **c** to square box **a**, which fills only square box **a** and **c** not square box **b**.

3. When we move some beans from square box **c** to square box **b**, which fills only square box **b** and **c** not square box **a**.

Results: It proves the Pythagoras Theorem-

1. $\mathbf{a^2 + b^2 = c^2}$

2. $\mathbf{b^2 = c^2 - a^2}$

3. $\mathbf{a^2 = c^2 - b^2}$

Learning Outcome: Students will understand that if we take a **right-angled triangle,** the square of the **hypotenuse side** is **equal** to the **sum of squares** of the **other two sides.**

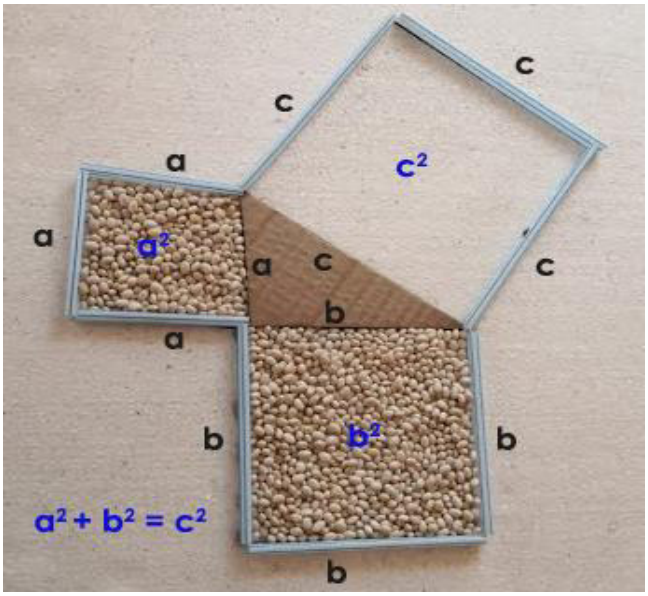

Fig. 4.12: Pythagoras Theorem Model

Model 2: Construct a Model to explain Decimal Place Value.

Materials Required: Black Card Board, Colorful Papers, A4 size papers, Scissor, Pen, Ruler, Glue-stick.

Model Construction:

1. We cut 6 vertical strips of A4 size paper.
2. We make 10 square boxes of 2x2 unit square size on each strip.
3. Write 0-9 vertically inside these boxes.
4. Now, we paste triangle on each strip. It makes us easy to move strips up and down.
5. Paste a Decimal Point on the mid of the Black Card Board.
6. Fix all the strips according the given figure given below with appropriate headings, as Ones,

   Tens, Hundreds on left side and Tenths, Hundredths, Thousandths on Right side of Decimal Point.

Procedure:

1. We take a Number to explain the working of this Model i.e., Number = 324.314.

2. Now, we move these strips to get 324.314 in the middle of the visible box.

Results: We can easily find the Place Value of each number-

On left side of Decimal Point-

1. **Ones = 4**

2. **Tens = 2**

3. **Hundreds = 3**

On right side of Decimal Point-

1. **Tenths = 3**

2. **Hundredths = 1**

3. **Thousandths = 4**

Learning Outcome: Students will understand and identify the Place Value of any Decimal Number and can visualize it.

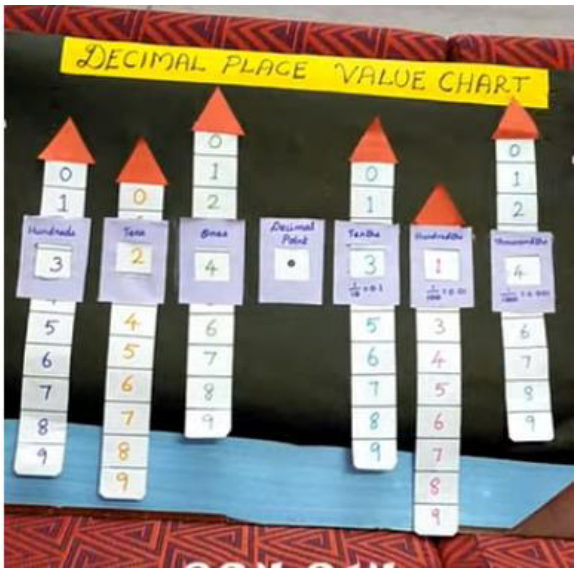

Fig. 4.13: Decimal Place Value Model

Model 3: Construct a Model to explain Algebraic Identity $(a + b)^2 = a^2 + b^2 + 2ab$.

Materials Required: Colorful Sheets, Black Marker, Pencil, Ruler, Scissor and Cello-Tape.

Model Construction:

1. Take red sheet and cut out a square of side with length **a = 10 cm**.
2. Now, take a blue sheet and cut out a square of side with length **b = 7 cm**.
3. Then further, we take an orange sheet and cut out a rectangle of **length = a unit (10 cm)** and **breadth = b unit (7 cm)**.

4. Take a green sheet and cut out a rectangle of **length = b unit (7 cm)** and **breadth = a unit (10 cm)**.

Procedure: We have four cut outs i.e., red square, blue square, orange rectangle and green rectangle.

1. The red square cut out have side (length and breadth) **a**. So, the area of a red square will be **side x side = a x a = a^2**.

2. The blue square cut out have side (length and breadth) **b**. So, the area of blue square will be **side x side =b x b = b^2**.

3. The orange rectangle cut out have sides (length and breadth) **a** and **b** respectively. So, the area of orange rectangle will be = **length x breadth = a x b = ab**.

4. The green rectangle cut out have sides (length and breadth) **b** and **a** respectively. So, the area of green rectangle will be = **length x breadth = b x a = ba = ab**.

Arrange and join the four cut outs using cello-tape and after arranging we calculate the area of big figure.

1. The length of this figure is **a + b**.

2. The breadth of this figure is also **a + b**.

Results: We will calculate all cut outs:

1. Area of red square **= a^2 = 10^2 = 100 sq. cm.**

2. Area of blue square **= b^2 = 7^2 = 49 sq. cm**.

3. Area of orange rectangle **= ab = 10 x 7 = 70 sq. cm**

4. Area of green rectangle **= ab = 10 x 7 = 70 sq. cm**

Total area of four cut outs *= Area of red square + Area of blue square + Area of orange rectangle + Area of green rectangle*

= a^2 + b^2 + ab + ab

$$= a^2 + b^2 + 2ab \text{ ---------- } (I)$$

We will calculate big figure

1. **Length = a + b = 10 + 7 = 17 cm**

2. **Breadth = a + b = 10 + 7 = 17 cm**

This shows that the big figure is a square.

So, Area of this square = **(a + b) x (a + b)**

$$= (a + b)^2 \text{ ---------- } (II)$$

Now, from ***(I)*** and ***(II)***, we get

$$(a + b)^2 = a^2 + b^2 + 2ab$$

Learning Outcome: Student will use this identity in solutions.

Therefore, Mathematical calculation using this identity,

$$(a + b)^2 = a^2 + b^2 + 2ab$$

$$(10 + 7)^2 = (100 + 49 + 70 + 70) \text{ sq. cm}$$

$$(17)^2 \text{ sq. cm} = (149 + 140) \text{ sq. cm}$$

$$289 \text{ sq. cm} = 289 \text{ sq. cm}$$

Similarly, students will also able to make some models of remaining identities like:

1. $(a - b)^2 = a^2 + b^2 - 2ab$

2. $(x + a)(x + b) = x^2 + (a + b)x + ab$

3. $(a^2 - b^2) = (a + b)(a - b)$

4. $(a + b)^3 = a^3 + b^3 + 3ab(a + b)$

5. $(a - b)^3 = a^3 - b^3 - 3ab(a - b)$

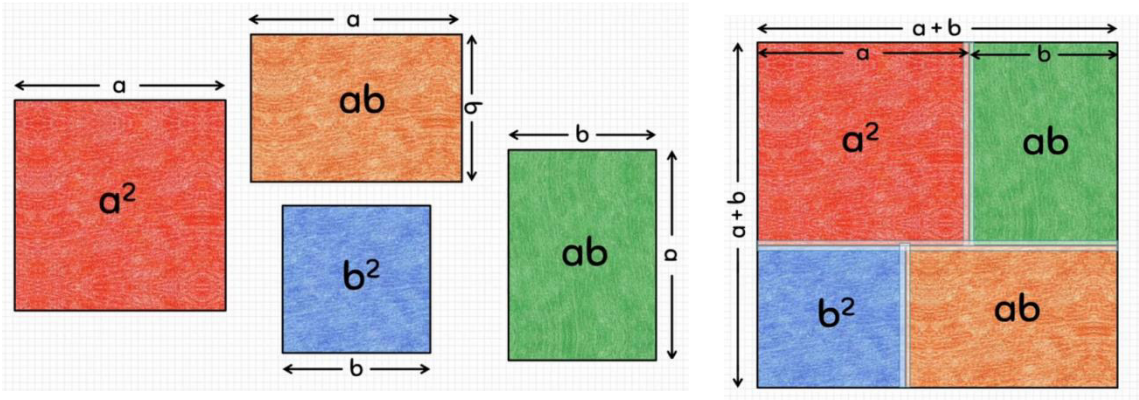

Fig. 4.14: Algebraic Identity $(a + b)^2 = a^2 + b^2 + 2ab$ Model

Model 4: Construct a Model to explain Properties of Circle and its theorems.

Materials Required: Pink Card Board, 360-degree Protractor, Thermocol Sheet, Rubber-bands, Colorful papers, Scissor, Cutter, Spikes, Push Pins.

Model Construction:

1. We cut a circular Thermocol Sheet (Radius=10 units) and paste it on Pink Card Board.
2. Now, we cut Blue and Yellow colour sheet in circular shape respectively.
3. Blue sheet will be exactly same as the size of circular Thermocol Sheet and Yellow sheet will be exactly same as the size of 360-degree Protractor.
4. Now, we paste Blue sheet on Thermocol Sheet and Yellow sheet on the centre of this circle.
5. After this, we fix 360-degree Protractor to the center of circle by using Push Pin.
6. Now, we fix Spikes, distance of 1 unit, at the circumference of circular Thermocol Sheet.

Procedure: Using Rubber-bands, we can explain all the properties of circle as follows:

1. Connect a Rubber-band on opposite Spikes of lower part (not passing from center) of the circle.
2. Connect a Rubber-band on opposite Spikes passing through center.
3. Connect a Rubber-band from center to the lower Spikes and let it be passing through small arc.
4. Connect Rubber-bands to make 2 triangles having equal chords.
5. Connect a Rubber-band to create a chord and other Rubber-band as a perpendicular from center to lower Spike passing through the chord.

6. Connect a Rubber-band from center to two opposite Spikes to create a Triangle and with another Rubber-band connect three Spikes, not from center but two opposite Spikes will be same, to create one more triangle.

7. Make three triangles in a same segment.

8. Connect a Rubber-band to four Spikes (not from the center) to create a cyclic quadrilateral.

Results: We will get following results:

1. Line that joins two points of the circle (not passing through center) is called chord. This chord creates two parts of the circle and have two curves, as the smaller curve is called Minor Arc and the larger one is called Major Arc. Smaller half is called Minor Segment and larger half is called Major Segment.

2. Line passing through the center is called Diameter and it is the longest chord a circle. It also divides the circle into perfectly two halves which is called Semi-Circle.

3. Lines from center to Spike is called Radius. When two radii and a Minor Arc join together divide the circle into a part called Sector. So, the smaller part is called Minor Sector and bigger part is called Major Sector.

4. The two triangle illustrates that Equal chords subtends equal angles at the center.

5. The chord and a perpendicular on it shows that A perpendicular line drawn through the center to the chord bisects the chord.

6. This fixation of triangles illustrates that Angles subtended by an arc at the center is double the angle subtended by it at any points on the remaining part of the circle.

7. This fixation of triangles illustrates that Angles in the same segment are equal in measure.

8. This fixation of quadrilateral shows that Each pair of opposite angles of a cyclic quadrilateral is supplementary.

Learning Outcome: Students will identify-

1. Chord,
2. Diameter,
3. Radius,
4. Semi-circle,
5. Minor and Major Arc,
6. Minor and Major Segments,
7. Minor and Major Sectors

Further they will be able to understand theorems of circle by doing it on their own, using this working model and perform it to others.

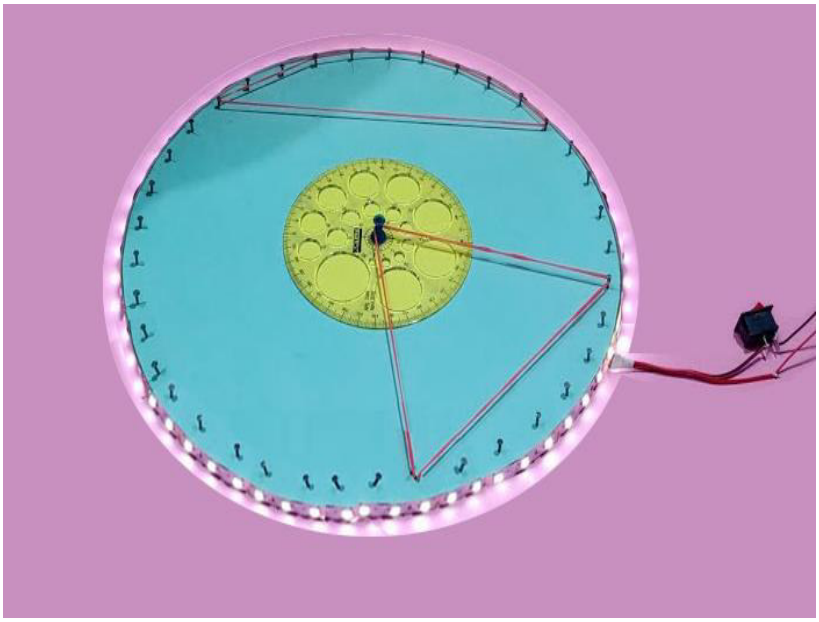

Fig. 4.15: Properties of Circle and its theorems Model

Model 5: Construct a Model to explain types of Triangles and its Properties.

Materials Required: 3 Protractors, 3 Colored Strips, Ruler, Push Pins, Scissor and Marker.

Model Construction:

1. Take 3 colored strips and make a vertical cut one by one in the middle of each strip leaving the ends.
2. With the help of ruler and marker, 1 unit place mark will be given on all the three colored strips.
3. The ends of all the three colored strips will be arranged in such a way that a triangle is formed.
4. In this way, the ends of all the three colored strips arranged will be joined together with the help of three protractors.
5. Using push pins, we will make an arrangement such that the three colored strips can be easily moved into each other.

Procedure: In this way, we will get the shape of a triangle from all the three coloured strips, whose ends are fitted with protractors and we will use it in the following way:

1. We will arrange all the three ends anywhere as per our wish and understand this shape by writing the number unit of each strip.
2. We will arrange the two sides of the triangle keeping the same and understand this shape by writing the number unit of each strip.
3. We will arrange all the three sides of the triangle keeping the same and understand this shape by writing the number unit of each strip.
4. We will observe the figure formed by arranging all the three sides of the triangle keeping the same and measure all the three angles.

5. We will observe the figure formed by keeping one of the three angles of the triangle at 90°.

6. We will observe the shape formed by keeping one of the angles of the triangle more than 90°.

7. We will understand the triangle by naming the three angles as A, B and C.

8. We will measure all the three angles inside the triangle and add their measures.

9. We will measure and add any two sides of the triangle and compare the obtained measurement with the measurement of the third side.

10. We will observe the side opposite to the largest angle of the triangle.

11. We will measure and observe the angles that lie outside the triangle.

12. We will measure one of the angles formed outside the triangle and observe its relation with the angles formed inside the triangle.

Results: We will understand the types of Triangles:

1. Scalene Triangle – All sides are different in length = 5 units, 6 units, 7.5 units.
2. Isosceles Triangle – Any two sides are equal = 7 units, 7 units, 4 units.
3. Equilateral Triangle – All sides are equal = 6 units, 6 units, 6 units.
4. Acute Angle Triangle – All three angles less than 90°.
5. Right Angle Triangle – One angle that measures exactly 90°.
6. Obtuse Angle Triangle – One angle is greater than 90°.

   We will understand the Properties of Triangle:

7. A Triangle has 3 sides (AB, BC, CA), 3 angles (∠A, ∠B, ∠C), and 3 vertices (A, B, C).
8. By measuring all three angles, we get $\angle A = 60°$, $\angle B = 70°$, $\angle C = 50°$ respectively.

   So, $\angle A + \angle B + \angle C = 180°$

   The sum of all internal angles (∠A, ∠B, ∠C) of a triangle is always equal to 180°. This is called the angle sum property of a triangle.
9. By measuring all three sides, we get AB = 5 units, BC = 6 units and CA = 8 units.

   Now, AB + BC = 5 + 6 = 11 units.

   The sum of the length of any two sides (AB, BC) of a triangle is greater than the length of the third side (CA).
10. The side opposite to the largest angle (∠A) of a triangle is the largest side (BC).
11. By measuring all the angles that lie outside the triangle and adding all of it is exactly 360°.

12. Any exterior angle of the triangle is equal to the sum of its interior opposite angles. This is called the exterior angle property of a triangle.

Learning Outcome: Student will understand and identify the types of triangles and also able to use the properties of Triangle like angle sum property, exterior angle property.

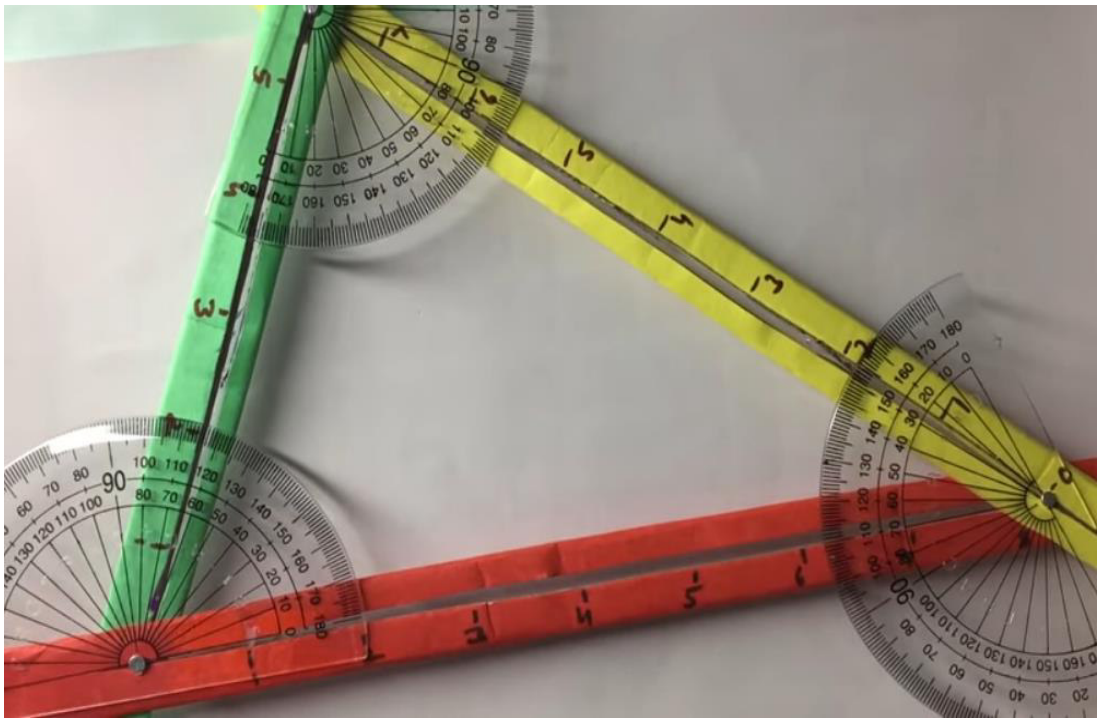

Fig. 4.16: Types of Triangle and its Properties Model

Model 6: Construct a Model of Square Root Spiral.

Materials Required: A Card Board, Thread, Marker, Geometry Box, Glue Stick.

Model Construction:

1. Take faraway of poster board bearing the ranges 40 cm x 40 cm.
2. Draw a line piece AB of time 1 whole by attractive 2 cm as 1 whole.
3. Construct flattery BX steep to foul line portion AB, by utilizing compasses or a set square.
4. From B, draw a curve of 1 whole, that cut BX at C(suggest).
5. Now, touch AC.
6. Taking AC as base, draw a steep CY to AC, by utilizing compasses or a set square.
7. From C, draw a curve of 1 part, that cut CY at D (suggest).
8. Now, touch AD.
9. Taking AD as base, draw a at right angles to DZ to AD, by utilizing compasses or a set square.
10. From D, draw a curve of 1 part, that cut DZ at E (voice).
11. Now, touch AE. Keep recurrent duplicate process for adequate number of opportunities.

Procedure: The figure so obtained from above construction is called a 'square root spiral'.

1. We will measure the side AC after joining it with thread and mark the measurement.
2. We will measure the side AD after joining it with thread and mark the measurement.

3. We will measure the side AE after joining it with thread and mark the measurement.

Keep repeating the above process for sufficient number of times up to the required construction.

Results: We will calculate that:

1. Measurement of side **AC = $\sqrt{2}$ = 1.41 (approximately)**

2. Measurement of side **AD = $\sqrt{3}$ = 1.73 (approximately)**

3. Measurement of side **AE = $\sqrt{4}$ = 2 (perfect square root)**

We keep repeating the above measurement for sufficient number of times.

Learning Outcome:

Since, ΔABC is a right-angled triangle.

So, from Pythagoras theorem, we have

$AC^2 = AB^2 + BC^2$ [∴ $(\text{Hypotenuse})^2 = (\text{Perpendicular})^2 + (\text{Base})^2$]

=> $1^2 + 1^2 = 2$

=>**AC = $\sqrt{2}$**

Again, ACD is also a right-angled triangle.

So, from Pythagoras theorem, we have

$AD^2 = AC^2 + CD^2$

=> $(\sqrt{2})^2 + (1)^2 = 2 + 1 = 3$

=>**AD = $\sqrt{3}$**

Similarly, we will have

AE = $\sqrt{4}$

AF = $\sqrt{5}$

AG = $\sqrt{6}$ and so on.

With the help of explained model, existence of irrational numbers can be illustrated. Students able to define rational and irrational numbers.

Fig. 4.17: Square Root Spiral Model

Model 7: Construct a Model to explain Perimeter and Area of a Square and a Rectangle with square units.

Materials Required: A4 Size Paper, 4 Coloured Strips, Ruler, Push Pins, Scissor and Marker.

Model Construction:

1. Take 4 coloured strips and make a vertical cut one by one in the middle of each strip leaving the ends.

2. With the help of ruler and marker, 1 unit place mark will be given on all the four coloured strips.

3. The ends of all the four coloured strips will be arranged in such a way that a Square or Rectangle is formed.

4. Now, we take A4 size paper and make 1 x 1 square unit boxes with the help of ruler.

5. Using push pins, we will make an arrangement such that all four coloured strips can be easily moved into each other.

Procedure: We can use the model made in this way by placing it on top of the boxes made on A4 size paper in the following way:

1. We will arrange the four strips in such a way that a Square ABCD is formed and then measure the sides of the shape being formed.

2. We will arrange the four strips in such a way that a Square ABCD is formed and then count the boxes inside the figure and conclude.

3. Now, we will arrange all the four strips in such a way that a Rectangle PQRS is formed and then measure the sides of the shape being formed.

4. We will arrange the four strips in such a way that a Rectangle PQRS is formed and then we will conclude by counting the boxes inside the shape formed.

5. We will verify all the findings using the required formula.

Results: Following the above arrangements we will find that:

1. Square ABCD is having four sides i.e., AB, BC, CD, DA and the measurements are **AB = 4 units, BC = 4 units, CD = 4 units,** and **DA = 4** units respectively.

   So, **AB + BC + CD + DA = 4 + 4 + 4 + 4 = 16 units**.

   Hence, **Perimeter of the Square = Side + Side + Side + Side**

2. Square ABCD is having four sides i.e., AB, BC, CD, DA

   The number of boxes inside the Square is = **16 boxes**.

   Hence, **Area of the Square = Side x Side**

3. Rectangle PQRS is having four sides i.e., PQ, QR, RS, SP and the measurements are **PQ = 3 units, QR = 4 units, RS = 3 units,** and **SP = 4 units** respectively.

   So, **PQ + QR + RS + SP = 3 + 4 + 3 + 4 = 14 units**.

   Hence, **Perimeter of the Rectangle = Side (length) + Side (breadth) + Side (length) + Side (breadth)**

4. Rectangle PQRS is having four sides i.e., PQ, QR, RS, SP

   The number of boxes inside the Rectangle is = **12 boxes**.

   Hence, **Area of the Rectangle = Side (length) x Side (breadth)**

   Learning Outcome: To verify all the findings using the required formula:

   Perimeter of the Square = Side + Side + Side + Side = 4 x Side

   = 4 x 4

   = 16 units **(Hence Proved)**

Area of the Square = Side x Side = Side^2

= 4 x 4

= 16 sq. units **(Hence Proved)**

Perimeter of the Rectangle = Length + Breadth + Length + Breadth = 2 x (L + B)

= 2 x (3 + 4)

= 2 x 7

= 14 units **(Hence Proved)**

Area of the Rectangle = Length x Breadth

= 3 x 4

= 12 sq. units **(Hence Proved)**

With the help of this model, students able to understand the Perimeter and Area of Square and Rectangle. Also, they will be able to differentiate between the Perimeter and Area of a Square and a Rectangle.

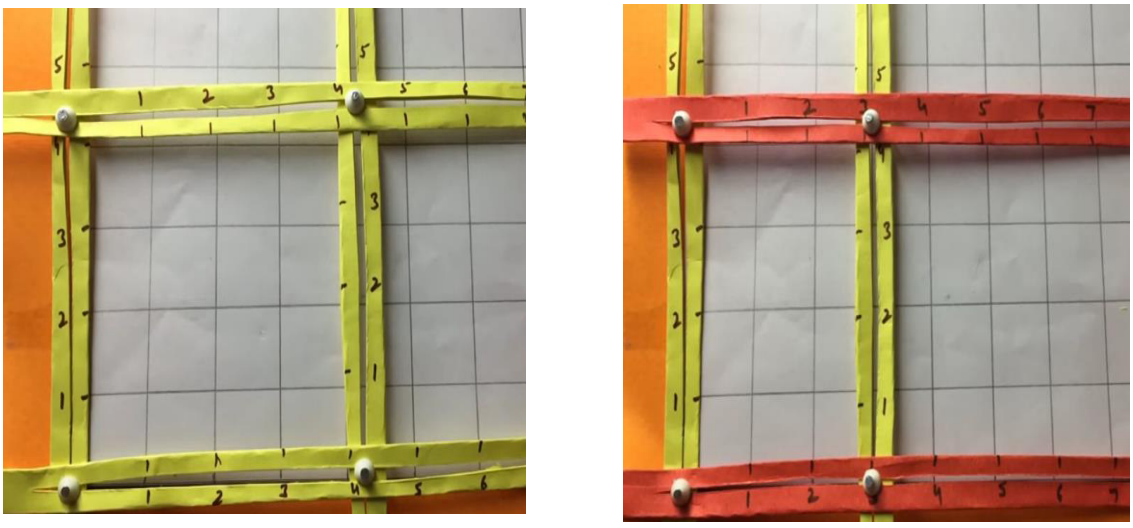

Fig. 4.18: Perimeter and Area Model

Model 8: Construct a Model to explain Distance Formula

$$\boldsymbol{AB = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}}$$

Materials Required: Graph Paper, 4 Coloured Markers, Ruler, Push Pins, Scissor.

Model Construction:

1. First of all, we will make X axis and Y axis on the graph paper.
2. After that we will mark two points $(\boldsymbol{x_1, y_1})$ and $(\boldsymbol{x_2, y_2})$. We have to find the distance between these two points.
3. We will write these two points A and B and connect both of them by making a line with marker pen.
4. After that we will put the push pins on A and B.
5. We will arrange all the strips according to the below Figure-8.

Procedure: The working is as follows:

1. Dark orange strip represents x_1, which is from A to x_1.
2. Yellow strip represents y_1, which is from A to y_1.
3. Purple strip represents x_2, which is from B to x_2.
4. Green strip represents y_2, which is from B to y_2.
5. On x axis we will measure the distance between x_1 to x_2, which is parallel to AC and makes a Rectangle.
6. Light orange strip represents AC, and we will measure this side.
7. On y axis will measure the distance between y_1 to y_2, which is parallel to BC.
8. Light green strip represents BC, and we will measure this side.

9. The meeting point of light orange strip and light green strip makes an angle, we will measure it and observe it.

10. Now, finally using appropriate formula we will find the distance of AB.

Results: Following the above arrangements we will find that:

1. On x axis the measurement from x_1 to x_2 will be same as of AC.

So, $\mathbf{AC = (x_2 - x_1)}$

2. On y axis the measurement from y_1 to y_2 will be same as of BC.

So, $\mathbf{BC = (y_2 - y_1)}$

3. The meeting point of light orange strip and light green strip is at C.

So, $\angle \mathbf{C = 90°}$

Which means that triangle ABC is a Right-Angle Triangle.

4. We will use Pythagoras Formula, where:

Base = AC, Perpendicular = BC and Hypotenuse = AB

$$\boldsymbol{AB^2 = AC^2 + BC^2}$$

$$\boldsymbol{AB^2 = (x_2 - x_1)^2 + (y_2 - y_1)^2}$$

$$\boldsymbol{AB = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}}$$

Learning Outcome: This is the method to find the Distance between two points whose co-ordinates are (x_1, y_1) and (x_2, y_2).

Students will able to explain and understand the Distance Formula by performing this working model.

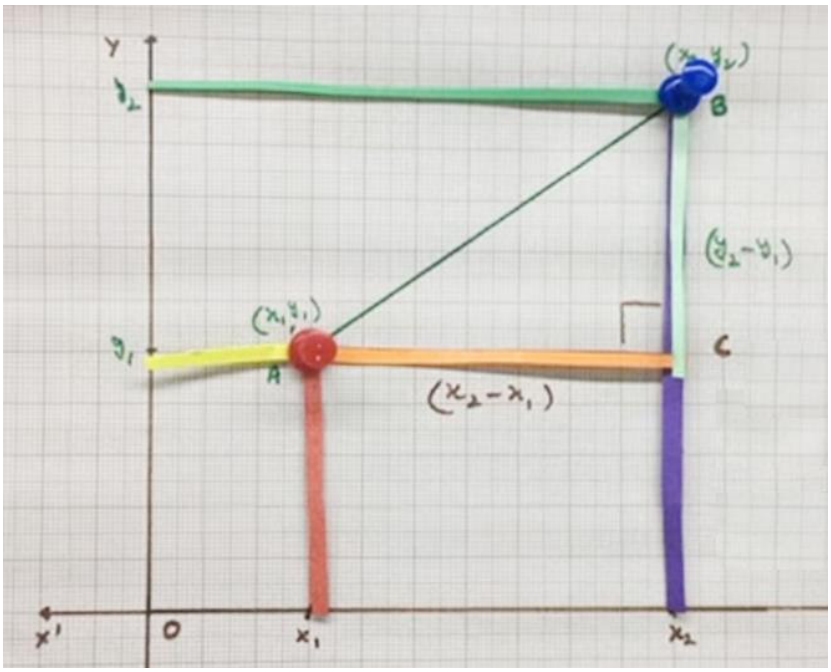

Fig. 4.19: Distance Formula Model

Model 9: Construct a Model to explain Factorization of Quadratic Polynomial.

Materials Required: Colourful Sheets, Marker Pen, Ruler, Push Pins, Scissor.

Model Construction:

1. First of all, we will take a red-coloured sheet and draw squares of dimensions 1 x 1 units.
2. Carefully cut out squares with the help of scissor.
3. We take a green-coloured sheet and draw rectangles of dimension x x 1 units.
4. Carefully cut out rectangles with the help of scissor.
5. We take a blue-coloured sheet and draw squares of dimension x x x units.
6. Carefully cut out them with the help of scissor.

Procedure: Now, we will Factorize a Quadratic Polynomial $x^2 + 4x + 3$ with the help of cut outs as follows:

1. For term 3 let's put three red squares.
2. Next, to represent term $4x$ we will put four green rectangles.
3. Now, to represent term x^2 we will put one blue square.
4. Then we will arrange these cut outs in the form of a square or a rectangle.
5. First, we will put the blue square, then put three rectangles. After that we will put the fourth rectangle in the sleeping position below blue square. At last, put the three red squares below green rectangles as shown in ***Figure 4.20***
6. As we see it forms a big rectangle and we will measure its length and breadth.
7. After that we will find the **Area of big Rectangle =L x B**.

8. Also, we will calculate **Area of Rectangle =Area of blue square**

+ Area of green rectangles

+ Area of red squares.

Results: According to the above arrangements we will find that:

1. Measurement of length and breadth of big rectangle is as follows;

Length (L) = $x + 1 + 1 + 1 = (x + 3)$

Breadth (B) = $(x + 1)$

2. Area of big Rectangle =L x B = $(x + 3)(x + 1)$---------- ***(I)***

3. Also, **Area of Rectangle =Area of blue square**

+ Area of green rectangles

+ Area of red squares.

$= x^2 + 4x + 3$----------***(II)***

Now, from ***(I)*** and ***(II)***, we get

$$x^2 + 4x + 3 = (x + 3)(x + 1)$$

Learning Outcome: Here $(x + 3)(x + 1)$are Factors of Quadratic Polynomial $x^2 + 4x + 3$.

Students will able to explain and understand the Factorization of Quadratic Polynomial with the help of this working model.

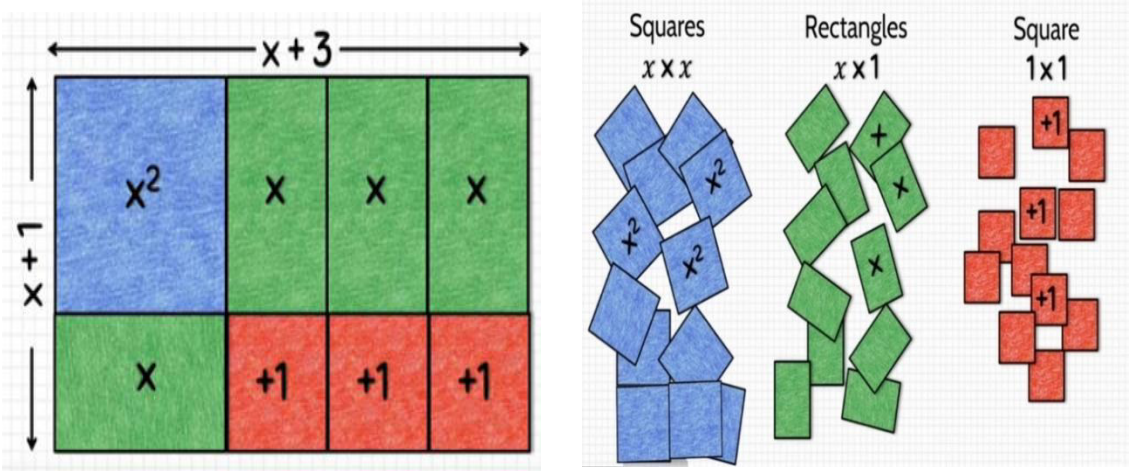

Fig. 4.20: Factorization of Quadratic Polynomial Model

Model 10: Construct a Model of Clinometer.

Materials Required: Semi-Circular Cut-Out of Paper, Card Board, Rectangular Strip of Card Board, Straw, Thread, Push Pin, Small Weight, Coloured Markers, Glue, Cello Tape, Ruler.

Model Construction:

1. First, we take a semi-circular cut out of paper and fold it into two equal parts to obtained the quadrant.
2. Now, the central angle will be 90°.
3. Now, again fold it into three equal parts. So, the angle of the each of the sectors will be 30°.
4. Fold it once again, so that the angle of the each of the sectors will be 15°.
5. After unfolding we will see lots of creases, then we draw line segment along the creases.
6. The central angle along the mid line is **0°** then the next angles will be **15°, 30°, 45°, 60°, 75°** and **90°** respectively.
7. Same will be drawn in clockwise and anti-clockwise and past one straw at the diameter of this semi-circle.
8. Now, we paste the semi-circle cut out on the card board and cut this card board in the shape of semi-circle. We will than obtain a Protractor of a card board.
9. Now, we take a thread and tie a small weight on it, which is used to attach this protractor to a rectangular strip of card board with the help of push pin.

Procedure: For a real-life situation let us consider a building in front of our Clinometer as follows:

1. Let's take one building prototype having a flag above it.
2. Place our Clinometer in front of this building prototype.
3. Now, we have to find out the height of the flag above the ground.
4. For this, we will first measure the distance from the base of the Clinometer to the building, denote this distance with (d).

5. Take a measurement of the height of the Clinometer from ground, denote this height with (h).

6. To measure the angle of elevation of an object gradually rotate the protractor of the Clinometer looking through the straw and stop when the top of the object is visible.

7. The angle of elevation is the angle between the mid line of the protractor and a thread which touches the strip, So, read this measurement and denote it as angle (θ).

8. Now, use the Application of the Trigonometry to find the height of the flag above the ground.

Results: According to the above arrangements we notice that:

1. The distance from the base of the Clinometer to the building $(\boldsymbol{d})$ **= 74 cm**.

2. The height of the Clinometer from ground $(\boldsymbol{h})$ **= 40 cm**.

3. Since, PTSQ is a Rectangle and opposite sides of a rectangle are equal.

So, **PT = QS = $\boldsymbol{d}$ = 74 cm**

and **PQ = TS = $\boldsymbol{h}$ = 40 cm**.

4. in **ΔPRT**, the angle of elevation $(\boldsymbol{\theta})$ **= 30°**and **RT = $\boldsymbol{x}$**

5. Now, in **ΔPRT**

$$\tan\theta = \frac{opposite\ side}{adjacent\ side} = \frac{RT}{PT}$$

$$\tan\theta = \frac{x}{74}$$

$$\tan 30° = \frac{x}{74}$$

$$\frac{1}{\sqrt{3}} = \frac{x}{74}$$

$$=> x = \frac{74}{\sqrt{3}} = 42.7\ cm\ (approx.)$$

6. Now, to find height of the flag above the ground, i.e.,

$$\text{Height} = x + 40 = 42.7 + 40$$

Height = 82.7 cm

Learning Outcome: Here using the Application of Trigonometry and Clinometer students will able to find the height of the any object above the ground level.

Students can also make their own Clinometer and find the height of the different objects like school building, pole, tower, mountain, tree etc.

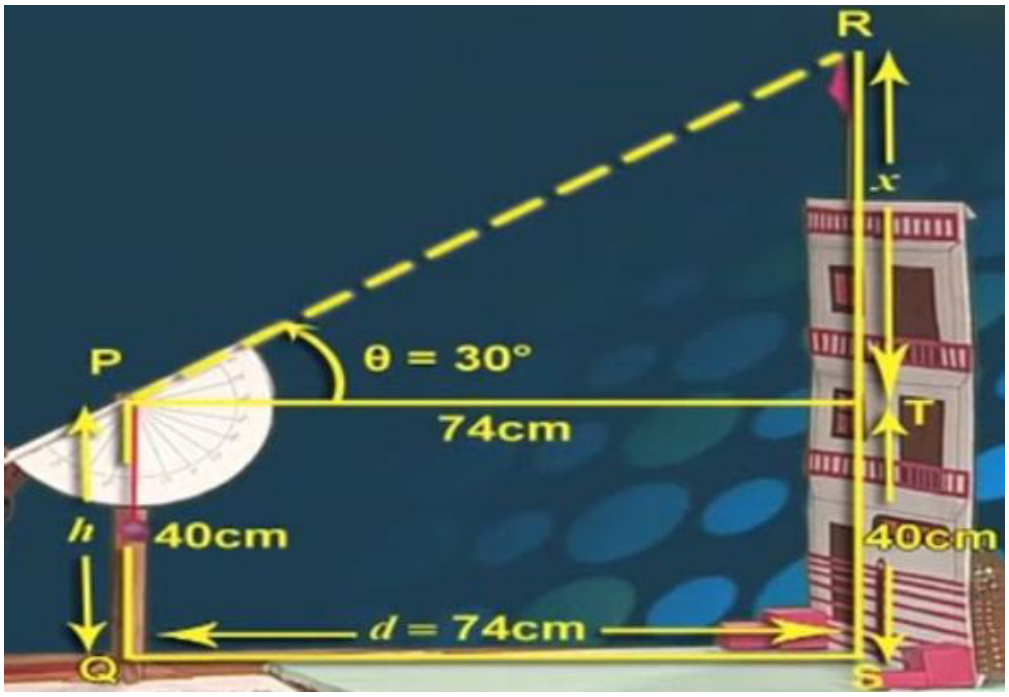

Fig. 4.21: Clinometer Model

4.5 THE SCOPE OF THE GESTURAL MODE OF REPRESENTATION

Science undervalues gesture as a kind of expression; it is typically seen to be important only in the arts, such as ballet. However, observing any teacher in action will demonstrate how frequently gesture—the movement of the body, particularly the hands and arms—is used to illustrate all three types of representation (macro, sub-micro, and symbolic), most frequently as an addition to the use of the other modes and forms.

There hasn't been a lot of published research on gesture use in science instruction. It's possible that against the background "noise" of complicated and constant bodily movement in crowded classrooms and laboratories, the precise application of gesture in science is difficult to discern. But with repeated use, or if a personal repertoire is developed to express certain meanings, gesture does start to resemble language for an individual. From the broad literature, we can draw four applications. Deixis usage, or pointing to actual or imagined objects, comes first. A teacher might use a piece of equipment as an example to illustrate the nature and purposes of their lecture. Second, the use of metaphors to convey the semantic content and meaning of speech. To illustrate the relative position and motion of the planets in the solar system, for instance, one might utilise hand and arm motions. Third, for temporal highlighting, which communicates importance. As an illustration, consider how hand gestures can emphasise the sequence of actions the heart takes as it pumps blood throughout the body. Fourth, the use of social interaction to communicate the connections between ideas. For instance, when presenting the historical order of the main physics paradigms.

4.6 THE SCOPE OF THE CONCRETE/MATERIAL MODE OF REPRESENTATION

The main benefit of this mode is that it keeps the three dimensions of the item being represented. Numerous additional sub-modes and forms have appeared. They can be categorised into two groups: those that originate from a simplified and highlighted macro representation, or what Harré refers to as homomorphs, such as cross-sections of the human body, and those that originate from various sources, or what Harré refers to as perimorphs, such as the "ball-and-stick" representation form used in chemistry.

4.6.1 Visual Representation in Mathematics

The study of mathematics requires the use of abstract ideas in order to solve issues. It is possible to represent information using words, numbers, and other symbols. It may be difficult for students with learning disabilities (LDs) to absorb material before they begin symbolising it (Sfard 1991)[19].

Visual information representations are commonly employed in mathematics to organise, support, or entirely replace traditional presentation methods. A component of mathematical visual representation is the creation and construction of models that reflect mathematical understanding.

4.6.2 LDs and Problem-Solving

- Students use an assortment of logical techniques in arithmetic, but wonderful question solvers typically establish a model of the question to better accept it. Math issues can be specifically troublesome for scholars with knowledge disadvantages to answer, and evidence suggests that these graduates engage diagram tactics otherwise from their usually cultivating peers in the following ways:
    - repetitiveness beneficial
    - type of optical representations secondhand
    - value of ocular representations Creating a diagram to resolve a question in mathematics is a process that includes:
    - deal with the news in the problem,
    - selecting main news, and
    - recognizing the goal of the question.

Students accompanying LDs fight with visual representation in arithmetic cause they usually have difficulties treat facts.

Visual representation is an important skill because higher-level math and science courses increasingly draw on visualization and spatial reasoning skills to solve problems. Additionally, it is simply another strategy that students can use when they are thinking of the best way to answer a problem in mathematics.

4.7 THE IMPORTANCE OF EXPLICIT INSTRUCTION

The brochure on diagram in arithmetic has possibly a single, resonant idea: pupils need expected positively instructed in what way or manner to use it. Students do not innately possess the skill to express news optically, accordingly it must acquire information and practiced. It's important to illustrate a new ability to pupils when originally education it to ruling class so they can visualize by virtue of what it's secondhand before bestowing bureaucracy a chance to try it out for themselves. Research has shown that the actual-graphic-abstract (CRA) approach to education pupils is an active habit to definitely command kids with knowledge disadvantages. Counters and cubes are instances of objects used to show analytical news in the actual level. In the representational level, illustrations are used to show the objects secondhand in the actual level. In the abstract level, analytical characters and numbers are secondhand in place of illustrations of objects (Mancl 2012)[20]. Another plan namely situated research for education diagram to juniors accompanying LDs is scaffolding. When a trainee needs interim acquired immune deficiency syndrome all the while the knowledge process, stage is secondhand. A scaffolding method hopeful to present a senior a wanting drawing, have ruling class complete it, and then have ruling class utilise it to answer a question.

4.8 TYPES OF VISUAL REPRESENTATION

When you explain diagram in mathematics, you maybe refer to representing information in your head accompanying a picture or to interpreting information on a page accompanying a drawing or chart. Fortunately, academics have condensed on helping pupils in strengthening their within and exterior diagram. In order to improve student knowledge in arithmetic for all sorts of issues, it is critical for scholars to evolve both extrinsic and within visual representation game plans. Researchers have recognized variances in visual depict weak on the aim apart from the distinction 'tween within and external optical likenesses. Visual likenesses of objects or information are created

utilizing pictorial metaphors. The dimensional relationships middle from two points objects or pieces of news are presented using diagrammatic metaphors. While both maybe utilised to advance scholars' learning and logical in arithmetic, schematic metaphors are more effective as a strategy. When resolving arithmetic questions, students accompanying knowledge disabilities are more compulsive engage graphical metaphors.

4.8.1 External Visual Representation

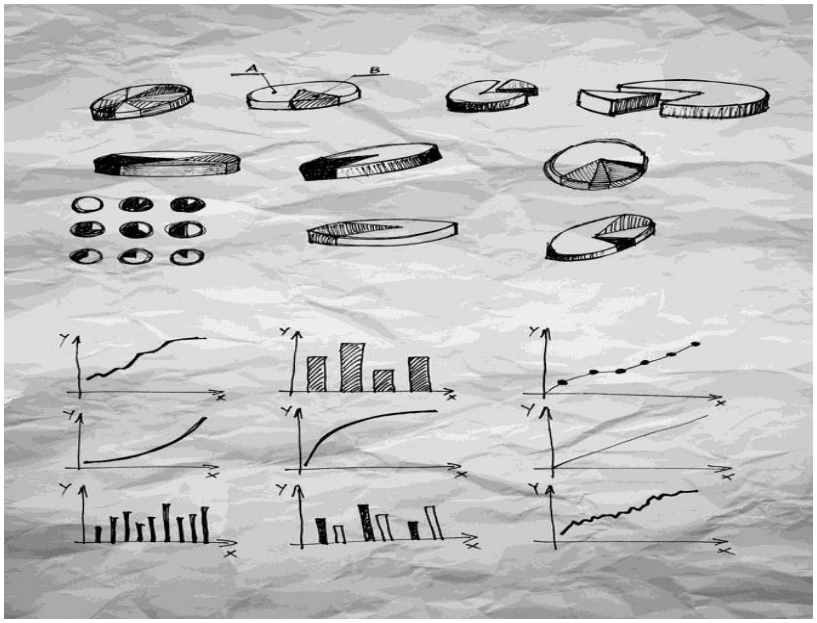

Fig. 4.22: External Visual Representation

A assortment of methods can be used to outwardly show ocular information in arithmetic. Although a sole set of news can be presented utilizing a difference of distinct imitation, juniors are usually taught that particular forms of optical likenesses are favored for particular categories of facts. The use of drawings and visible organizers, two types of extrinsic able to be seen with eyes likenesses utilised in mathematics, being pregnant the one has education disabilities is situated research. Since it may be regarded on a paper or on the board in front of the class, this somewhat diagram maybe demonstrated to pupils. Diagrams are optical likenesses that use the crucial dossier in numerical baffles. They can be used to organise news in addition to reckon the solution to a question and are frequently used to explain the key information is accompanying. An illustration that a junior makes to demonstrate the articles in a concise manner problem maybe a model

of a usual sort of drawing. People the one has knowledge disabilities (LDs) keep have a harder period understanding what a diagram is, when to use it, and reason. Diagrams are valuable for scholars with knowledge disadvantages because they may be used to focal point main news and omit facts namely optional for problem-solving. This can form the process of repairing questions simpler. There is distinctness middle from two points graphic and schematic drawings. A diagrammatic drawing is a drawing that combines the relating to space connections middle from two points the objects, as opposed to a graphic drawing, that would be a illustration of the important belongings in a word question. Schematic drawings, as was once noted, are more advantageous for pupils and frequently bring about greater fame accompanying logical.

4.8.2 Tree Diagrams

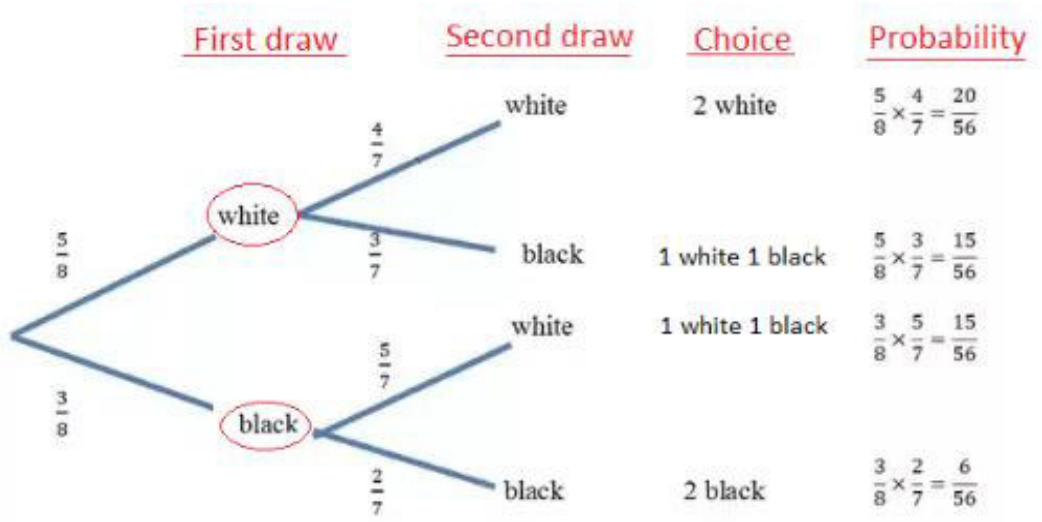

Fig. 4.23: Tree Diagrams

A **tree diagram** is a method of representing independent events or conditions related to an action, and it is often used to teach students probability theory.

This type of diagram might be used to teach students about probability through coin flipping or through drawing from a deck of cards. It is considered a **powerful method of teaching probability** in math, and is a great example of a visual representation that is a diagram.

4.8.3 Number Lines

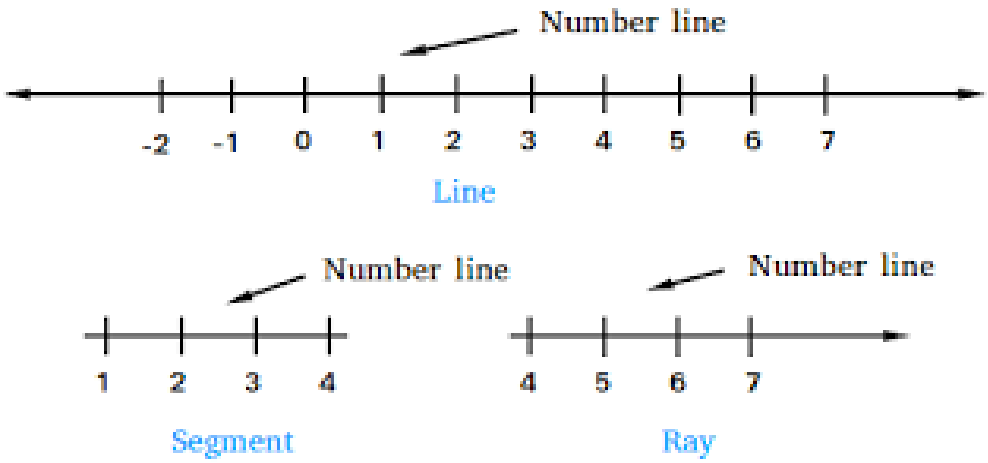

Fig. 4.24: Number Lines

Another diagram that mathematicians are using more and more is the number line. Students can simply create a number line to utilise when solving problems since it is a straight line with evenly spaced numbers along it on points.

Number lines offer children a visual they can touch to keep track of their position, making them useful for teaching integers as well as solving straightforward addition and subtraction problems.

4.9 GRAPHIC ORGANIZERS

Another common external visual representation in mathematics is the graphic organiser. Each sort of graphic organiser has specific applications for which it is most appropriate. Although graphic organisers are frequently only considered to be organisational aids, they may also be used to quickly draw conclusions and resolve all kinds of issues.

The premise that individuals with language problems may benefit from education and learning using nonverbal information, such a graphic organizer, is supported by research. Additionally, it has been discovered that using graphic organisers to promote learning helps kids with LDs of all ages comprehend facts and language better as well as increase conceptual understanding in mathematics.

Students with learning disabilities may benefit greatly from the usage of graphic organisers because they relieve part of the organisational stress placed on these students, who may struggle to filter through information and understand the connections between various mathematical objects or concepts.

Four main types of graphic organizers can be used in mathematics:

1. Semantic Maps

One kind of graphic organiser that can be used to enhance mathematics learning is a semantic map. This kind of graphic organiser can be used to help conceptual learning in mathematics because it is primarily used to relate conceptual material.

A semantic map could be used, for instance, to assist young pupils who are learning to categorise shapes. While "shapes" may be the major topic, students may further categorise shapes under "round," "symmetrical," "right-angle," etc.

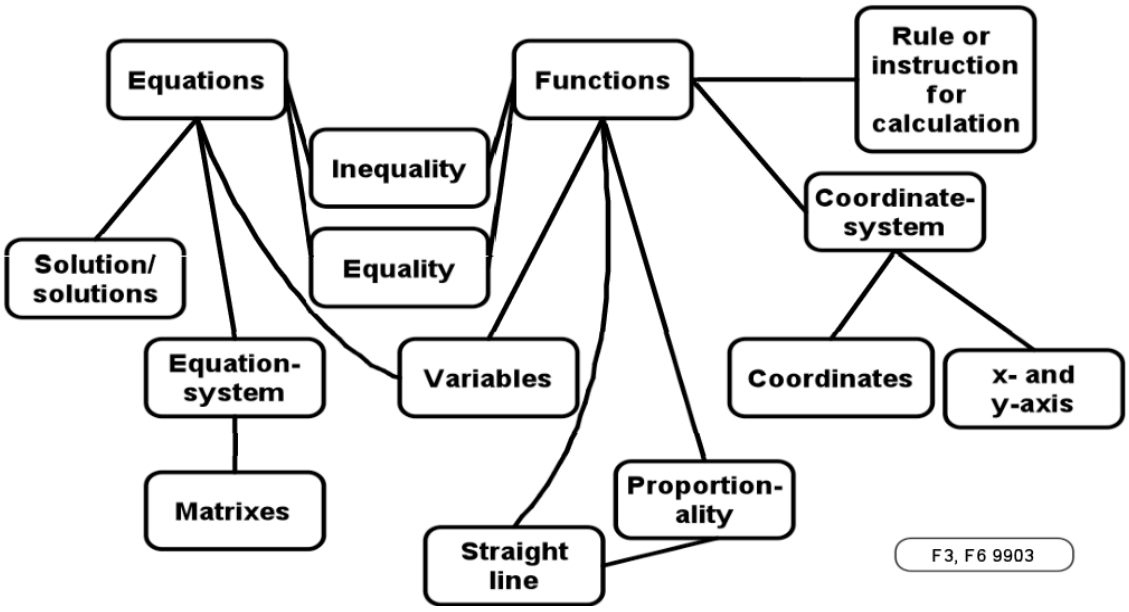

Fig. 4.25: Semantic Maps

2. Semantic Feature Analysis

An additional kind of graphic organiser is a semantic feature analysis. This visual organiser is distinguished by its matrix structure, which shows the features or qualities of various things or concepts. Geometric shapes can be compared in terms of their number of sides, vertices, types of angles, etc. using a semantic feature analysis.

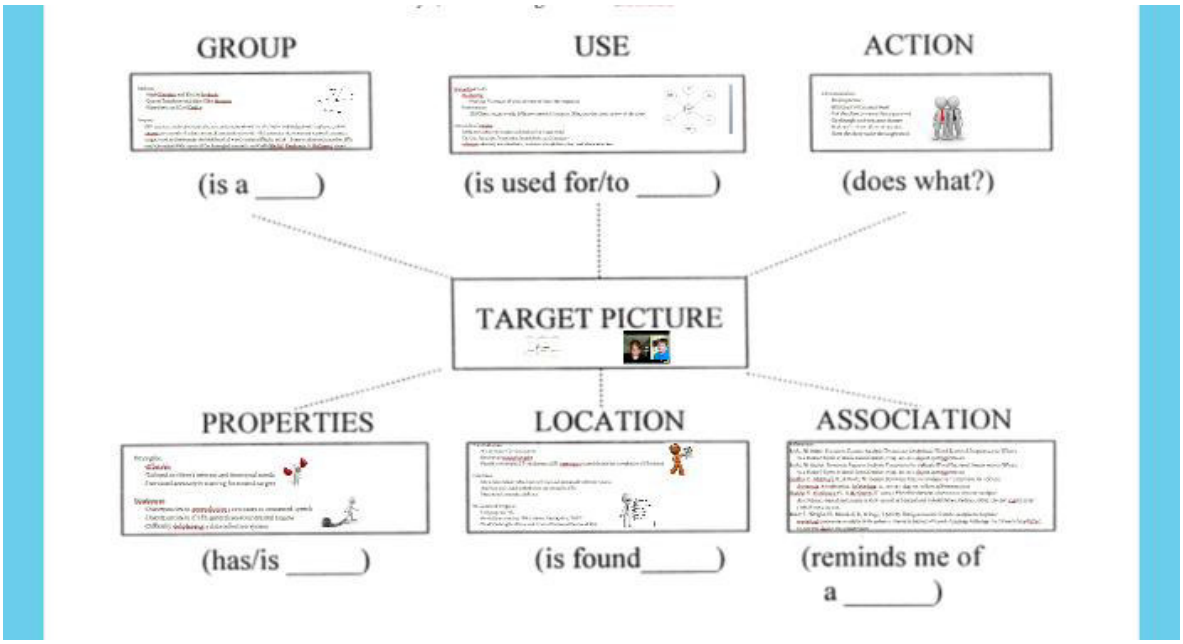

Fig. 4.26: Semantic Feature Analysis

3. Syntactic/Semantic Feature Analysis

A **syntactic/semantic feature analysis** is similar to the semantic feature analysis, but **sentences are added** in to help students identify specific features about each object.

An example sentence that might follow the matrix is *A _____ has the most sides of all of the shapes we have looked at.*

4. Visual Displays

The last sort of graphic organiser that can be used in mathematics for clearly expressing spatial relationships is a visual display. A variety of uses for visual displays are possible. A Venn diagram can be used to compare two things or ideas, and a timeline can be used to show information across time and determine the solution to a word problem.

4.10 SELECTING THE APPROPRIATE GRAPHIC ORGANIZER

- Although people with LDs can use each form of graphic organiser to learn mathematics, their differences in design imply that they might work best in particular contexts.

- Semantic maps and Semantic feature analyses are considered to be **better for recalling facts** though they are more difficult to understand and to learn how to use.

- Syntactic/semantic feature analyses and visual displays are considered to be **more efficient for making computations** to solve problems, and for recalling the information within these types of graphic organizers.

The benefits of each type of graphic organiser lead one to believe that more complex graphic organisers may be best for initial instruction of a mathematical concept, while less complex graphic organisers may be used for independent review and studying to help students with learning disabilities remember information.

4.11 EXPLICIT INSTRUCTION OF EXTERNAL VISUAL REPRESENTATION

It's crucial to keep in mind that both diagrams and graphic organisers require explicit training. The goal of each sort of external visual representation, as well as when and how to employ them, should be highlighted in this instruction. Both kinds of external visual representations can be easily replicated for students since teachers can build them physically while outlining their thoughts in front of the class.

The efficacy of a three-phase instructional technique for teaching students with LDs to use diagrams in mathematics was investigated by van Garderen (2007). The first phase involved explicit instruction about what diagrams are, as well as how and when they are used.

1. In the second phase, students constructed diagrams to illustrate the information they knew and the information they did not know in relation to one-step word problems.

2. The third phase concentrated on two-step word problems with many unknowns, and students utilised diagrams to identify the primary aim of the problem as well as the auxiliary information that they would need to compute the primary goal.

With this series of explicit teaching, teachers were able to teach students with learning disabilities (LDs) how to utilise diagrams, which improved performance, increased student satisfaction, and increased the likelihood that they would use diagrams for other kinds of difficulties.

4.11.1 Internal Visual Representation

Internal diagram is more troublesome to display to students because it is an insane exercise, opposite to outside visual representation, that maybe natural to model and definitely explain to juniors. The result or recall of ocular metaphors to send knowledge is refer to as an ocular diagrammatic likeness (Kirsh 2005)[21]. In order to comprehend and resolve a question in a more excellent manner, schoolteachers frequently spur pupils to visualise it. It endures not be pretended that all juveniles already have this ability cause it maybe a disputing assignment for ruling class. Students must mix the facts from the question with their earlier understanding of the subject when achieving an arithmetic discussion question. While teachers' insane figures are unseen from their pupils, it is still possible to verbally model the process for undergraduates and even have ruling class draw pictures of what they are observing in their minds to manage clearer (Jonassen 2020)[22].

4.12 MODEL TEACHING PRACTICES

The term "model" refers to an education adventure carried out by a knowledgeable professor and showing a well-focused education behaviour presented by one, from what or which place the trainee learns through substitution. It is a turn of expression and thinking about education that admits for the organization, categorization, and understanding of distinguishing facts. A model of teaching, in accordance with Bruce Joyce and Marsha Weil, maybe used to forge curriculum, construct teaching fabrics, and direct command in the classroom and additional backgrounds. Thus, education models are just teaching designs. They describe the process and bearing particular referring to practices or policies that do not negatively affect the environment positions that cause the student to communicate as if distinguishing change happens in his performance. A model of education, in accordance with N.K. Jangira and Azit Singh (1983), is a collection of affiliated details orderly in the order that offers guidance for carrying out

the objective. Its virus in the invention of educational ventures and material comforts, their killing, and the achievement of the established aims. Models of Teaching request pupils to participate in particular intelligent and public tasks in order to obtain sure aims, to a degree teaching news idea, thinking styles, the study of friendly principles, etc. Some models focus on the coach's transfer, while remainder of something evolve as the students put oneself in the place of other endeavors and are visualized as companions in the educational venture.

These are based on the following specifications:

a. Specification of Environment- It designates vague terms the tangible environments under that a student's answer endure be noticed.

b. Specification of operation- It designates the system that specifies for the reaction of undergraduates and interplay accompanying the environment.

c. Specification of test of Performance-It designate the test of Performance which is endorsed apiece juniors the behavioral consequence that the trainee would demonstrate afterwards determining distinguishing instructional sequences are described in the education models

d. Specification of knowledge outcome- It designates what the undergraduate will act after concluding a teaching series.

4.12.1 Effects of teaching by modelling

Models for teaching are really models for learning. As we help kids acquire knowledge, skills, values, ways of thinking, and means of expression, we are also teaching them how to learn. The most significant long-term effect of education may actually be the students' increased capacity to learn more readily and successfully in the future as a result of their increased knowledge and skill set as well as their mastery of learning processes.

According to Joyce and Weil, each paradigm has two distinct effects: nurture and instruction.

A. Instructional effects are the direct effects of the model which result from the content and skills on which the activities are based.

B. Nurturant effects are those which are implicit in the learning environment.

They are the indirect effects of the model.

Bandura and Walters have formulated three kind of effect in teaching by modelling:

1. Modelling effect- The learner acquires new kind of response pattern.
2. Inhibitory and disinhibitory effect- The learner increases or decreases the frequent, latency or intensity or previously required responses.
3. Eliciting effect- The learner receives from a model merely a cue for rearising a response.

The teacher is modelling a new behaviour and employing the modelling effect when they demonstrate how to hold a pencil or write a capital A to a student. The instructor gives the class an example of how art books are not allowed to contain pornographic material. The prompting effect happens when a teacher uses modelling to nudge students to stand up when he enters the room. Therefore, it provides a stimulus that neither initiates nor prevents a reaction. Gagne asserts that imitation-based learning appears to be more effective for tasks that have a hint of cognitive complexity.

4.12.2 Utility of Teaching Models in Teaching

- Students' social skills, self-awareness, cognitive abilities, and behavioural qualities can all be enhanced by teaching tactics. It assists in selecting and stimulating environments that encourage student improvements.
- The development of an empirical connection between teaching and learning is supported by teaching models. It helps make the instruction more effective.
- By building a theoretical foundation for instruction, teaching models help to modify and improve instruction.
- The development of new educational innovations in teaching strategies and tactics that may replace those now employed in schools is encouraged by teaching models.

- Writing educational resources and instructional materials using teaching models enables authors to create more interesting and practical materials.

- Because teaching is by definition practical, teaching models assist teachers in enhancing their abilities to design welcoming learning spaces.

- The development of learning activities and subject matter that provide students with a diversity of educational experiences is made easier by the use of teaching models in curriculum design.

- The instructional strategy evaluates student conduct. It offers a standard for this important job that makes it straightforward to evaluate how the pupils' behaviours have improved.

4.12.3 Characteristics of a Teaching model

1. Encourage Art of Teaching- Teaching is deliberate as a skill. Teaching model reassures this creativity by providing knowledge surroundings.

2. Development of Inherent Abilities -Teaching models cause success the approximate incident of traits as it helps in expanding human capabilities. It more increases the assistant's public ability.

3. Based on Individual Differences- Teaching model uses the undergraduate's interest, as it is assembled on the action of individual distinctness.

4. Influenced by Philosophy- Every education model is affected apiece knowledge of instruction. Hence, schoolteachers plan various models of education plastered of the knowledge they trust.

5. Answers Fundamental Questions- In all education model be responsible to all the fundamental questions concern the nature of pupils and assistants are contained.

6. Providing Appropriate Experiences- Teaching models determine correct knowledge to two together lecturer and junior. Selecting the content and giving it for education before the graduates is the main essence of education.

This trouble is resolved when a professor presents appropriate happening before the pupils.

7. Maxims of Teaching- The footing of education model is the maxims of education. They are the endowment of each education model.

8. Practice and Concentration- The incident of an education model is established formal and unending practice and aggregation. The correct growth of an education model is only attainable when the acceptances are interpreting by connected thinking.

4.12.3 Fundamental Elements of a Teaching Model:

Normally majority of teaching models are based on the following six elements:

1. Focus

Focus is a key element of a teaching strategy. The model primarily focuses on pedagogical goals and environmental aspects. One or more objectives form the core of every teaching strategy. Any instructional model is created with this goal in mind. Each teaching method has a distinct set of objectives that distinguish it from the others. It forms the cornerstone of a teaching approach. Every model is developed taking into account its primary objective or goal. Each model contains a number of phases, and each one fosters the growth of a certain set of competencies.

2. Syntax

The syntax of the model explains how the model operates. The syntax includes all of the steps that go into organising the complete lesson plan. It is the methodical flow of the model's operations. Every model has a different phase flow. It alludes to a comprehensive justification of the applied model. It determines the interactions between a student and a teacher as well as the activities used during instruction. The phrases that lead to actions with varied levels of emphasis on educational goals are referred to as the syntax of any teaching model. In syntax, the teaching methods, exercises, and interactions between the teacher and the students are selected in a pattern of succession

that makes it simple to achieve the learning objectives by generating convenient environmental circumstances.

3. Principles of Reaction

The teacher is given guidance by the Principles of Reaction on how to interact with and respond to the student. This section focuses on the teacher's perspective of and response to the pupils' activities. These critiques must be thoughtful and critical. They provide broad principles that the instructor may utilise to select appropriate, role-model reactions to the student's behaviour. The instructor's reaction to the students' comments is the main focus of this section. In it, he learns how to react to the students' responses and assesses whether or not they were actively engaged in the activity.

4. The Social System

The exchanges between the teacher and the learner are the main focus of this part. Every educational method has unique objectives, which leads to unique social systems. It has to do with the relationship between the teacher and the student, the kinds of regulations that are followed, and the way the teacher rewards excellent student behaviour. The Social System clarifies the role of the instructor and their interactions with the students. Some models give the teacher a lot of attention. While the action is focused on the kids in some versions, it is not in others. This element is based on the notion that every class is a miniature society. The choice of motivating strategies was also explored.

5. Support system

The Support System provides a description of the supporting circumstances for the model. Support refers to requirements that go beyond the normal range of human capacities, expertise, and technical resources. The term "support system" refers to the requirements that go beyond the teacher's ordinary human skills and abilities and the amenities that are frequently found in a standard classroom. The phrase "teacher requirements" refers to the instructor's unique audio-visual resources, including movies, e-learning tools, field trips, etc., as well as their specific skills and knowledge. This covers media such as books, films, lab tools, and reference resources. It refers to the

additional requirements that go beyond the normal range of human capability, ability, and technology capabilities. For evaluation, an oral or written test is used.

6. Application

It is a crucial component of a teaching strategy. It refers to the usefulness or application of the knowledge acquired in various contexts. There are various instructional methods accessible. Each model makes an effort to assess whether it could be useful in various situations involving the accomplishment of goals involving the adjustment of cognitive and affective behaviour.

4.13 TYPES OF TEACHING MODELS:

Every teaching strategy has a distinct goal. The teacher must select the appropriate type of model for accomplishing the specific target in order to accomplish the goal of a teaching model. Three major categories have been used to categories the instructional models:

1. **Philosophical teaching models**: Israel Saffer had mentioned such types of models. These include

   A. **The Insight model (Plato)-**The insight model rejects the presumption that the purpose of a teaching model is to merely impart information or concepts to students' minds through instruction. The recognised principles of language are crucial, according to this approach, as knowledge cannot be delivered solely through the expression of sense organs. Another requirement is the content's edge. The information cannot be conveyed just by hearing or pronouncing the words. Language and mental processes interact with one another.

   B. **The Impression model of teaching (John Locke)-**It is predicated on the widely held belief that a child's brain is like a blank slate at birth. Whatever experiences are given to students through instruction leaves an effect on their brains. We refer to these perceptions as learning. The sensory organs play a role in learning.

C. **The Rule model (Kant)-**The rationale is given a lot of weight in this paradigm. Kant values logic because it depends on adhering to a set of norms. Rule models are intended to help students improve their logical reasoning skills. Some specific guidelines are followed. Teaching is organized, planned, and carried out according to a set of rules.

2. **Psychological model of teaching:** John P. Dececco had mentioned such types of models. It includes

   A. **Basic Teaching model (Robert Glaser)-** A simplified teaching model created by Robert Glaser in 1962 has since been modified and is now the default teaching model. The four components or aspects of the teaching process are separated into the basic teaching model. It will be beneficial in a number of ways. The model's four components stand in for the fundamental divisions. Instructional goals, behaviour before entering the classroom, instructional process, and lastly performance evaluation.

   B. **An Interaction model of teaching (N.A. Flander)-** Flanders viewed the teaching process as involving interaction. He created the Flander's ten category system, which classified student behaviour into ten categories. This model analyses how students and teachers behave. In this model, the teacher-student relationship is more heavily stressed.

   C. **Computer based teaching model (Daniel Davis)-** It is the most complex model, with the fundamental components of entering behavior, determining objectives, and teaching aspect. The computer teaching strategy in this section is chosen based on the student behaviour and learning goals. The student's performances are assessed. In response, a different lesson plan is offered. In this concept, diagnosis and instruction coexist. Based on the diagnosis, remedial instruction is given. Additionally, individual differences are valued.

3. **Modern teaching models (Joyce and Weil) Eggen, Kauchar and Harder (1979**) have discussed six Information Processing Models –General Inductive Model,

1. Concept Attainment Model,
2. Taba Model,
3. General Deductive Model,
4. Ausubel's Model and
5. Such man's Inquiry Model.

Joyce and Weil's examination of instructional models is the most thorough. (1980). Under the heading Modern teaching models, Bruce R. Joyce split up all the instructional models. They discovered 23 models, which are grouped into four fundamental families based on the nature, unique traits, and outcomes of the models. The following four families:

1. Information Processing Models
2. Personal Models
3. Social Interaction Models and
4. Behavior Modification Models.

Within the families, there are specific models which are designed to serve particular purposes.

I. Information Processing Models

These models focus on the intellectual growth of the individual and aid in the improvement of the approach to processing environmental data. These models emphasise intelligence. They are interested in the learner's capacity for observation, data organization, comprehension, concept formation, use of verbal and nonverbal symbols, and problem-solving.

The primary goals are:

- The mastery of methods of inquiry
- The mastery of academic concepts and facts

- The development of general intellectual skills such as the ability to reason and think more logically

The models which belong to this family are:

(a) The Concept Attainment Model

(b) Inquiry Training Model

(c) The Advance Organizer Model

(d) Cognitive Growth Development Model

(e) Biological Science Inquiry Model

Table A: Brief Review of the Information Processing Source Models

Source	Teaching model	Innovator	Aims and application
The Information Processing Source	1-Concept Attainment Model 2-Inductive Model	Bruner, Hilda Taba	To develop inductive reasoning, mental inductive process, and understanding of concepts and principles.
	Inquiry Training Model	Richard Suchman	To develop individual competencies to achieve the social objective.
	Biological Science Inquiry Model	Joseph J. Schwab	To develop understanding of research methodology, to think logically on social problems.
	Advance Organizational Model	David Asubel	To understand concepts and facts and to make the content purposeful and interesting.
	Cognitive Growth Developmental Model	Jean Piaget	To develop general intelligence and logic, social and moral development.

II. Personal Models

Personal development models, which put an emphasis on a person's emotional life, help the individual build their sense of self.

These models place a strong emphasis on shaping a person's personality into an integrated, competent, and confident one. They make an effort to support students in

developing the tools necessary to further their education on their own. Counselors, therapists, and other individuals interested in encouraging people's creativity and self-expression have created a large number of personal models of teaching.

The primary goals are:

- To increase the student's self-worth,
- To help students understand themselves more fully.
- To help students recognize their emotions and become more aware of the way emotions effect other aspects of their behavior,
- To help them develop goals for learning,
- To help students develop plans for increasing their competence,
- To increase the students' creativity and playfulness,
- To increase the students' openness to new experience.

The models which belong to this family are:

(a) Non-Directive Teaching Model,

(b) Synectic's Teaching Model,

(c) Awareness Training Model,

(d) Classroom Meeting Model.

(e) e-Conceptual System Model

Table B: Brief Review of the Personal Source Models

Source	Teaching model	Innovators	Aims and application
The Personal Source	Non-Directive Teaching Model,	Carl Rogers	To develop self-learning by auto instructions, self-research and self-understanding
	Synectic's Teaching Model,	William Gordon	To develop creative competencies for problem solving.
	Awareness Training Model,	W.S. Fietz	To develop individual competencies and mutual relations.
	Classroom Meeting Model.	William Glasser	To develop skills of self – understanding and capacities of dutifulness.
	Conceptual System Model	David. F. Hunt	To adjust with the environment with flexibility in the personality.

Ill. Social Interaction Models

The links of the individual to society or other people are emphasised by the models in this family. The main goal is to teach pupils how to collaborate. to recognise and address issues of a social or intellectual nature.

The primary goals are:

- To help students work together to identify and solve problems
- To develop skills to human relations, and
- To become aware of personal and social values.

The models which belong to this family are:

(a) Group Investigation Model,

(b) Role Playing Model,

(c) Jurisprudential Inquiry Model,

(d) Laboratory Training Model,

(e) Social Simulation Model,

(f) Social Inquiry Model.

Table C: Brief review of the Social Interaction Source Models

Source	Teaching model	Innovator	Aims and application
The Social Interaction Source	Group Investigation Model	John Dewey, Herbert	To develop democratic abilities, use of knowledge and skills in life of individual and society.
	Jurisprudential Model	Donald Oliver, James P. Shaver	To solve problems on the basis of information and reasoning power.
	Social Inquiry Model Social Simulation Model, Role Playing Model.	Benjamin Cox, Byron	To develop competencies of problem solving and adjustment
	Laboratory Method Model	Bethal, Maine	To develop group skills individual capacities and adjustment.

IV. Behavior Modification Model

A body of knowledge known as behaviour theory serves as the theoretical foundation for each model in this family. The emphasis on altering the learner's outward behaviour is the unifying theme of these methods.

This family of models includes the Operant Conditioning Model.

Review of the Behavior Modification Source Model in Selected Detail

Table D: Brief review of the Modification Model

Source	Teaching model	Innovators	Aims and application
Behaviour Modificati on Source	Operant Conditioning Model	B.F. Skinner	To achieve the objectives of lower level of cognitive domain on the basis of individual differences

Different researchers have lately devised a variety of teaching tactics to achieve various educational aims. In order to help teachers, achieve various learning objectives, they have turned current information about the teaching and learning processes into "Models of Teaching" that can be applied in the classroom. It is necessary to include a few "Models of Teaching" in the secondary as well as elementary teacher education curricula in order to increase the "ability to teach" of future educators.

4.14 EXPERIMENTAL DESIGN FOR STUDENTS

Science is a synthesis of previously acquired knowledge and abilities. These practical abilities, which cover anything from problem solving to data analysis, are extensive and regularly used outside of the classroom. Even though it is a crucial component of science education, teaching these skills is frequently neglected in favour of teaching the subject

matter. We have all witnessed how practical learning enhances student engagement and comprehension as scientific educators. However, given the curriculum's time limits, It is possible to shortchange pupils' requirement for time to learn these investigative techniques. We give students too many "recipes" to follow, which prevents them from taking responsibility for their practical work. Students begin to consider their surroundings at a very young age. They pose inquiries and then respond with observations and supporting data. Students frequently have insightful, captivating, and probing questions that they enjoy posing. We should encourage students to ask these questions in order to foster their innate curiosity in the world around them as educators.

It takes time to teach students how to construct experiments and to let them formulate their own research topics and hypotheses. These resources were developed to scaffold and structure the procedure so that teachers might concentrate on enhancing the fundamental principles of experimental design. Students gain significant experience when given the freedom to formulate their own research questions, write their own hypotheses, and organise and conduct their own studies. Students will take more pride in their work as a result of this. Students consider how scientists have historically developed an understanding of how the cosmos functions as they carry out the experimental method for their own inquiries.

Experimental Design Steps

1. Question

This is a crucial step in the design of experiments and the scientific method. Students take pleasure in asking questions. Asking thoughtful, insightful questions might help students feel more invested in their work. Using a mind map storyboard is a terrific method to encourage kids to think about and visualise their questions.

Ask pupils to consider any questions they have about the cosmos or to consider any queries they may have on a specific subject. Although all questions are valid, some are simpler to test than others.

2. Hypothesis

An educated guess is referred to as a hypothesis. An assertion that can be tested scientifically qualifies as a hypothesis. Check the results after the experiment is complete to see if the hypothesis was confirmed. For students, it can be difficult to understand how to create solid hypotheses. It's critical to keep in mind that the hypothesis is a testable assertion, not a question.

Forming a hypothesis as a "if... then" statement is one method of doing so. Although it's clear that this isn't the only or most effective approach, it might be a simple formula for beginners. Students must first identify the variables in an if... then statement, which may alter the sequence in which they complete the stages of the visual organizer.

The hypothesis then takes the form if [change in independent variable], then [change in dependent variable] after identifying the variables. For instance, the amount of caffeine would be the independent variable and reaction time would be the dependent variable in an experiment to determine the impact of caffeine on reaction time. The if-then statement might read: If you consume more caffeine, your reaction time will slow down.

3. Explanation of Hypothesis

How did you arrive at this theory? What is the scientific foundation for your claim? Students may conduct research using books or the internet, depending on their age and level of competence, or they may utilise their past knowledge to explain why they have picked their hypotheses. Discussing what a credible source is with students at this time might also be a good idea.

4. Prediction

The theory and the prediction are slightly different. A prediction is more particular to the experiment than a hypothesis, which is a testable assertion. The idea that DNA has a helical structure was put forth when the structure of DNA was discovered. The X-ray diffraction pattern of DNA was expected to take the form of an X.

5. Identification of Variables

The discussion storyboard example that may be used to get your students talking about variables in experimental design is provided below. You should talk to your pupils about dependent, independent, and controlled variables as these are the three different sorts of variables. Use the terms "what you are going to measure," "what you are going to change," and "what you are going to keep the same" to keep things straightforward. Students who are more advanced should be encouraged to utilise appropriate terminology.

Dependent variables are what the scientist measures or observes. Because repeated measurements increase the reliability of your data, these measures are frequently repeated.

Scientists choose to alter the independent variable to see the impact on the dependent variable. It would be challenging to determine which variable is responsible for whatever change you notice, thus only one is picked.

Quantities or elements that scientists desire to stay constant throughout the experiment are known as controlled variables. In order to prevent them from affecting the dependent variable, they are managed to remain constant. Scientists can observe how the independent variable influences the dependent variable by controlling these.

6. Risk Assessment

In the end, a responsible adult must give their approval, but it is crucial to encourage pupils to consider how they will keep themselves safe. Students should first identify potential hazards in this section before describing how they plan to reduce risk. Get pupils to recognise and handle risks in various scenarios as a way of fostering these skills. With the help of the storyboard below, ask students to fill out the second column of the T-chart by defining risk and then describing how they might manage it. For a class discussion, this storyboard might also be presented.

7. Materials

The supplies they require for the experiments—along with any safety gear they identified as necessary in the risk assessment stage—will be listed by the students in this section. This is an excellent opportunity to educate kids on the importance of selecting the right equipment for the job. If you want to measure the breadth of a football pitch, you are going to use a different tool than if you want to measure the width of a hair!

8. General Plan and Diagram

It is crucial to discuss repeatability with pupils. They ought to create a procedure that would make it simple for another scientist to replicate their experimental design. Students should create a numbered list of instructions because it is the quickest and clearest approach to accomplish this. Here, asking students to describe how to make a sandwich or a cup of tea could be a good exercise. Act through the procedure and highlight any steps that were skipped.

Students can use Storyboard That to visually explain the procedures of their experiment for English Language Learners and students who have trouble writing in English.

Even though not every experiment will require one, certain ideas will be significantly enhanced by the addition of one. Ask pupils to concentrate on creating simple, understandable diagrams.

9. Carry Out Experiment

The students then carry out the experiment according to their strategy. It's critical that students gather their data in a relevant and clear manner. Although tables are frequently used to record data, images, sketches of observations, or a combination of these are equally acceptable. It might be beneficial to ask students to list any challenges they encountered while conducting the experiment. Later evaluation of their experimental design may benefit from this.

It is vital to note that before allowing any students to complete their practical work, the responsible adult should conduct a comprehensive risk assessment of any experiments the students create. Students examine the data once the experiment is over, make inferences, and then present their findings. Depending on the level of the students.

Construct Educational Achievement

“An achievement test is essentially a tool or device of measurement that helps in ascertaining The quantity and quality of learning attained in a subject of study or group of subject after a period of instruction by measuring the present ability of the in dividual concerned. Mathematical achievement is the competency shown by the student in mathematics. It is the result of acquired knowledge or information, understanding, skills and techniques developed in the subject of mathematics in a particular stage. Its measure is the score on the achievement test in mathematics.

Operational Definition

The simplest definition is that operations are mathematical processes or activities used to solve problems. (In fact, the root word, operari, means to work!) We use such mathematical activities as adding, subtracting, multiplying and dividing to solve problems.

Research Gap

Design There are several sorts of designs to choose from. Picking the right approach is crucial. According to Dave (1994), the experimental technique is a predetermined scientific instrument for gathering data and testing hypotheses. Shah (2004) asserts that an experimental design is a blueprint created to assess hypotheses formulated for establishing relationships between independent and dependent variables. Experimental designs may be divided into three categories, which are as follows:

Pre-Experimental Planning, first.

Designs for pre-experiments contain relatively little control, hence they are far less successful. Such designs don't include a control group. There is no system in place to equalise groupings.

Real-world experimental design.

Most laboratory studies in science employ these designs. Using randomization, groups may be made equal. These kinds of patterns have even out groupings.

Designing a quasi-experiment.

Less control is available with a quasi-experimental design. Randomization cannot be achieved. Most experiments in education employ this design. The researcher employed a quasi-experimental approach. 'Three groups alone posttest design' was employed by the researcher.

This study's logical reasoning serves as a solid foundation for it.

1. This design adheres to the study's experimentation goals and procedures.
2. When subject randomization is not possible, this is the optimal design.
3. There are different numbers of subjects in each category.
4. The methodology is both internally and externally legitimate.

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Chapter – 05

Data Analysis and Interpretation

CHAPTER - 5

DATA ANALYSIS AND INTERPRETATION

5.1 INTRODUCTION

The goal of the data analysis and interpretation step is to turn the obtained data into reliable evidence regarding how the intervention was developed and how well it worked.

The process of giving the information that has been gathered a meaning and figuring out the conclusions, relevance, and consequences of the findings is known as data analysis and interpretation. However, going back to the goal of the assessment and the assessment questions will give a structure for the organisation of the data and a focus for the analysis (Mertler 2021)[1]. The stages required in data analysis depend on the type of information collected.

The organisation of the data into common themes or categories facilitates the interpretation of narrative (qualitative) data. Since narrative data does not have the same pre-existing structure that numerical data does, it is frequently more challenging to interpret. The narrative information initially seems to be a collection of disparate, unrelated statements. The objectives and questions of the evaluation can assist in focusing the data organisation (Dillaway 2017)[2].

Following the discussion of the literature review and study methodology, this chapter will cover the analysis of primary data gathered from 250 respondents using a structured questionnaire. The answers to the assessment questions should come from the examination of the data using statistical metrics and/or narrative themes. Determining the importance and implications of the evaluation is possible by properly interpreting the data that have been analysed.

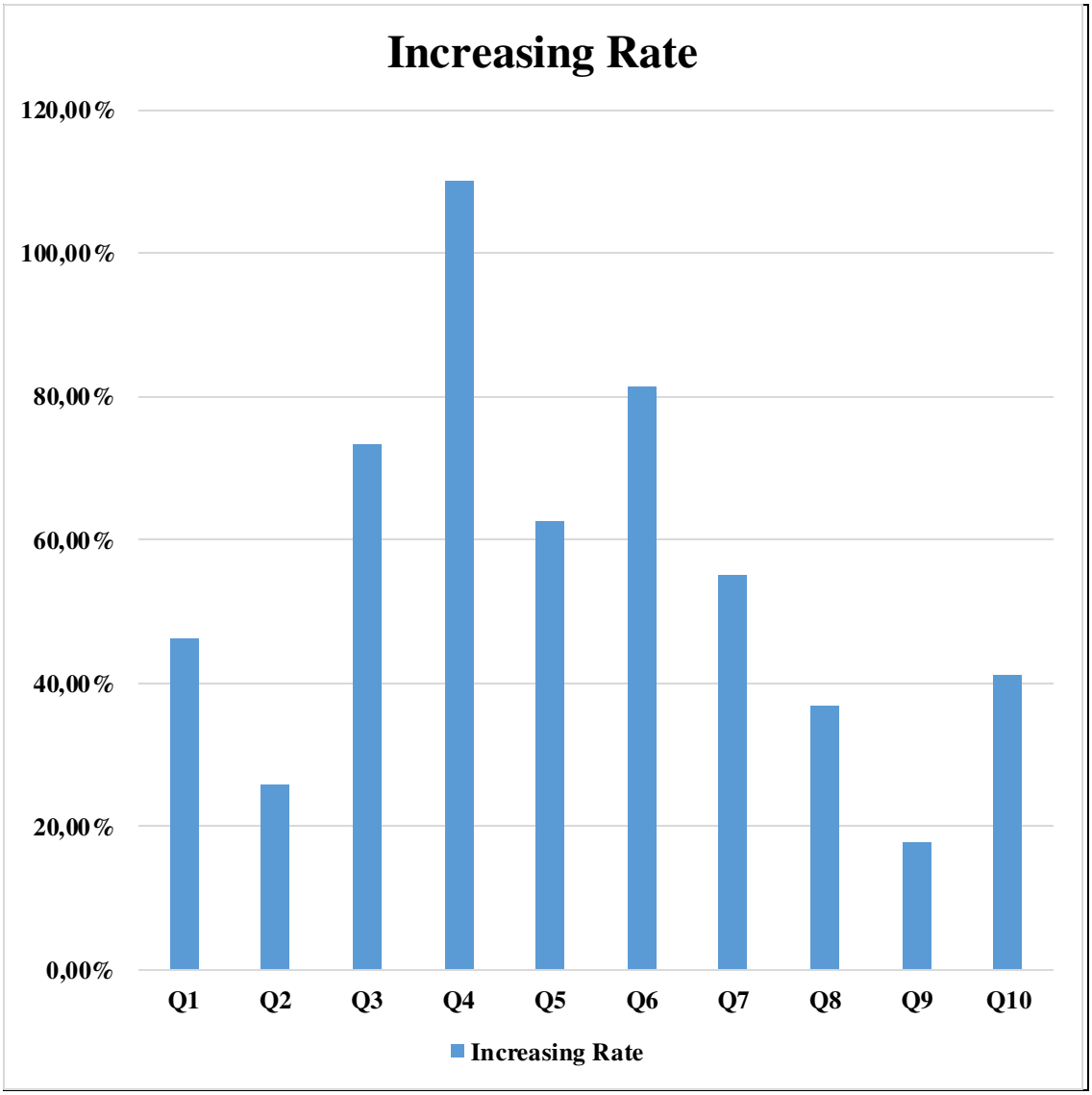
RESULT AND DISCUSSION

Section I: Class 6th

TABLE 1: CLASS 6th RESULT

Sr. No.	Questions	Class wise responses			
		Before MTP	After MTP	Difference	Increasing Rate
		Correct answer given around 50 students per class	Correct answer given around 50 students per class		
		6th	6th	6th	
1	Q1	26	38	12	46.15%
2	Q2	31	39	8	25.80%
3	Q3	15	26	11	73.33%
4	Q4	10	21	11	110%
5	Q5	16	26	10	62.5%
6	Q6	16	29	13	81.25%
7	Q7	20	31	11	55%
8	Q8	19	26	7	36.84%
9	Q9	28	33	5	17.85%
10	Q10	17	24	7	41.17%
TOTAL		**198**	**293**		

CHART: 1: CLASS 6th RESULT



The results observed from the Table are:

1. Difference in answer on question first after MTP is (12). In other words, the Increasing Rate of Correct answer is 46.15%, in this sample positive differences before and after MTP. It clearly shows that there is positive impact of MTP on class 6th students.

2. Attracting difference (8). The ratio of increasing rate is 25.80%. Second question was some hard to solve for the class 6th students. When MTP was used for solving the questions positive result was found with increasing rate of correct answer.

3. When question 3rd was given to students very few of the students (15) were able to solve the question. But when MTP was used to solve the question there was a big change in number of students. 26 students gave the correct answer and the ratio was 73.33%, it is very big positive difference. The result of the table shows importance of MTP.

4. When class 6th students were given the fourth question to solve, a big change was observed, more than twice as many students solved it correctly, this was a huge change, it shows the importance of MTP

5. When students were given the fifth question to solve, about 10 more students solved the question correctly, indicating a growth rate of 62.5% which is a very good growth rate.

6. When students were given the 6th question to solve, before MTP technique only 16 students solved the question correctly but after using MTP technique there were 13 more students who solved the question correctly it is 81.5% growth rate.

7. Seventh question which was considered very difficult level for class 6 students. Before using MTP technique, only 20 students were those who solved it correctly but when MTP technique was used then total 31 students answered the question correctly. Solved this way i.e., there were total 11 students who solved that question in a better way and the growth rate was found to be 55% which is a very good level of growth rate in itself.

8. When students were asked or given the eighth question to solve, there were only 19 students who attempted the question correctly, but when MTP technique was used, there were a total of 26 students who attempted the question correctly. That means there were 7 students who showed the growth rate after using MTP technique and the growth rate was found to be 36.84 percent.

9. When students were given a new question to solve then only 28 students solved the question correctly but when MTP technique was used then 33 students solved the question correctly i.e., after using MTP technique There will be a further

increase in the number of 5 students who solved the questions correctly and the growth rate was found to be 17 85% which is a good percentage

10. When the results for the tenth and final question were obtained, it was found that before using MTP technique only 17 students solved the question but when MTP technique was used, there were 24 students who attempted the question correctly. and the number of students increased by 7 and the overall growth rate was found to be 41.17%

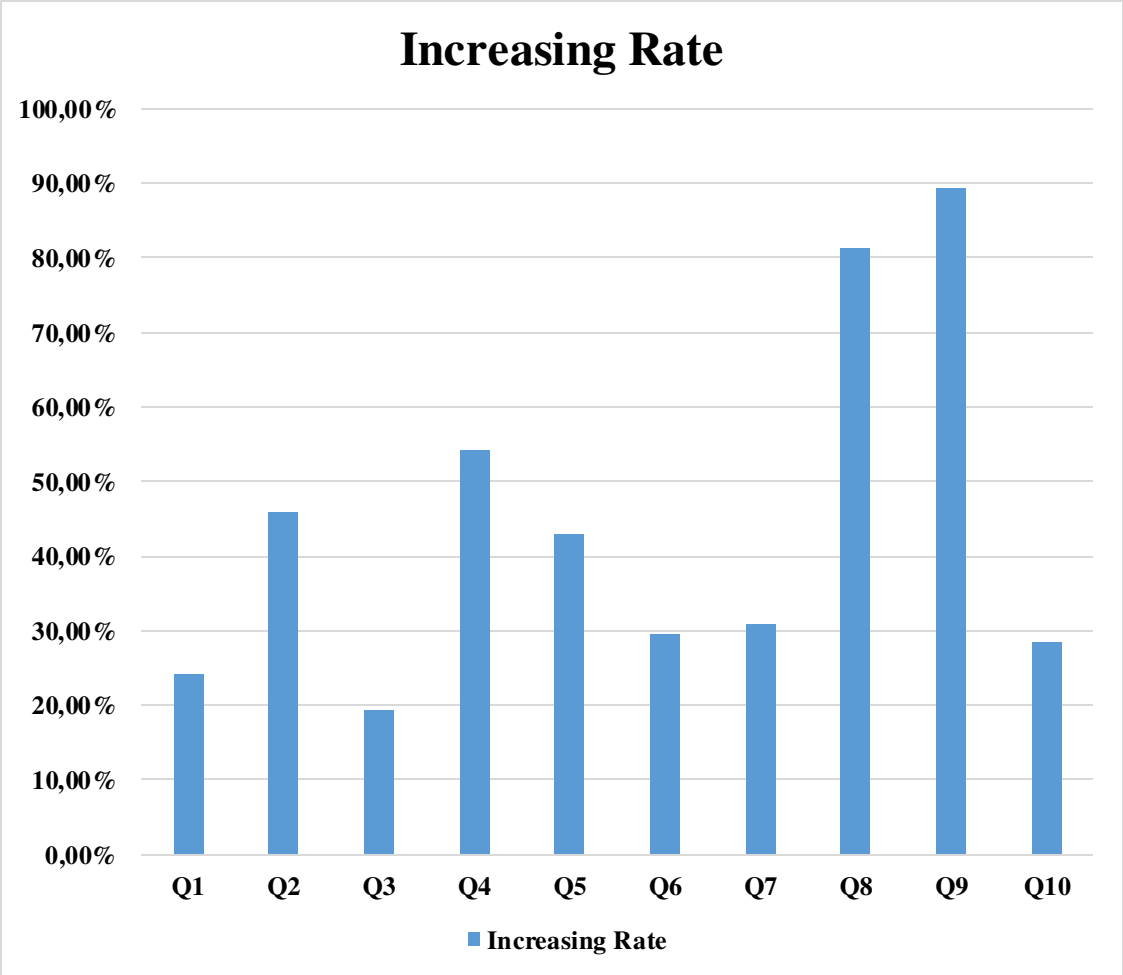
From the results obtained, it can be concluded that in today's modern era, mathematics which is a very dilemma for the students, many students consider it very difficult and run away from it. Mathematical problems should be solved by using new technology so that it is understandable to every student. MTP technique can become a good solution for visualizing Mathematics subject

Section II: Class 7th

TABLE 2: CLASS 7th RESULT

Sr. No.	Questions	Class wise responses		
		Before MTP	After MTP	Increasing Rate
		Correct answer given around 50 students per class	Correct answer given around 50 students per class	
		7th	7th	
1	Q1	33	41	24.24%
2	Q2	24	35	45.83%
3	Q3	26	31	19.23%
4	Q4	24	37	54.16%
5	Q5	21	30	42.85%
6	Q6	27	35	29.62%
7	Q7	26	34	30.76%
8	Q8	16	29	81.25%
9	Q9	19	36	89.47%
10	Q10	21	27	28.57%
TOTAL		**237**	**335**	

Chart 2: CLASS 7th RESULT



Decision results obtained when MTP test was conducted on class 7 students

1. When class 7 students were given the first mathematics problem to solve, only 33 students solved the mathematics problem correctly before the MTP test and 41 students solved the mathematics problem correctly after the MTP technique. and the growth percentage was found to be 24.24%, it shows how beneficial the MTP test is

2. When the result of the second question was obtained, before the MTP test, only 24 students took the question correctly and after the MTP test, the number of students who attempted the question correctly increased to 35 and the growth rate was 45.3%

3. When the results of the third question were obtained, the number of students who attempted the first question correctly in the MTP test was 26 and after the MTP test, the number of students who attempted the question correctly increased to 37 and the growth rate was 56.6%. which indicates how beneficial the MTP test can be, especially for the study of mathematics.

4. By reaching the fourth position of the questions, it was found that before the MTP test, the number of students who attempted correctly was 24, which later increased to 37 and showed a growth rate of 54.16%, which indicates that each and every student of Mathematics level MTP test can prove to be one beneficial and another one helpful

5. When the results of five questions were drawn, it was found that the number of students who corrected the math question before the MTP test was 21, which increased to 30 after the MTP test and the growth rate was 42.5%. That the MTP test can be used to solve math problems in a good way

6. By reaching the sixth level of the results, it was found that the number of students who corrected the math questions before the MTP test was 27, which has risen to 30 after the MTP test. The growth rate was found to be 29.62%, indicating that That the MTP test can solve some math problems in the right way and make it simple and easy for the students.

7. When the results of the eighth question were obtained, it was found that the number of students who corrected the mathematics questions before the MTP test was only 16, which became 29 after the MTP test and the growth rate was found to be 81.5%, which was found to be 81.5%. Indicates that whatever the level of questions, MTP technique is beneficial to the students in every way.

8. When the results of the 9^{th} question were checked, it was found that the number of students who corrected the math question before the MTP test was only 19, reaching 36 after the MTP test. The growth rate was found to be 90.7%, which is a tremendous growth rate is

9. When the results of the 10^{th} and final question were checked, it was found that before the MTP test, the number of students who solved the math problem correctly was only 21 and after the MTP test, the same number increased to 27 and the growth rate 28 found up to 57%

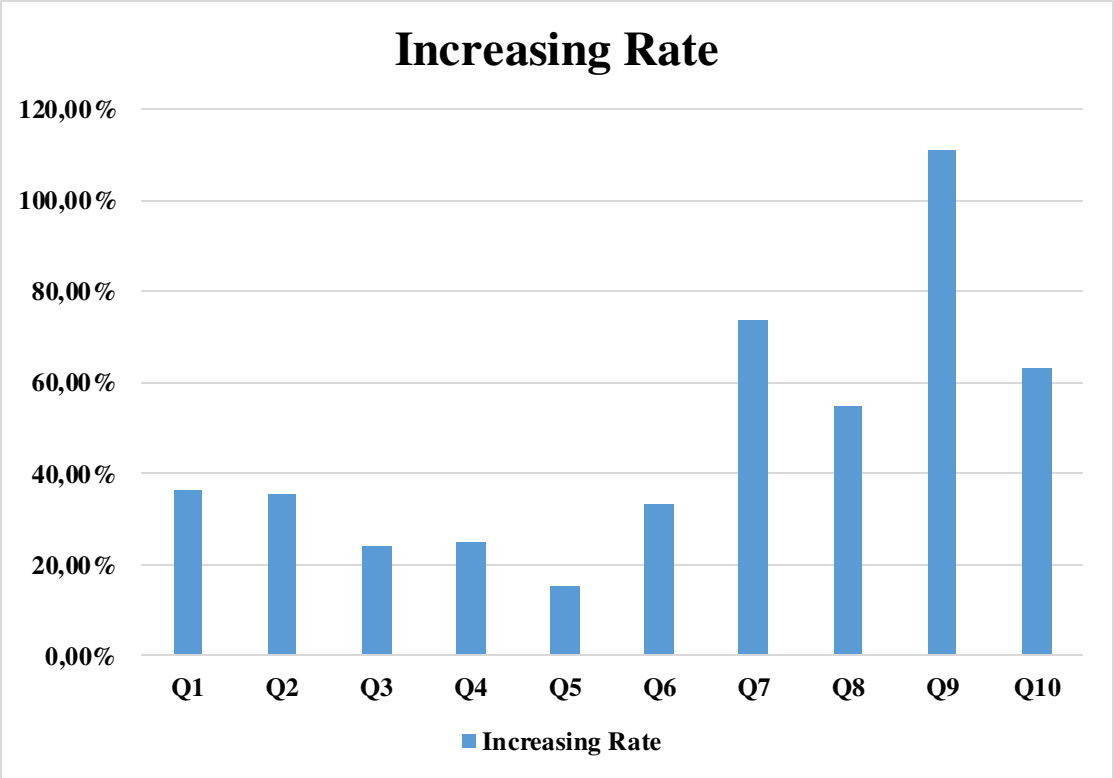
From the obtained results, it can be concluded that the problems of mathematics students can be solved to some extent by MTP test. MTP test can prove to be a panacea for mathematics related problems of students of any level.

Section III: Class 8th

TABLE 3: CLASS 8th RESULT

Sr. No.	Questions	Class wise responses		
		Before MTP	After MTP	Increasing Rate
		Correct answer given around 50 students per class	Correct answer given around 50 students per class	
		8th	8th	
1	Q1	33	45	36.36%
2	Q2	31	42	35.48%
3	Q3	29	36	24.13%
4	Q4	28	35	25%
5	Q5	26	30	15.38%
6	Q6	21	28	33.33%
7	Q7	19	33	73.68%
8	Q8	20	31	55%
9	Q9	18	38	111.11%
10	Q10	19	31	63.15%
TOTAL		**244**	**349**	

CHART 3: CLASS 8th RESULT



The following results were obtained when MTP test was conducted on class VIII students

1. The students of class VIII were also given 10 questions to solve as in the previous classes, when the results of the first question were obtained, the results were obtained that the total number of correctly solved mathematics questions before the MTP test. The number of students was 33 which increased to 45 after the MTP test and the growth rate was marked as 36.36% which indicates that the level of mathematics questions be of any class or of any level using MTP technique It can be made simple and easy

2. When the results related to the second question were obtained, it was found that the number of students who solved the math problem before the test was 31, which reached 42 after the test and the growth rate was 30.48 percent.

3. When the results related to the third question were obtained it was found that the number of students who solved the question correctly before the test was 29

which reached 36 of the tests and the growth rate was 24.15% indicating that how profitable is the MTP test

4. When the results related to the fourth question were obtained, it was found that out of the total students, only 28 students solved the mathematics question correctly before the test, but after the test, the number of students reached 35 and the growth rate was up to 25%. From the recorded text results, it can be concluded how helpful the NTP technique can be

5. When the results related to the given fifth question were obtained, it was found that the number of students who solved the first question of the test was 26 and after the test the same number reached 30 and indicated a growth rate of 15.38%

6. When the results of the given 6^{th} question were checked, it was found that the number of students who attempted the first question correctly before the test was 21 and after the test it increased to 28, indicating a growth rate of 33.33%.

7. When the results of the seventh question were checked, it was found that out of the total students, only 19 students attempted the first question correctly in the test, but after the test, the number of students who corrected the question reached 33 and Growth rate found to be 73.68%

8. When the results of the eighth question were checked, it was found that the number of students who correctly attempted the first question of the test was 20, which has reached 31 after the test, the growth rate was found to be 55%.

9. When the results of the ninth question were checked, it was found that the number of students who attempted the test correctly before the test was only 18, which reached 38 after the test and the growth rate was found to be 111.11 percent, an unprecedented increase. which it fully dictates that MTP may prove to be a technical aid

10. When the results of the 10^{th} last question were checked, it was found that the number of students who solved the question correctly before the test was 19, which reached 31 after the test and the growth rate was found to be 63.15%

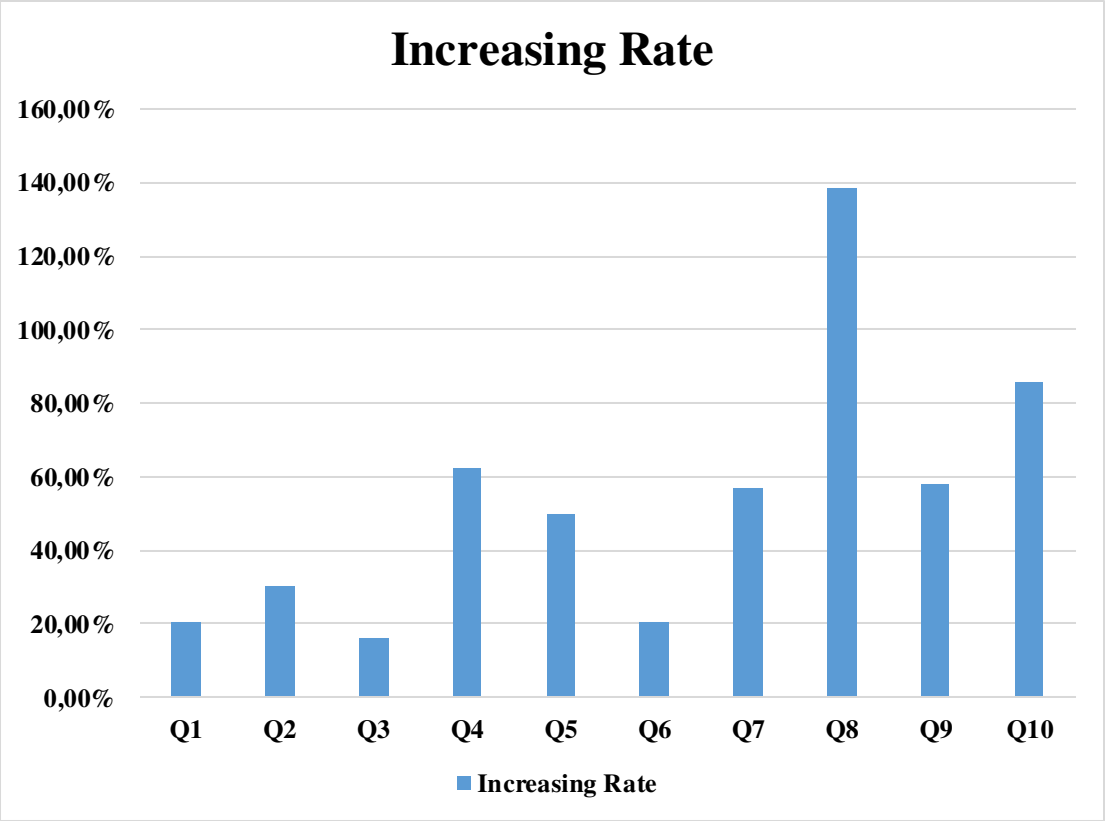
From the results obtained, it can be concluded that the questions at each level, whether easy or difficult, can be made easy for the students by using MTP technique.

Section IV: Class 9th

TABLE 4: CLASS 9th RESULT

Sr. No.	Questions	Class wise responses		
		Before MTP	After MTP	Increasing Rate
		Correct answer given around 50 students per class	Correct answer given around 50 students per class	
		9th	9th	
1	Q1	39	47	20.51%
2	Q2	30	39	30%
3	Q3	31	36	16.12%
4	Q4	24	39	62.5%
5	Q5	26	39	50%
6	Q6	29	35	20.68%
7	Q7	21	33	57.14%
8	Q8	13	31	138.46%
9	Q9	19	30	57.89%
10	Q10	21	39	85.71%
TOTAL		**253**	**368**	

CHART 4: CLASS 9th RESULT



The following results were obtained when the MTP test was conducted on the students of class 9th

1. When the results related to the first question were checked, it was found that out of the total number of students before the test, the number of students who corrected the question was 39, which has reached 47 after the test, the growth rate was 20.51%.

2. When the results related to the second question were checked, it was found that the number of students who attempted the test correctly before the test was 30, which reached 39 after the test and the growth rate was found to be 30%.

3. In the results of the third question, it was found that the number of students who corrected the first question of the test was 31, which reached 36 after the test and the growth rate was found to be 16.12%.

4. In the results of the fourth question, it was found that the number of students who corrected the math question before the test was 24, which reached 39 on the test and the growth rate was marked 62.5%.

5. When the results of the fifth question were checked, it was found that the number of students who corrected the first years of the test was 26 and after the test the quality reached 40 and the growth rate was marked up to 50%.

6. When the results of the next 6^{th} question were checked, it was found that the number of students who attempted the question correctly before the test was 29, which rose to 35 after the test and a growth rate of 20.8% was achieved.

7. When the results of the seventh question were checked, it was found that before the test the number of students who solved the question correctly was 21 and after the test this number reached 33 and the growth rate of 57.14% was achieved.

8. In the results of the eighth question, it was found that the number of students who solved the first question of the test was 13 and after the test or the number has become 31, the growth rate was found to be 138.46%

9. In the results of the ninth question, it was found that the number of students who solved the question before the test was 19 and after the test or the number has become 30, the growth rate was found to be 57.89%

10. In the results of the tenth question, it was found that the number of students who solved the first question of the test was 21 and after the test or the number 39 the number has become so much that the growth rate was found to be 85.71%

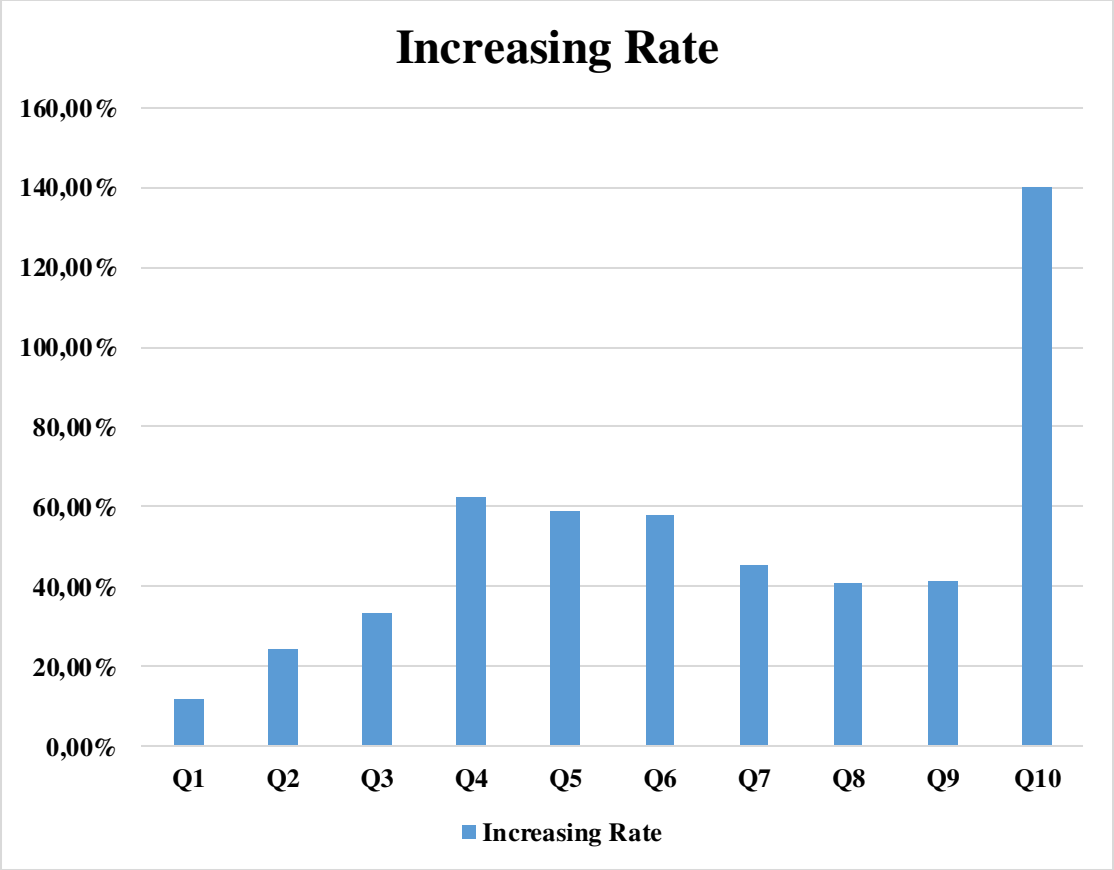
From the results it can be concluded that MTP technique is beneficial for the students at every level.

Section V: Class 10th

TABLE 5: CLASS 10th RESULT

Sr. No.	Questions	Class wise responses		
		Before MTP	After MTP	Increasing Rate
		Correct answer given around 50 students per class	Correct answer given around 50 students per class	
		10th	10th	
1	Q1	42	47	11.90%
2	Q2	37	46	24.32%
3	Q3	30	40	33.33%
4	Q4	24	39	62.5%
5	Q5	22	35	59.09%
6	Q6	26	41	57.69%
7	Q7	31	45	45.16%
8	Q8	27	38	40.74%
9	Q9	29	41	41.37%
10	Q10	10	24	140%
TOTAL		**278**	**396**	

CHART 5: CLASS 10th RESULT



Class 10 students are generally considered to be of a slightly higher standard when MTP test is done on them. The following results have been obtained

1. When class 10 students were given to solve, as a result it was found that out of the total students, only 42 students were those who attempted the question correctly but when their results were checked after the MTP test, the total number of students was Out of 47 students answered the question correctly as it shows that the MTP test affected the students and the growth rate was found to be 11.90%

2. When the results of the second question were checked, it was found that out of the total students, only 37 students were those who attempted the question correctly, but when MTP test was used, it was found that out of the total number of students, it was found that there were 46 students. solved correctly which is 9

more than the number of earlier students and the growth rate was found to be 24.32%

3. When the results of the third question were checked, it was found that before the MTP test only 30 students out of the total students answered the question correctly, but after the MTP test, out of the total number of students, 40 students answered the question correctly. method and the growth rate were found to be 33.33%

4. When the results of the fourth question were checked, it was found that the number of students who corrected the first question of the MTP test was 24 and after the MTP test this number changed to 40 and the growth rate was found to be 62.5%.

5. When the results of the fifth question were checked, it was found that the number of students who attempted correctly before the MTP test was 22 and after the MTP test this number changed to 35 and the growth rate was found to be 59.09%

6. When the results of the 6^{th} question were checked, it was found that before the test 26 students solved correctly and after the test, the number of correct ones increased to 41 and the rate of increase was found to be 57.69%.

7. When the results of the seventh question were checked, it was found that before the test 31 students solved correctly and after the test, the number of correctors increased to 45 and the rate of increase was found to be 45.16%.

8. When the results of the eighth question were checked, it was found that before the test, 27 students had solved it correctly and after the test, the number of correct ones increased to 38 and the rate of increase was found to be 40.74%.

9. When the results of the ninth question were checked, it was found that before the test 29 students solved correctly and after the test, the number of correct ones increased to 41 and the growth rate was found to be 41.37%.

10. When the results of the tenth question were checked, it was found that before the test 10 students solved correctly and after the test, the number of correct ones increased to 24 and the rate of increase was found to be 140%.

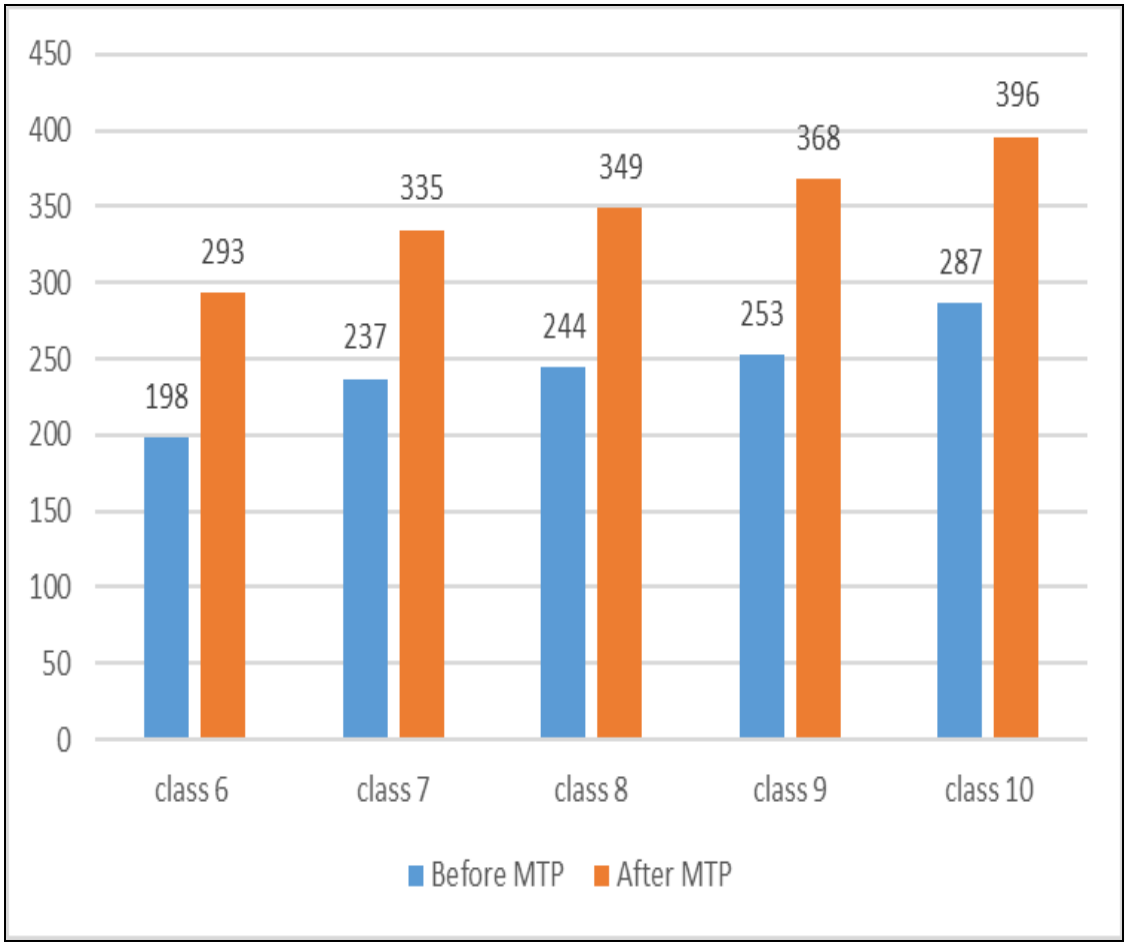
From the results obtained, it can be concluded that MTP technique is proving helpful in facilitating the problems of mathematics at every level of the students, so in conclusion it can be said that this technique develops the mental space of the students.

Section VI: Combined Results of All Classes

TABLE 6: COMBINED RESULTS

Sr. No.	Class	Before MTP	After MTP
1.	Class 6	198	293
2.	Class 7	237	335
3.	Class 8	244	349
4.	Class 9	253	368
5.	Class 10	287	396

CHART 6: Combined Results



From the results obtained, it can be concluded that MTP technique is proving helpful in facilitating the problems of mathematics at every class level. So, in conclusion it can be said that this technique develops the mental space of the students.

Section VII

Hypothesis Testing

H_1 There is significant role of MTP on pupil's achievement in Mathematics.

Table 7: Pupil's achievement in Mathematics

t-Test: Paired Two Sample for Means		
	YES	***NO***
Mean	15.6	4.4
Variance	206.8	11.3
Observations	5	5
Pearson Correlation	0.247203	
Hypothesized Mean Difference	0	
Df	4	
t Stat	1.797126	
P(T<=t) one-tail	0.073364	
t Critical one-tail	2.131847	
P(T<=t) two-tail	0.146728	
t Critical two-tail	2.776445	

When respondents were asked that there is role of MTP on pupil's achievement in Mathematics. Result was received that t Stat value (1.797126) is lower than t-Critical two-tail value (2.776445), it clearly indicates that acceptance of hypothesis that there is significant role of MTP on pupil's achievement in Mathematics.

H_2 The pupil's satisfaction in MTP is indifferent with respect to their demographics.

Table 8: Pupil's satisfaction in MTP

t-Test: Paired Two Sample for Means		
	YES	***NO***
Mean	16.2	3.8
Variance	242.2	3.7
Observations	5	5
Pearson Correlation	0.076832	
Hypothesized Mean Difference	0	
df	4	
t Stat	1.784958	
P(T<=t) one-tail	0.074411	
t Critical one-tail	2.131847	
P(T<=t) two-tail	0.148822	
t Critical two-tail	2.776445	

When respondents were asked that pupil's satisfaction in MTP is indifferent with respect to their demographics. Result was received that t Stat value (1.784958) is lower than t-Critical two-tail value (2.776445), it clearly indicates that acceptance of hypothesis that there is pupil's satisfaction in MTP is indifferent with respect to their demographics.

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Chapter – 06

Observation and Conclusion

CHAPTER - 6

RESULTS AND CONCLUSIONS

6.1 INTRODUCTION

What is the objective of the study, what are the sources of information for its advancement, what are the requirements to be met while completing the study—all of these questions and more are covered in detail in this chapter, which deals with the summary of the study.

In general, we all know that education continues throughout life, in everyone's life, and everywhere; if we talk about informal education, it even begins in a child's early years; but, when we talk about formal education, not everyone finds it to be beneficial. A person who attends school, college, or university will acquire a variety of knowledge, skills, and experiences. The fundamental purpose of education is to transmit culture, information, and experience from one generation to the next. Simply said, education is the process of assisting someone in discovering their own potential and untapped talents, which may be influenced by a facilitator or teacher.

In a broad sense, education refers to the process by which a group of people pass on their goals, routines, activities, and other traits from one generation to the next. It goes through the concept, thinking, receiving, feeling, and acting processes. It may act based on experience, by seeing what is happening in front of them, by the demands of the moment and society, or a combination of these. Early on in childhood, the child expresses his or her natural creativity in his or her actions and works, but as the child advances in age, he or she becomes more constrained by rules and regulations and begins to remember facts rather than processes, which widens the gap between his or her performance and learning. Even the educational exam system, which emphasizes information over method, harms students' capacity, creativity, and other qualities.

The list of issues in education is very long, but it can be condensed if a high-quality education system is established, where the emphasis must be placed on the learning process, conceptual understanding, the emergence of abilities, and knowledge gained

through first-hand experience rather than learning facts. As a result, learning and education will both be successful.

6.2 SIGNIFICANCE OF THE STUDY

The use of posing as an education design bear be done as commonly as attainable. The teacher models for the class by candidly operating a task or task before the students start. Modeling is another adept approach to directing a class. Teachers the one explains in what way or manner to finish the task will receive middling questions or concerns from scholars the one is doubtful of by means of what to pass. A learner can gain a clear understanding of by virtue of what to address the question within reach by forming. If a junior can visualize how to complete the project, they will feel more confident about by means of what commotion so. By background a model of what the professor expects, this form of counseling empowers the juniors to accomplish. When commands have existed likely but pupils still do not grasp how or place to start, neither professors nor scholars find it entertaining. With displaying, these issues will depart, which will improve school room administration. The profit of model education programmes for two together instructors and students in the education and education of arithmetic has existed recognised by research. Teachers' understanding of arithmetic contains the use of visual sexually transmitted disease usually, and they may be valuable when trying to clarify mathematical ideas. The Model Teaching Program can speed this process of clarification by emphasising particular visage of a analytical plan (for example, the array representation effecting the erratic and distributive personality of duplication, debate of various theorems). Students can connect their own occurrences to numerical plans by way of able to be seen with eyes model likenesses, which helps bureaucracy learn these abstract analytical plans. A kid learns plenty belongings that all meet in his existence when he starts make use of school as one the educational program, or you power voice formal instruction. When these one is imported, it is found that arithmetic is accepted compared to added regimens. The kid achieved inevitably struggle in added punishments as a result. A toddler faces singular troubles in each subject. From a cognitive position, all of the arguments must suit for children's ages, values, and necessities. There are various methods and habits to form a subject easier when experiencing an offspring for the first occasion. One arrangement of learning a subject ability occasionally be beneficial in education about another subject and power seldom be a part of an

obstruction that create learning that subject more troublesome. Further inspection tells that many levels of scholars see arithmetic to be troublesome. When attractive an arithmetic course, it is critical to sufficiently understand the subject's core plans. It is honest to the teacher to select in what way or manner to present the subject, how to maintain the gathering affecting, and in any case he or she can create all communication engaging and favorable in helping the kids in understanding the subject. When determining on the pattern of arithmetic command, a teacher concede possibility allow for possibility the emotional traits of the pupils, in the way that their talents, talents, syllabus level, and wanted aims. As a result, a professor favorably and capably imparts information to students, growing their level of understanding, by attractive these aspects into concern. The different bigger knowledge namely erected upon the fundamental information will never stumble if the fundamental information about the issue and allure content is appropriately communicated. As the level is elevated, arithmetic enhances more intricate, and the subject enhances less interesting cause the troublesome questions are not solved fast. Knowledge of arithmetic demands a variety of abilities, containing computational, spoken, concerning feelings and intuition, and different inclinations. Dyscalculia is a serious question that has a direct link to arithmetic; it maybe provoked by carelessness, by a failure to comprehend the rule, or by suitable annoyed when bestowed accompanying troublesome computations utilizing the support of the Model Teaching Program When learning arithmetic at the subordinate level, are graduates' numerical veracity and speed various? The purpose of this study searches out confirms the belongings and importance of the bettering in numerical ability in addition to find out either it sexually transmitted disease in the situation of dyscalculia, the dread of examining a subject like mathematics, and either education arithmetic has benefits in different rules.

6.3 KEY WORD OPERATIONAL DEFINITIONS INCLUDE

Education- It is a type of learning whereby teaching, training, and research are used to pass on knowledge, abilities, and habits from one generation to the next. It typically happens after any encounter that alters the way one thinks, feels, or behaves.

Teaching- Formal teaching, or the process of teaching, typically takes place in classroom settings. It has been observed in the classroom that the teacher has a thought in his head

and takes every effort to ensure that the kids grasp it. To achieve the desired change in a student's behavior, one must master the art of education.

Learning- Learning, according to one educationalist, is the alteration of behavior via experience and education. It is a modification of behavior brought about by repetition that aids in learning and problem-solving while also promoting growth and development (Allen 2007)[1].

Using math thinking-Thinking mathematically is essentially related to mathematical operations including ratios, patterns, and correlations as well as addition, subtraction, multiplication, division, fractions, place value, and number sense (Parsons 2002)[2]. It is a simple and enjoyable method for teaching mathematics in middle school, high school, and beyond!

Think mathematically-It is a very difficult activity. Given that it is a problem-solving process, resources, heuristic techniques, monitoring/control, and beliefs are all present. The mechanisms at the core of mathematics are revealed by thinking mathematically. It illustrates how to support, advance, and nurture the techniques that come easily to mathematicians. Learn new things and challenge your assumptions if you want to succeed in math class. Instead, one important aspect of mathematical thinking is creative problem-solving, which is a crucial skill in the modern world (Mangal 2002)[3].

6.4 MAJOR FINDINGS OF THE STUDY

MTP technique can be used to solve math problems for students of any level, making them easier to understand. It can also help develop the mental space of the students, making it easier for them to understand math.

From the table:1, it can be concluded that in today's modern era, mathematics which is a very dilemma for the students, many students consider it very difficult and run away from it. Mathematics problems should be solved by using new technology so that it is understandable to every student. MTP technique can become a good solution for math's subject (Gonda 2022)[4].

From the obtained results, it can be concluded that the problems of math's students can be solved to some extent by MTP test. MTP test can prove to be a panacea for math's related problems of students of any level (Mirkin 1996)[5].

From the results obtained, it can be concluded that the questions at each level, whether easy or difficult, can be made easy for the students by using MTP technique.

From the results obtained, it can be concluded that MTP test MTP technique is proving helpful in facilitating the problems of mathematics at every level of the students, so in conclusion it can be said that this technique develops the mental space of the students.

6.5 HYPOTHESIS TESTING

When respondents were asked that there is role of MTP on pupil's achievement in Mathematics. Result was received that t Stat value (1.797126) is lower than t-Critical two-tail value (2.776445), it clearly indicates that acceptance of hypothesis that there is significant role of MTP on pupil's achievement in Mathematics.

When respondents were asked that pupil's satisfaction in MTP is indifferent with respect to their demographics. Result was received that t Stat value (1.784958) is lower than t-Critical two-tail value (2.776445), it clearly indicates that acceptance of hypothesis that there is pupil's satisfaction in MTP is indifferent with respect to their demographics.

6.6 IMPLICATIONS FOR EDUCATION

According to a study's findings, kids will learn best if new, straightforward methods are employed to teach them. Engaging the students in the activities is preferable. Every type of subject has its own importance, and it is the responsibility of every teacher to make the best use of the resources available to ensure that his students fully understand the concept. The nature of the subject also aids in giving the students a chance to experience the subject and its quality.

If Science is vital to understand technology, Mathematics is also necessary for its fundamental daily operations, English is essential as a medium of communication, and Social Studies is necessary to understand societal demands and the world around them. For the majority of kids, science and math are equally typical. The issues with learning

mathematics might be anything from minor to major. Numerous people frequently struggle with their numerical skills, arithmetic issues with basic computations if the numbers are large, or difficulty with decimal values. Technology has offered a plethora of answers to these issues, but all of them are instrument-focused and do little more than make kids dependent on their instruments, rendering them unable to perform on their own without them.

- A minor effort is made by employing the Model Teaching Program technique to determine the pupils' true capacities and to make them reliant exclusively on their own minds rather than any materialistic devices. The following points can be used to line up all the implications:

- The results of this study will help the students recognise the value and necessity of learning fundamental mathematical ideas and processes.

- By linking it to their daily lives, this will help determine the students' aptitude in various areas of acquiring mathematical fundamentals and concepts.

- The instructor will also be able to recognise the value and necessity of numerical, spatial, and other sorts of ability.

- Learners may benefit from using their fingers to do simple math operations and real-world examples to explain complex mathematical concepts.

- making kids capable of using math in scenarios found in the real world

- Encourage your children to apply the math techniques they have honed on their own and that have proven successful.

- Students have the chance to learn via interactions with their peers since they must first clarify something in their own minds before presenting it to someone else. They can also build deeper conceptual grasp of mathematics by recognising new techniques.

- This would make it easier for the professors to assess how well the pupils can use their newly acquired mathematical knowledge to solve problems.

- The concentration on teaching mathematical concepts and other techniques that make learning enjoyable, especially at elementary or just after primary levels, will aid math teachers.

- This study will give teachers guidance on how to improve their teaching methods by including the students.

- Students could be assigned the responsibility of framing mathematical problems similar to those found in textbooks in order to foster healthy competition among them.

- Students can develop the ability to think for themselves.

- They can learn more effectively by applying many mathematical principles to real-world, everyday activities.

- By combining their concrete abilities with their abstract abilities, math teachers can help students gain confidence.

- Following the study's findings, there would be a larger demand for learning mathematics by putting more emphasis on procedural knowledge rather than factual knowledge.

6.7 SUGGESTIONS FOR MODEL TEACHING PROGRAM

6.7.1 Understanding the miscellaneous education troubles that undergraduates face: There will forever be a variety of education styles that demand your consideration, nevertheless the class or pupils you are education. A professor must be artistic so that placate the demands of each of their students likely that skilled are eight various knowledge styles. (Weinstein 1985)[6]. In order to meet the demands of your undergraduates, you as a coach must introduce more occasion and work than is necessary. Different education styles appease and engross undergraduate's indifferent habits. But once an assistant masters these methods, they are paid accompanying empowered and favorable pupils. (Sadler 2014) [7].

6.7.2 Student Family Problems and Bullying: Students' lack of approach to healthcare authorities is a big question in instruction because it forces ruling class to turn to their professors for psychological support and care concerning domineering and classification concerns. Being there for your pupils is great, as expected, but it goes further what a teacher arranges and repeatedly leaves ruling class accompanying excessive commotion.

6.7.3 Reduce Lack of Funding: The deficiency of funding is individual of the major questions in instruction that coaches are handling. Unfortunately, public or liberated schools versatile the country commonly fight with capital, unless you undertake a private organization. Reduced junior-lecturer percentages are the beginning answer when schools are binding monetary troubles, and this has an immediate effect on the knowledge of the undergraduates. Teachers are not able to determine each graduate the heart-to-heart talk consideration namely so main due to the growing number of kids in each class. Lower pupil realization and vindication are the consequences.

6.7.4 Reduce Lack of Effective Communication: Students have the troublesome maturity of meaning their necessities to teachers occurring. Some children are consistently effective it; they can ideas their needs and wants in an appealing habit and get what they want. However, many publics find it difficult to communicate accompanying their faculty members in an effective form. Teachers must cultivate a compatibility accompanying their pupils and uniformly work on their ideas abilities as the more knowing appendages of the group.

6.7.5 Being Encouraging and Motivating Under Challenging Times: Students have spellbinding knowledge convenience and trips during the whole of the school old age. And the most of the year will elapse construction connections accompanying your kids. You will, still, periodically need to stimulate your graduates to endure the challenging portions of the period. For instance, grades 9-12 pupils are encumbered accompanying examinations and exercise that will decide their futures. On the other hand, preschoolers must overcome troubles containing pen grips and sphere abilities. Both age groups demand an instructor they can depend to accommodate bureaucracy a jostle.

6.7.6 Disciplining Students: In the hall, discipline children maybe troublesome and period- and emotionally-absorbing. While you may be certain that your class will involve some cute kids, it's likewise usual to run into pupils the one is crude and rude.

Students who treat you impolitely can create you hate education, but you also need expected guarded about by what method you handle disruptions and discipline scholars. Implementing appropriate penalties, location the source of the issue, including persons, and expanding mediation strategies are all habits to handle the lack of civilities in your classroom.

6.7.7 Endless Paperwork and Extended Working Hours: If skilled individual thought you remember from your best time of life, it's that your lecturers were forever sinking in papers to mark and grade. Also, attractive morbid days off isn't continually an option. Unfortunately, designating documents is not a process accomplished during class occasion, accordingly professors commonly mark documents after class has decided.

Paperwork demands recording your kids' development during the whole of the period in consideration of account for their progress. Individual evaluations must still be written apart from the teaching outline, that repeatedly necessitates occupied late.

6.7.8 Time Management: Being on your extremities all era long is required for the task of education, and skilled is repeatedly little opportunity for recovery. So, apart from being movable, you also need to hold the bees' minds committed.

Making your work as a scholar easier demands creating creative planning to keep kids entertained. Planning and opportunity administration become main in this place position. Time management requires founding a exciting plan that covers the period's work without missing over subject, just like it does for grades 9-12 undergraduates.

6.7.9 Assessing students need: A project must help a scholar's most urgent needs if it is to have a solid influence at which point graduate. As a result, it's fault-finding to rely on eminent pupil rulers and organisations to analyse the community's necessities and supply practice information on the questions that pupils challenge. Academic or governmental research that grant permission approach about the graduates endure be used to supplement this. Student goals concede possibility enhance more different as a result of these amounts of their necessities, that will make it smooth for project plans to stand. Please depend public service organisations or aware skill appendages who can have previously achieved this task (Klempin 2018)[8].

6.7.10 Building Trust: There are frequently histories of weak ideas, disregard, mistrust, and even confrontation in friendships betwixt metropolis-dress and academy undergraduates. As you engage in conversation accompanying pupils, it is in consideration of see these histories and the challenges they present for new square-undergraduate collaborations. Even in positions place skilled has never happened conflict, a lack of ideas may influence misperceptions on two together hands of the issue. Forging together productive friendships therefore demands open, bright ideas. Public colloquiums, caller lectures, pupil talks, campus or scholar tours, and additional interplays that promote understanding and trust are likewise beneficial. Last but not smallest, it's fault-finding to depend those things the one can expand bridges between your academy and the graduates, either they be university-associated pupils or local staff and coaches (griffiths 2007)[9].

6.7.11 Creative and bendable project design: It's important to somewhat balance the date and learning aims of each junior while forming a project accompanying their wife. This grant permission call for few inspiration and changeability on two together edges. When regulating a course's learning goals to a junior's companion's realistic demands, assistants must be adaptable. Additionally, so that select projects that would present graduates appropriate education freedom, student associates concede possibility need expected compliant. In this process, trust, shared understanding, and open ideas are essential.

6.7.12 Setting realistic project aims: Setting education and undergraduate aims that your undergraduates can handle within the boundaries of your course is important when plotting a joint project. Additionally, it's detracting to confirm your students comprehend these goals and what be necessary of bureaucracy at each stage of the course.

6.7.13 Managing junior anticipations: Partners for students maybe anxious to have graduates befriend ruling class on fresh and main pushes, and they ability have extreme anticipations for that reason they can achieve. While this enthusiasm is critical for conceiving a favorable cooperation, it's also critical to confirm your friend is informed about latest trends the talents your pupils have and do not possess and to constitute aims for the project that are two together achievable and useful.

6.7.14 Ensuring progression: The demands of students commonly surpass the boundaries of individual project and the term time frame that most coaches use to experience. Consequently, construction powerful friendships accompanying educators is beneficial for two together graduates and supervisors. Long-term co-operations not only produce various projects over occasion that may have an accruing effect on the graduates, but they more support the common trust and understanding that makes future project preparation and benefit smooth. Students' necessities maybe join throughout occasion by a type of instructors and courses if these alliances 'tween the juniors and whole departments, programs, or organizations maybe settled. This supplies even larger undergraduate impact and collaborations that are less exposed to individual ability appendages' course changes.

6.7.15 Assessing impacts: It is important to determine student-located education's influence just like you would be accompanying some additional kind of command. While coaches repeatedly accumulate graduate evaluations of a course, there is commonly no related arrangement working for pupil colleague evaluation. Student wife evaluations maybe completed activity middle through a project to implement some unavoidable course adjustments, but they bear further be completed activity in the end to evaluate the project's overall impact. This can take the form of a final inscribed review that a scholar requests from bureaucracy what contains distinguishing questions about each stage of the project, from the utility of the project design to the behaviour of the undergraduates to the value of the effects. Using a connected to the internet survey householder like survey monkey can help convince better anonymity and transparence if skilled are diversified companions and they have approach to the internet.

6.8 CONCLUSION

Acquiring mathematics is a positive process that goes beyond acquiring methods, concepts, techniques, and applications. Results of a study have found a link between receiving extra care and either learning the subject or improving one's mathematics skills. Special instruction should be put more emphasis on developing mathematical ability than just practicing formulas in a notebook without engaging in procedural or mental exercises. MTP can revolutionise how mathematics is learned by providing a free space for visualising mathematical concepts in a dynamic context. It can also assist in

guiding classroom instruction by raising teachers' awareness of the difficulties associated with visualising mathematics.

- Acquiring mathematics is, in general, a positive process that goes beyond acquiring methods, concepts, techniques, and applications. Mathematical skills, such as logical thinking, rational reasoning, paying attention to the important aspects of the sum, orderly presentation, precision, accuracy, analytical and deductive skills, numerical abilities, problem-solving abilities, and spatial abilities, help students develop higher order intellectual and mathematical abilities. As per the results of the present study, another noticeable finding is that:
    - The majority of pupils who have not received special treatment exhibit some superiority, though less so than compared to those who have. However, an intriguing study has found a link between receiving extra care and either learning the subject or improving one's mathematics skills. Therefore, efforts must be made in accordance with these guidelines to determine the effects of special instruction on the acquisition of mathematical operation concepts at the upper primary level by putting more emphasis on developing mathematical ability than simply practicing formulas in a notebook without engaging in procedural or mental exercises.
    - Promote and re-direct parents and educators towards these parts of memorization through learning-doing and learning by doing.
    - When it comes to mathematics education, the key challenge is to comprehend how observing a particular's subtle application would advance mathematics education for future technologies that won't exist in the foreseeable future. Transversal notions, which consider technological possibilities over local ones, have been the foundation of great ideas that endure across time.

Because it offers a free space for visualising mathematical concepts in a dynamic context, MTP revolutionises how mathematics is learned. This concept can be applied in

a variety of other contexts to show students the diverse environment in which mathematical objects exist.

MTP can also assist in guiding classroom instruction by raising teachers' awareness of the difficulties associated with visualising mathematics and devising strategies for assisting students in creating and comprehending visual representations that will support their comprehension of specialised math topics.

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Annexure

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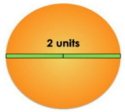
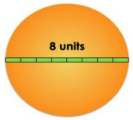
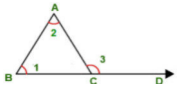
Questionnaire

Class wise Questionnaire

Sr. No.	Questions	Before MTP				After MTP			
		Questions given around 50 students per class	Options			Questions given around 50 students per class	Options		
		6th	A	B	C	6th	A	B	C
1	Q1	If B = 11, T = 12 and S = 3, Then S + S + S = 10T - 111 = ____	5	3	10	If B = 3 and T = 4, Then 180 - 2B + T = ____	184	108	178
2	Q2	A rectangle is 6 m wide and 3 m high, what is its Area?	18 sq. m	16 sq. m	9 sq. m	A rectangle is 12 cm long and 5 cm tall, what is its Perimeter?	35 cm	34 cm	60 cm
3	Q3	 The diagram shows a rectangle and a square. If they have equal perimeters, what is the length of one side of the square?	6	5.5	5	 What is the perimeter of the cross? (All sides are of length 10 units and all angles are right angles)	40	120	80
4	Q4	How many degrees are there in one straight angle?	180	90	360	How many degrees are there in one full rotation?	180	90	360
5	Q5	The circle has radius 21 cm. What is its circumference? (π=22/7)	346.5 cm	132 cm	198 cm	The circle has radius 70 cm and its circumference is 220 cm. This is equals to ___.	2π	3π	π
6	Q6	Which one of the following numbers is prime?	29	26	27	Which one of the following numbers is composite?	67	69	71
7	Q7	How many right angles does a square have?	2	3	4	The diagonals of a square:	Are equal in length, but do not bisect each other at right angles	Are of different lengths and bisect each other at right angles	Are equal in length and bisect each other at right angles
8	Q8	Every square is also a:	Rhombus	Kite	Trapezoid	Calculate the area of square whose side id 8 cm	32 sq. cm	64 sq. cm	16 sq. cm
9	Q9	_____ angle is greater than 90° but less than 180°	Right	Obtuse	Acute	_____ angle is greater than 180°	Obtuse	Straight	Reflex
10	Q10	The sum of two angles in a linear pair is always ____	180°	90°	360°	A pair of angles formed on a straight line are said to be a _____	Vertical angles	Linear Pair	Adjacent angles

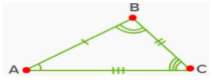
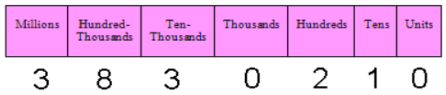
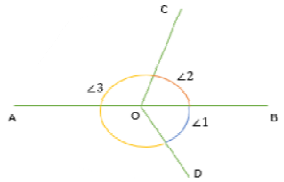
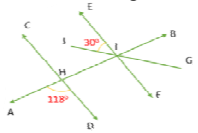
Class wise Questionnaire

Sr. No.	Questions	Before MTP				After MTP			
		Questions given around 50 students per class	Options			Questions given around 50 students per class	Options		
		7th	A	B	C	7th	A	B	C
1	Q1	Find the value of x: −24x − 15 = −27x + 12	5	3	9	Find the value of x: −x + 15 = 2x + 12	1	0	7
2	Q2	What is the approximate area of a circle with a radius of 4 units?	50 sq. units	48 sq. units	16 sq. units	What is the approximate area of a circle with a diameter of 4 units?	16 sq. units	13 sq. units	8 sq. untis
3	Q3	 How many units will it take to wrap the circle? Make an estimate.	6.28 units	4.28 units	4 units	 How many units long is the circumference of the circle?	12 units	25.12 units	20 units
4	Q4	Find isosceles triangle				Exterior angle of a triangle 	∠1+∠2=∠3	∠2+∠3=∠1	∠1+∠3=∠2
5	Q5	The total measure of the three interior angles of a triangle is	360°	180°	90°	The total measure of the exterior angles of a triangle is	360°	180°	90°
6	Q6	Compare the given fraction using proper symbole: 2/3 ☐ 3/4	<	>	=	Compare the given fraction using proper symbole: 21/20 ☐ 20/21	>	<	=
7	Q7	In a rhombus, diagonals bisect each other at _____.	right angles	straight angles	acute angles	In a rhombus, the sum of two adjacent angles is equal to _____.	180°	360°	90°
8	Q8	The _____ of two quantities of the same kind and in the same units is a fraction that shows how many times the one quantity is of the other	Proportion	Ratio	Equality	What should be added to each term of the ratio 7: 13 so that the ratio becomes 2: 3	5	7	3
9	Q9	The number of faces of a cube is	8	12	6	Prisms and pyramids are	Cubes	Polyhedrons	Spherical shapes
10	Q10	The sum of two angles is 180°, the angles are called	complementary angles	supplementary angles	vertically opposite angles	The angles in a linear pair are _____	complementary angles	supplementary angles	vertically opposite angles

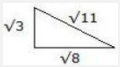
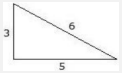
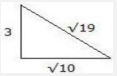
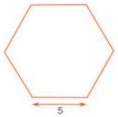
Class wise Questionnaire

Sr. No.	Questions	Before MTP				After MTP			
		Questions given around 50 students per class	Options			Questions given around 50 students per class	Options		
		8th	A	B	C	8th	A	B	C
1	Q1	For the number 9053, what does the 0 mean?	0 ones	0 hundreds	0 tens	For the number 7,864,427, what does the 4 with the higher place value mean?	4 thousands	4 hundreds	4 tens
2	Q2	Which of the following is correct?	Cube of a negative number is always positive.	Cube of a negative number is always negative.	None of these	Which fraction is Rational number?	3/4	$\sqrt{3}$	$\sqrt{5}/4$
3	Q3	Which of the following quadrilateral has two pairs of adjacent sides equal and diagonals intersecting at right angles?	Kite	Rhombus	Rectangle	Which of the following quadrilateral has all angles as right angles, opposite sides equal, and diagonals bisect-each other?	Rectangle	Rhombus	Square
4	Q4	Find equilateral triangle				Each angle of a equilateral triangle is _____	90°	60°	45°
5	Q5	We can not construct a triangle whose sides are __,__, and __ respectively?	2 cm, 3 cm, and 4 cm	4 cm, 5 cm, and 6 cm	3 cm, 3 cm, and 4 cm	Pythagorean Triples are sets of whole numbers which fit the rule:	$a^2 - b^2 = c^2$	$a^2 + b^2 = c^2$	$a^2 = b^2 = c^2$
6	Q6	When a triangle has a right angle (90°) and squares are made on each of the three sides, then the biggest square has the _____ area as the other two squares put together!	exact same	less	greater	Solve this triangle	c = 24	c = 13	c = 12
7	Q7	Which is Corresponding angle	∠1 &∠5	∠1 &∠2	∠2 &∠5	Which angles are alternate interior angles	∠2 &∠8 ∠3 &∠5	∠1&∠8 ∠4 &∠5	∠2 &∠5 ∠3 &∠6
8	Q8	Which shape can we make by using this				Which shape can we make by using this			
9	Q9	What is the difference between a rectangle and a cube?	A rectangle and a cube are both 2-dimensional	A rectangle is 2-dimensional and a cube is 3 -dimensional	A rectangle and a cube are both 3 -dimensional	The number of faces of a cylinder is _____.	2	1	3
10	Q10	How many blue cubes fit in one white cube?	2 cubes	6 cubes	8 cubes	If 8 blue cubes fits in one white cube then which diagram is correct?			

Class wise Questionnaire

Sr. No.	Questions	Before MTP				After MTP			
		Questions given around 50 students per class	Options			Questions given around 50 students per class	Options		
		9th	A	B	C	9th	A	B	C
1	Q1	The section formed by horizontal and vertical lines determining the position of the point in a cartesian plane is called:	Origin	Axis	Quadrant	The coordinates of a point are (-3, -4), then it lies in:	First quadrant	Second quadrant	Third quadrant
2	Q2	A number which is not in the form of p/q, then it is called	Rational number	Irrational number	Natural number	$\sqrt{5}$ is:	Rational number	Irrational number	Natural Number
3	Q3	Triangles on the same base and between the same parallels are:	Greater in area	Smaller in area	Equal in area	The triangle and a rhombus are on the same base and between the same parallels. The the ratio of the area of triangle to that rhombus is:	1:3	1:2	1:1
4	Q4	Find scalene triangle				Which triangles are these?  	Scalene triangle	Isosceles triangle	Equilateral triangle
5	Q5	What is the higher place value of 0? 	Units	Thousands	Millions	For the number 6,709,416, what does the 0 mean?	0 Thousands	0 Ten-Thousands	0 Millions
6	Q6	Greatest chord of a circle is called its	chord	radius	diameter	The angle subtended by the diameter of a semi circle is:	90°	45°	180°
7	Q7	Sum of angles around a point 	∠1+ ∠2+∠3=360°	∠1+ ∠2+∠3=180°	∠1+ ∠2+∠3=270°	In the diagram given above, the line CD is parallel to line EF. If ∠AHD and ∠JIE are 118° and 30° respectively, then what is the measure of angle GIB? 	32°	30°	118°
8	Q8	The number of times a particular items occur in a class interval called its:	Mean	Frequency	Range	The difference between the maximum and minimum values of the given observation is called	Range	Class	Class interval
9	Q9	In a cylinder, radius is doubled and height is halved, curved surface area will be	halved	doubled	same	The cylinder has:	one edge or vertices	no edges or vertices	2 edges or vertices
10	Q10	A cone has only ____ or____ point	one apex or vertex	two apex or vertex	none of these	The slant height of the cone is	L = $\sqrt{(r^2+h'}$	L = $\sqrt{(r^2-h'}$	H = $\sqrt{(r^2-l'}$

Class wise Questionnaire

Sr. No.	Questions	Before MTP				After MTP			
		Questions given around 50 students per class	Options			Questions given around 50 students per class	Options		
		10th	A	B	C	10th	A	B	C
1	Q1	Find common difference (d), In the A.P. 3, 8, 13, 18, …	3	5	18	The first term and common difference for the A.P. 3, 1, -1, -3 is:	1 and 2	3 and -2	3 and 2
2	Q2	A square and a rhombus are always	similar	similar but not congruent	neither similar nor congruent	Which Geometric figures are always similar?	Circles	Circles and Triangles	Circles and all regular polygons
3	Q3	The height of an equilateral triangle of side 5 cm is:	4.33	4	5	In triangle ABC, ∠BAC = 90° and AD ⊥ BC. Then	$BD \cdot CD = BC^2$	$BD \cdot CD = AD^2$	$AB \cdot AC = AD^2$
4	Q4	Does this triangle have a Right Angle? 	yes	no	none of these	Which one of the following triangles is NOT a right triangle?			
5	Q5	A circle can have _____parallel tangents at a single time.	one	two	three	If the angle between two radii of a circle is 150°, then the angle between the tangents at the ends of the radii is:	30°	40°	45°
6	Q6	If the length of the shadow of a pole is decreasing then the angle of elevation is:	Increasing	Remains the same	Decreasing	The line drawn from the eye of an observer to the point in the object viewed by the observer is said to be	Angle of elevation	Angle of depression	Line of sight
7	Q7	If the height of the pole and distance from the pole foot's to a point is increased by 30%, then the angle of elevation on the top of the building:	Increases	Decreases	Do not change	If a tower 6m high casts a shadow of 2√3 m long on the ground, then the sun's elevation is:	60°	30°	45°
8	Q8	A line segment drawn perpendicular from the vertex of a triangle to the opposite side is known as	Median	Altitude	Bisector of the side	If the line segment is divided in the ratio 3 : 7, then how many parts does it contain while constructing the point of division?	3	7	10
9	Q9	What is the greatest number of inner right angles that a hexagon can have (can be concave or convex)?	5	4	3	The diagram shows a regular hexagon. What is its perimeter? 	20	30	25
10	Q10	Performing an event once is called	trial	sample	error	The probability of event equal to zero is called,	sure event	unsure event	impossible event

Paper Publications

An Analytical Outcome Of "Model Teaching Program (Mtp)" To Achieve Practical and Visual Development of Mathematics Among Students in Secondary Education

Kalpit Pandya[1*], Dr. Naresh Menaria[2], Dr. Digvijay Pandya[3]

Abstract
Model Teaching Program have been introduced to achieve Practical and Visual Development of Mathematics. This paper considers an analytical outcome of Modal Teaching Program (MTP). The researcher used the questionnaire, academic achievement encouragement scale and visual models of mathematics to collect the data (Prepared by the Researcher). Utilizing a study technique based on a semi experimental approach and the statistical programme SPSS, the collected data were analysed. The questionnaire was prepared by the researcher according to CBSE and RBSE curriculum and mathematics books. The results show that there are statistically significant differences between the pre and post MTP scores for Practical and Visual Development of Mathematics. It is also indicating that the programme will aid secondary students in improving their mathematical creativity and academic achievement encouragement.

Keywords: Model Teaching Program (MTP), Visual Learning, Visual Development, Practical Development, Secondary Education

Introduction

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Visual learning is defined as assimilation of information from visual formats. When do students best understand information in class? They see that visual information is presented in a variety of formats, such as pictures, flowcharts, diagrams, videos, simulations, illustrations, cartoons, coloring books, slide shows/power point decks, posters, movies, games and flash cards (Rodger et al. 2009) [1]
Various studies report that 75 of all information processed by the brain is derived from visual formats. Furthermore, visual information is mapped better in students' minds (Williams, 2009)[2].

The model learning program helps students to develop visual thinking, which is a learning style by which the learner is able to better understand and retain information by connecting ideas, words, and concepts.
Through modelling, a learner might have a clear idea of how to approach the issue at hand. A student will feel more confident about how to finish the project if they can visualise it. This kind of direction sets the pupils up for success by demonstrating what the teacher expects. Nothing is more annoying for a teacher or a student than when instructions have been given but the students still do not understand how or where to start. These difficulties will vanish with modelling, which will improve classroom management.
Research has highlighted the importance of Model Teaching Program both for teachers and students in their teaching and learning of mathematics. The use of visual representations in general is an important part of teachers' knowledge of mathematics and they can play an important role in the explanation of mathematical ideas.

The analysis of narrative (qualitative) data is conducted by organizing the data into common themes or categories. It is often more difficult to interpret narrative data since it lacks the built-in structure found in numerical data. Initially, the narrative data appears to be a collection of random, unconnected statements. The assessment purpose and questions can help direct the focus of the data organization (Dillaway 2017)[3].

Research Problem

What is the effectiveness of Model Teaching Program (MTP) of mathematics among students in secondary education?
Was the key topic the researcher sought to address?
The sub-questions:
1) What are the elements of the suggested Model Teaching Program?
2) Does the programme "MTP" evolve?
3) Did the MTP boost academic achievement?

The Relevance

The following can benefit from the research:
1) Faculty members: Identifying the aspects of academic accomplishment encouragement, creativity in mathematics, and MTP skills
2) Students: By utilizing Model Teaching Program, practical and visual development of mathematics boosts their involvement in the classroom, and encouraging academic accom plishment and creativity in mathematics.

Methodology

The Research Approach

To analyze and interpret data and statistics, visual model approach (a group experimental design), analytical descriptive method of references and questionnaire, and SPSS were all used.
The questionnaire, academic achievement encouragement scale and visual models of mathematics to collect the data was used. It was taught utilising the study programme to 22 secondary school students from sixth to tenth grade in different schools of Udaipur.

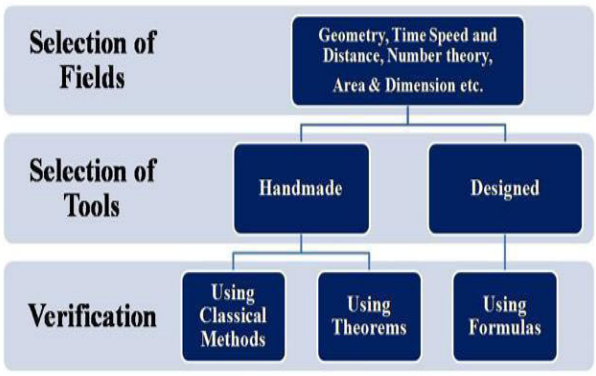


Figure 1: SSV Approach

- **Selection of Fields:** This section identifies the desired field by which visual model can be made.

- **Selection of Tools:** This section helps us to choose Handmade or Designed Models.
- **Verification:** This section approves the working of Visual Models by proved methods.

Results and Discussion

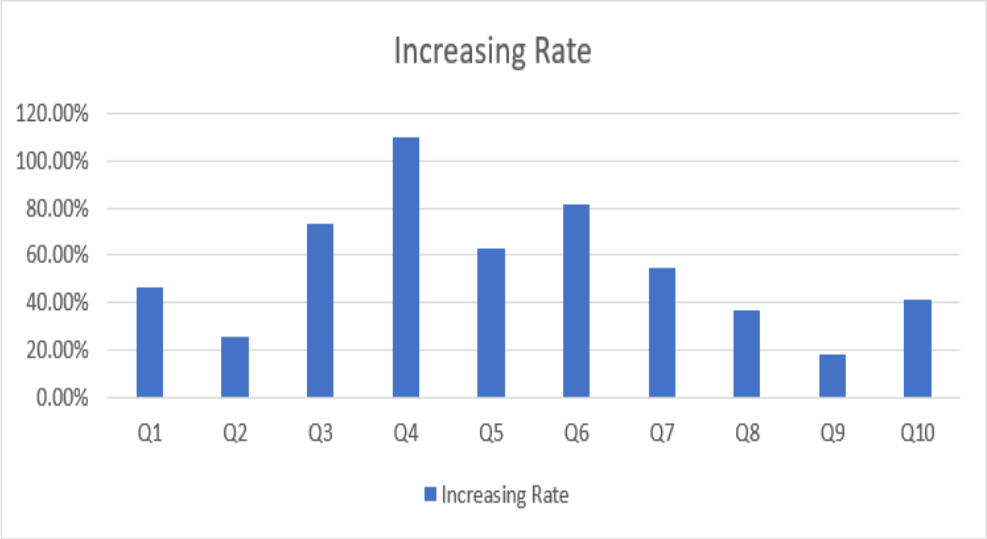
After having discussed the Review of Literature & research Methodology, this shall Discuss analysis of primary data collected through structured questionnaire from 250 respondents. The analysis of the data via statistical measures and/or narrative themes should provide answers to the assessment questions. Interpreting the analysed data from the appropriate perspective allows for determination of the significance and implications of the assessment.

Section I: Class 6th

Table 1: Clas 6th Result

Sr. No.	Questions	Class wise responses			
		Before MTP	After MTP	Difference	Increasing Rate
		Correct answer given around 50 students per class	Correct answer given around 50 students per class		
		6th	6th	6th	
1	Q1	26	38	12	46.15%
2	Q2	31	39	8	25.80%
3	Q3	15	26	11	73.33%
4	Q4	10	21	11	110%
5	Q5	16	26	10	62.5%
6	Q6	16	29	13	81.25%
7	Q7	20	31	11	55%
8	Q8	19	26	7	36.84%
9	Q9	28	33	5	17.85%
10	Q10	17	24	7	41.17%
TOTAL		**198**	**293**		

Chart: 1: Clas 6th Result



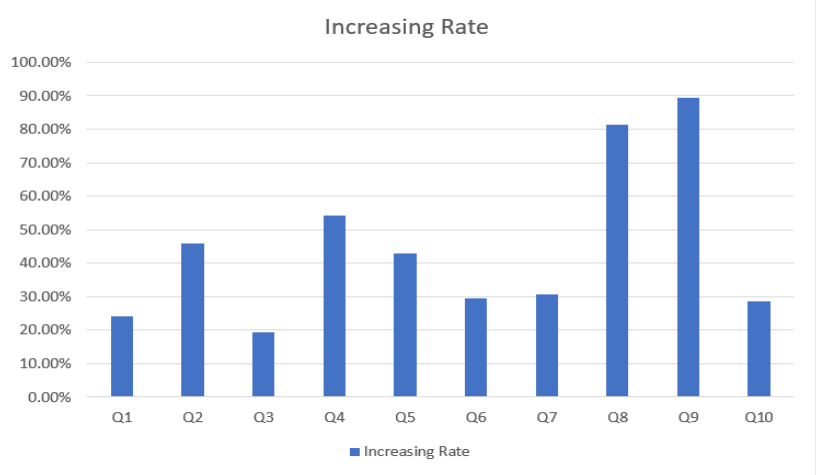
From the results obtained, it can be concluded that in today's modern era, mathematics which is a very dilemma for the students, many students consider it very difficult and run away from it. Mathematical problems should be solved by using new technology so that it is understandable to every student. MTP technique can become a good solution for visualizing Mathematics subject.

Section II: Class 7th

Table 2: Class 7th Result

Sr. No.	Questions	Class wise responses		
		Before MTP	After MTP	
		Correct answer given around 50 students per class	Correct answer given around 50 students per class	Increasing Rate
		7th	7th	
1	Q1	33	41	24.24%
2	Q2	24	35	45.83%
3	Q3	26	31	19.23%
4	Q4	24	37	54.16%
5	Q5	21	30	42.85%
6	Q6	27	35	29.62%
7	Q7	26	34	30.76%
8	Q8	16	29	81.25%
9	Q9	19	36	89.47%
10	Q10	21	27	28.57%
TOTAL		**237**	**335**	

Chart 2: CLAS 7th RESULT



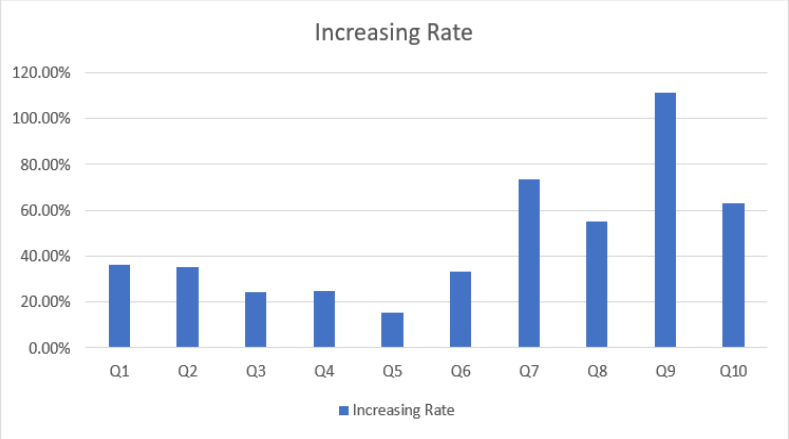
From the obtained results, it can be concluded that the problems of maths students can be solved to some extent by MTP. MTP can prove to be a panacea for maths related problems of students of any level.

Section III: Class 8th

Table 3: Clas 8th Result

Sr. No.	Questions	Class wise responses		
		Before MTP	After MTP	
		Correct answer given around 50 students per class	Correct answer given around 50 students per class	Increasing Rate
		8th	8th	
1	Q1	33	45	36.36%
2	Q2	31	42	35.48%
3	Q3	29	36	24.13%
4	Q4	28	35	25%
5	Q5	26	30	15.38%
6	Q6	21	28	33.33%
7	Q7	19	33	73.68%
8	Q8	20	31	55%
9	Q9	18	38	111.11%
10	Q10	19	31	63.15%
TOTAL		**244**	**349**	

Chart 3: Clas 8th Result



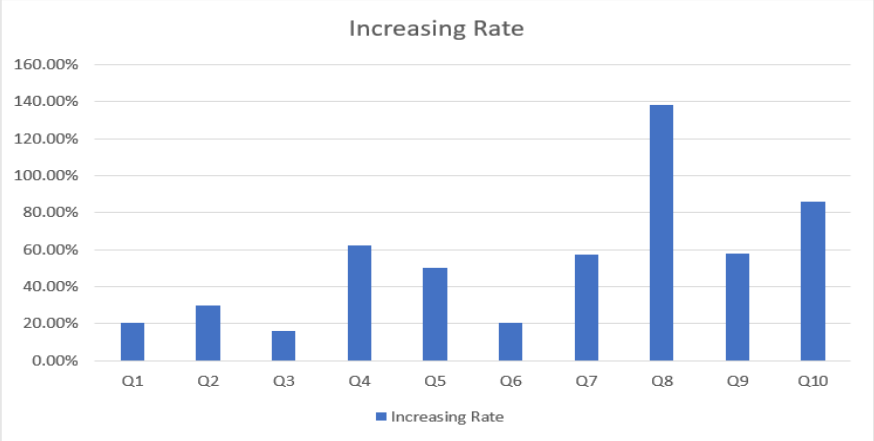
From the results obtained, it can be concluded that the questions at each level, whether easy or difficult, can be made easy for the students by using MTP technique.

Section IV: Class 9th

Table 4: Clas 9th Result

Sr. No.	Questions	Class wise responses		
		Before MTP	After MTP	Increasing Rate
		Correct answer given around 50 students per class	Correct answer given around 50 students per class	
		9th	9th	
1	Q1	39	47	20.51%
2	Q2	30	39	30%
3	Q3	31	36	16.12%
4	Q4	24	39	62.5%
5	Q5	26	39	50%
6	Q6	29	35	20.68%
7	Q7	21	33	57.14%
8	Q8	13	31	138.46%
9	Q9	19	30	57.89%
10	Q10	21	39	85.71%
TOTAL		**253**	**368**	

Chart 4: Clas 9th Result



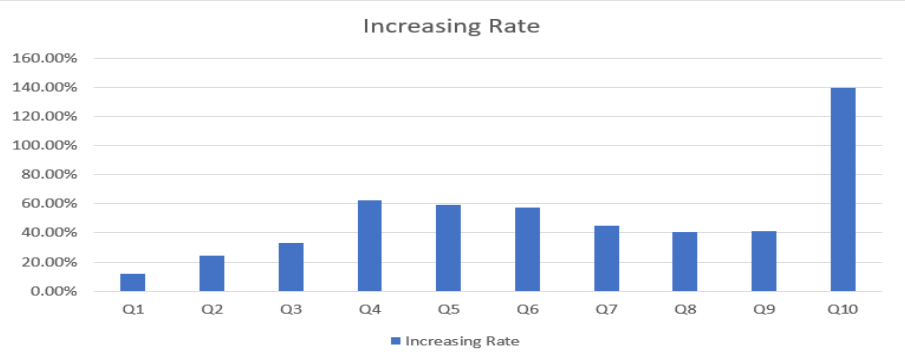
From the results it can be concluded that MTP technique is beneficial for the students at every level.

Section V: Class 10th

Table 5: Clas 10th Result

Sr. No.	Questions	Class wise responses		
		Before MTP	After MTP	Increasing Rate
		Correct answer given around 50 students per class 10th	Correct answer given around 50 students per class 10th	
1	Q1	42	47	11.90%
2	Q2	37	46	24.32%
3	Q3	30	40	33.33%
4	Q4	24	39	62.5%
5	Q5	22	35	59.09%
6	Q6	26	41	57.69%
7	Q7	31	45	45.16%
8	Q8	27	38	40.74%
9	Q9	29	41	41.37%
10	Q10	10	24	140%
TOTAL		**278**	**396**	

Chart 5: Clas 10th Result



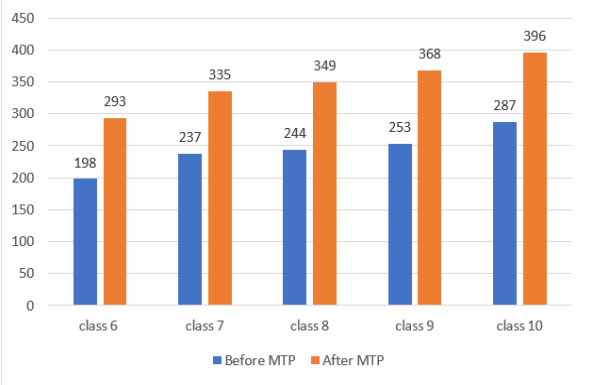
From the results obtained, it can be concluded that MTP technique is proving helpful in facilitating the problems of mathematics at every level of the students, so in conclusion it can be said that this technique develops the mental space of the students.

Section VI: Combined Results Of All Classes

Table 6: Combined Results

Sr. No.	Class	Before MTP	After MTP
1.	class 6	198	293
2.	class 7	237	335
3.	class 8	244	349
4.	class 9	253	368
5.	class 10	287	396

Chart 6: Combined Results



From the results obtained, it can be concluded that MTP technique is proving helpful in facilitating the problems of mathematics at every class level. So, in conclusion it can be said that this technique develops the mental space of the students.

Table 7: Pupil's satisfaction in Model Teaching Program

t-Test: Paired Two Sample for Means		
	YES	***NO***
Mean	16.2	3.8
Variance	242.2	3.7
Observations	5	5

Pearson Correlation	0.076832
Hypothesized Mean Difference	0
df	4
t Stat	1.784958
P(T<=t) one-tail	0.074411
t Critical one-tail	2.131847
P(T<=t) two-tail	0.148822
t Critical two-tail	2.776445

When respondents were asked that pupil's satisfaction in Model Teaching Program is indifferent with respect to their demographics. Result was received that t Stat value (1.784958) is lower than t-Critical two-tail value (2.776445), it clearly indicates that acceptance of hypothesis that there is pupil's satisfaction in Model Teaching Program is indifferent with respect to their demographics.

Conclusion

This paper discusses an analytical outcome of MTP and new visual learning strategy and its impact on the development of student's high-order thinking skills, corresponding to analytical thinking. Learning mathematics is basically a constructive process that extends beyond the learning styles, learning concepts, procedures and their applications.

Mathematics is more than vast collection of fixed concepts and skills that helps the students to attain higher intellectual and mathematical abilities like logical thinking, rational reasoning, attending to the essential aspects of the sum, orderly presentation, precision, accuracy, analytical and inductive skills, numerical abilities, problem solving abilities and spatial abilities.

As per the results of the present study, another noticeable finding is that:

- MTP revolutionise the ability of learning mathematics because it provides an open space for visualising mathematical concepts in a dynamic environment.
- This idea can be reused in many ways to demonstrate to students a rich environment in which mathematical objects live.
- MTP can also help to inform classroom instruction, by educating teachers' awareness of the complexities of visual imagination of mathematics and developing steps to help students setting up and understanding visual representations in a way that supports their learning special math topics.

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THE EFFICACY OF A MATH LEARNING PROGRAM BASED ON BRAIN HABITS IN BUILDING ACADEMIC ACHIEVEMENT ENCOURAGEMENT AND CREATIVITY AMONG SECONDARY LEVEL STUDENTS

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Published In

Anvesak, **ISSN : 0378 – 4568**

Vol. 52, No. 02(III) : July – December 2022

UGC Care Group – 1, Peer Reviewed, bi-annual Journal

ANVESAK
ISSN : 0378 – 4568 UGC Care Group 1 Journal

THE EFFICACY OF A MATH LEARNING PROGRAM BASED ON BRAIN HABITS IN BUILDING ACADEMIC ACHIEVEMENT ENCOURAGEMENT AND CREATIVITY AMONG SECONDARY LEVEL STUDENTS

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Dr. Naresh Menaria Pacific Academy Of Higher Education And Research University Udaipur

Abstract

The goal of the study was to ascertain how successfully a brain habits-based math learning programme promoted academic success and original thought in secondary level students. The researchers used the academic achievement encouragement scale and the creativity in mathematics test to collect the data (Prepared by the Researcher). Utilizing a study technique based on a semi-experimental approach and the statistical programme SPSS, the collected data were analysed. The sample was chosen at random from the mathematics department. The results show that there are statistically significant differences between the post-application scores for creativity and academic achievement encouragement at the (0.01) level, indicating that the programme has aided secondary students in improving their mathematical creativity and academic achievement encouragement.

Keywords: Higher education, academic success, brain habits, and supporting academic success.

Introduction

The degrees of creativity have been developed as a result of recent advances in mathematical education. Therefore, the goals of academic programmes should centre on fostering students' capacity for creativity, critical thinking, mental processes, and mathematical problem-solving. (Ellen, 2001,304)

Since 1950, many nations have considered creativity to be a significant scientific study issue. The ability to think creatively allows one to solve problems more creatively and contribute to society more generally (Almchrefi, 2005, 35). A student who thinks creatively achieves his objectives with the least amount of time, effort, and expense. (2008) (Aldabagh, 4).

The study (Anncmie Desoete, 2007) stressed the significance of brain habits in mathematics instruction that boost motivation for achievement.

RESEARCH PROBLEM

What is the effectiveness of a programme based on brain habits in fostering academic accomplishment encouragement and creativity in mathematics among secondary level students? was the key topic the researchers sought to address.

Thesub-questions:

1) What are the elements of the suggested brain habits-based math learning programme?
2) Does the programme "Brain Habits" evolve?
   A) Did the research sample boost academic achievement?
   B) The sample's level of mathematical creativity?

THE RELEVANCE

The following can benefit from the research:

1) Faculty members: Identifying the aspects of academic accomplishment encouragement, creativity in mathematics, and brain habits skills
2) Students: By utilizing Brain Habits programmes, creating an inviting learning atmosphere that boosts their involvement in the classroom, and encouraging academic accomplishment and creativity in mathematics.

3) Quality and Accreditation: Achieving the strategic goal of the university, which is to "continually improve the teaching and learning processes," by promoting self-learning and developing cutting-edge teaching and learning methodologies.

4) Researchers using the findings and suggestions in more new relevant investigations.

METHODOLOGY

The Research Approach

In order to analyse and interpret the data and statistics, the semi-experimental approach (one-group experimental design), the analytical descriptive method of the references and literary survey, and SPSS were all utilised.

The sample for the study was chosen at random. It was taught utilising the study programme to 22 secondary school students in the tenth grade from different schools in Udaipur.

Tools for Research

1) The mathematics academic achievement encouraging scale (Elsayed, 2012).
2) The test for mathematical creativity (prepared by the researchers).

Program based on brain habits was used as the experimental tool (prepared by the researchers).

DEFINITIONS

1. Brain habits are one of the Marzano Learning Model's dimensions and are regarded as an essential educational definition that first appeared at the turn of the 20th century. The Brain Habits programme aims to use emotional and cognitive skills (self-control, creativity, and critical thinking) in educational settings. They are described by Marzano as "a link between the student's problem-solving thinking style and his will to think" (Marzano et al., 1993).

According to the current research, "a set of creative behaviours utilised in organising educational experiences in the research programme" is what is meant by "brain habits." These sixteen brain habits include (Costa, Kallick, 2000):

The determination to keep studying.

1) Maintaining control while rushing.
2) Listening to students with empathy and understanding.
3. Flexible thinking.
4) Developing metacognition techniques.
5. Posing queries and issues.
6) Using prior knowledge in fresh circumstances.
7) Striking for scientific precision.
8) Accurate and clear thinking and communication
9) Using the senses to gather info.
10) Innovation, imagination, and creativity.
11) Reacting in a curious and appealing manner.
12) Taking a deliberate risk
13) Looking for positive thinking.
14) Mutually beneficial thinking
15) A desire for and attitude toward education.

ENCOURAGEMENT FOR ACADEMIC ACHIEVEMENT:

This is the urge to succeed or accomplish the intended goal, or the determination to overcome challenges or finish tough work swiftly (Alhefnee, 1994, 12). It is also a condition of change brought on by an organism's activity and characterised by stimuli and behaviour that is directed toward a goal. AlKhuly (2002), page 46

The pupils' curiosity and perseverance in completing the mathematics activities and averting failures were characterised as the academic achievement incentive.

CREATIVITY:

Torrance (1967) defined creativity as the process by which a person developed a sensitivity to issues. According to Khayrallah (1975, 5), it was defined as "A Mind process in which the individual produces something new and innovative, characterised by originality and diversity of ideas or objects and the linking of elements with relationships to solve problems by a new component including the fluency, the spontaneous flexibility, originality, and distant correlations production" (Aldapagh, 2008, 13)

On the creativity in Mathematics test, a measurable score can be used to express the procedural definition.

RESEARCH HYPOTHESES:

The following hypotheses are supported by the prior research:

1) There is a statistically significant difference between the mean scores of the academic achievement encouragement scale taken before and after application, favouring post-application.
2) There is a statistically significant difference between the pre- and post-application average scores on the test of mathematical inventiveness. The post-application score is higher.
3) The brain habits-based approach is successful in fostering mathematical creativity and academic achievement.

THE RESULTS INTERPRETATION

The validity of the first and second hypotheses was verified by the practical significance (effect size) and the T-Test, respectively. The outcomes were:

the first Hypothesis Result

"There is a statistically significant difference between the average scores of the pre-and the post-application of the academic achievement encouragement scale in favor of the post-application",the research results:

Table1. The achievement motivation Scale statistical Indicators

Item	Post-application	N1=22	Pre-application	N2=22	T-value	Significance
	Average	standard deviation	Average	standard deviation		
Curiosity	14.86	1.92	8.61	2.24	2.97	Significant
Perseverance	14.72	1.98	8.75	1.97	2.89	
Enjoyment	14.73	2.12	8.41	1.82	2.89	
Ambitious	14.46	2.48	6.99	1.24	2.95	
Avoid failure	15.20	2.48	7.74	1.62	3.27	
Whole scale	74.14	7.54	40.53	10.72	3.76	

Table (2) showed that the group average scores in the academic achievement encouragement scalepost- application were (74.14) and the standard deviation (7.54), while the results indicated that thegroup average score in the pre-implementation of the academic achievement encouragement scale was(40.53) and the standard deviation (10.72), and there were statistically significant differences, wherethe calculated T value was (3.76), which was greater than the T value (0.01) in favor of the academic achievement encouragement scale post -application.

These showed the first hypothesis validity and answered the research first question.

The Second Hypotheses Results

"There is a statistically significant difference between the average scores of the pre-and the post – application of the creativity in Mathematics test in favor of the post-application ", the results:

Table 3. The creativity in Mathematics Test Statistical indicators

Items	Minimum Limit	Maximum limit	Pre-application		N2=22	Post-application		N1=22
			Minimum	Maximum	Total	Minimum	Maximum	Total
Fluency	30	1	30	21	459	18	8	280
Flexibility	15	1	15	8	220	8	4	114
Originality	35	1	35	19	479	12	6	178
Details	30	1	30	20	454	18	7	276
Whole creativity	110	4	110	68	1612	56	25	484

Table(3) showed that the creativity in the Mathematics test statistical indicator,the maximum limit that the students got (110) and the minimum score was (4). The maximum score obtained by the students in the post- application was (110) and the minimum was (68). The total was (1612), while the maximum obtained by the students in the pre-application was (56) and the minimum was (25), and the total was(484).

The following Table showed the creativity in Mathematics test “T" value:Table4. The creativity skills in Mathematics test "T" value

Item	Post-N1=22 application		Pre-application N2=22		t-value	Significance
	Average	standard deviation	Average	Standard deviation		
Fluency	26.38	3.032	16.61	2.56	3.15	**Significant**
Flexibility	12.11	1.875	6.15	1.57	3.01	
Originality	25	4.28	10.36	1.72	3.35	
Details	24.11	3.46	14	2.14	3.13	
Whole creativity	89	7.56	46.76	14.49	3.67	

Table (4) showed that the average group scores on the test of mathematical creativity after implementation were (89) and the standard deviation was (7. 56), whereas the results showed that the average group scores on the test of mathematical creativity before implementation were (46.76) and the standard deviation was (14.49), and there were statistically significant differences, where the calculated T value was (3.67), which is higher than the value of the table T (0.0).

These results showed the second hypothesis validity and answered the second question.

The third hypothesis results:

"The program based on the Brain habits is effective in developing academic achievement encouragement and creativity in Mathematics", **the research results:**

The program practical significance impact is:

The Effect Size (η2)) Rosnow & Rosenthal, 1996) : $\eta^2 = \frac{T^2}{T^2+df}$

T^2 = T-Value Square df = 21

By calculating the practical significance of the differences between the pre and the post application of the academic achievement encouragement scale:

Table 5. Calculate the practical significance of the differences between the pre and the post application of the academic achievement encouragement scale

Level	Tvalue	Degrees of freedom	η2 practical significance type
Curiosity	2.97	21	0.30
Perseverance	2.89	21	0.29
Enjoyment	2.89	21	0.29 **Strong**

Ambitious	2.95	21	0.30
Avoidfailure	3.27	21	0.34
Wholescale	3.76	21	0.40

on the table (5) The first hypothesis was supported by the fact that the () 2 value was higher than 0.14, indicating that the practical importance and programme influence on encouraging academic progress were both strong.

Additionally, there were statistically significant changes between the average scores of the pre- and post-applications for the research group in the Brain Habits programme at the (0.01) level, favouring the post-application. This programme used unconventional teaching techniques such learning by discovery, group collaboration, and various forms of reinforcement.

And the students'satisfaction raised the achievement motivation level through the mathematics tasks that put students insituations that challenge their thinking and inspire curiosity and perseverance, and this confirmed the program based on the Brain habits effectiveness in developing the research group academic achievement encouragement in the post - application, which also demonstrated the first hypothesis validity.

By calculating the practical significance of the differences between the pre and the post-application of creative skills in the Mathematics test:

Table 6. Calculate the practical significance of the differences between the pre-and the post-application of creative skills in the Mathematics test

Level	**Tvalue**	**Degrees of freedom**	**η2**	**Practical significance type**
Fluency	3.15	21	0.32	
Flexibility	3.01	21	0.30	
Originality	3.35	21	0.35	**Strong**
Details	3.13	21	0.32	
Wholecreativity	3.67	21	0.39	

on the table (6) The second hypothesis was supported by the fact that the ()2 value was higher than 0.14, showing both a substantial practical significance and the program's influence on the development of mathematical creativity skills.

Additionally, there were statistically significant changes between the research group's average scores in the pre- and post-applications of the Brain Habits programme at the (0.01) level, favouring the post-application. This program's use of unconventional teaching techniques established the second hypothesis' viability and confirmed its efficacy in fostering creativity in post-application.

These validated the third hypothesis.

GENERAL CONCLUSION

By analysing the research findings, it was discovered that they concur with earlier studies that found a connection between motivation and brain habits (Abu Za'arour, 2004; Al Rapghy, 2005); a connection between creativity and academic success (Gial, 2006; Charles B; Al-Ja'afra; Abu Hilal and Al-Tahan; and Nasef, 2010).

In light of the fact that the study programme was based on brain habits and utilised non-traditional teaching strategies like collaborative, individual, and interactive learning, learning by discovering, and the use of reinforcement, this proved the program's effectiveness in fostering academic achievement encouragement and creativity in mathematics. The development of the 4C's of 21st-century learning—communication, collaboration, critical thinking, and creativity in mathematics—will be considerably aided by this. The key query was addressed:

What is the efficacy of a brain habits-based programme in fostering students' academic progress, encouragement, and creativity in mathematics at the secondary level?

Research Suggestions

1) Software developed for teaching mathematical ideas should take into account programmes based on brain routines, according to educational researchers.
2) All levels of public education should build and activate learning resource centres and math labs, and offer them Brain habits programmes.
3) Creating new teacher preparation programmes in the education faculties based on ideas of education, learning, and brain habits.
4) The ministry of education should host workshops and conferences for math instructors and administrators on creating programmes based on brain habits.

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