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(A Central University, Ministry of Education, Govt. of India)
(Accredited Grade "A" by NAAC)

IMPACT OF ICT MEDIATED CONSTRUCTIVIST APPROACH ON TEACHING MATHEMATICS ACHIEVEMENT OF SECONDARY SCHOOL STUDENTS

THESIS

SUBMITTED IN PARTIAL FULFILMENT OF THE
REQUIREMENT FOR THE AWARD OF THE DEGREE
OF

DOCTOR OF PHILOSOPHY

IN

EDUCATION

BY

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Enrolment No. A171075

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LIST OF ABBREVIATION

ZPD	Zone of Proximal Development
MKO	More Knowledgeable Other
ICT	Information and Communication Technology
OER	Open Educational Resources
NCF	National Curriculum Framework
TTC	Control Group pretest and posttest comparison
TTE	Experimental group pretest and posttest comparison
MAT-I	Mathematics Achievement Test (Pretest)
MAT-II	Mathematics Achievement Test (Posttest)
CEC	Control and experimental group comparison
DV	Difficulty Value
DI	Discrimination Index
ICTMCA	ICT- Mediated Constructivist Approach
TA	Traditional Approach

Chapter-I
Introduction

1.0 Introduction

Education is fundamental for our development, both materially and spiritually. It is the education that ignites one's own spiritual sensibilities, gives depth to thoughts and ideas. Also, the national spirit creates freedom of thought and scientific temperament. Social change is possible only through education. It removes darkness and widens the mind. This ideology of education is reflected in our constitution. Even during the struggle for independence, Indian leaders called school children the real wealth of the nation. As it is rightly said, real wealth is not in banks or treasuries, not in lockers, not in basements, but in school classrooms, playgrounds, science labs, libraries, and laboratories. Various experiments have been carried out to achieve this goal, for example, Gandhiji's basic education, Swami Vivekananda's human and spiritual education, Dr. Radha Krishnan's scientific education and values, Tagore's natural landscapes and cultural education, Acharya Rama Murthy's vocational education, Acharya's environmental education, etc.

In today's world, a rich number of new ideas and new information are emerging. Education is needed to understand and act on these issues. We cannot solve these problems without education. Given the above needs, the government, keeping in view the importance of education, set up education commissions and paid special attention to a better future for the citizens of the country because without education, we cannot do much in developed countries. Education is also a key part of improving the economy and quality of life in a country.

Education is a process through which human beings have their best moral, spiritual, physical, and cultural development. Education is the main source of human development. Man cannot recognise humanity or achieve perfection without education. It is through education that character changes and skills and knowledge increase. From birth to death, the educational process continues. Education brings society out of darkness

into light and enlightens the whole world. The ancient philosophers regarded education as the third eye, which gives man insight and consciousness to know all the issues that must be completed correctly, resulting in overall development and prosperity, soul comfort, and the ability to adapt to changing circumstances. In the beginning, when man observes the environment and the surroundings, he needs logical thinking in order to understand nature and the laws of nature or to become acquainted with the reality of various things in nature. And this logical thinking develops on the basis of the study of different subjects. Because every subject is a part of education, and with its help, children's inner abilities are stimulated and their logical and creative thinking is promoted. Mathematics is a subject that promotes logical thinking, reasoning, and problem-solving abilities.

Knowledge of mathematics helps to understand and reflect on all kinds of sciences. As today's world is totally dependent on science and technology, more and more knowledge of mathematics is required. Therefore, teachers of mathematics have a responsibility to try to teach mathematics in a very effective and simple language. The student will be able to perform better in mathematics only when the basic concepts of mathematics are clear. Conversely, if the teacher does not explain the basic concepts of mathematics well, then the interest of students in mathematics decreases. And this creates a negative attitude towards mathematics among students. It does not develop students' cognitive ability, logical thinking, reasoning ability, problem-solving ability, and mental ability. As a result, their mathematical achievement is affected.

Recent advances in information and communication technology (ICT) have affected every field, including education. Technology-based learning is seen as a promotion for mathematics students, especially to enhance their logical and reasoning abilities, the evolution of conceptual understanding, and the development of activity-based learning. In the past, education was generally based solely on the transfer of education. But recent advances in ICT have changed the way we approach learning and teaching. Nowadays, art-teaching strategies at the school level are being linked to the constructivist approach to teaching.

According to constructivists, the evolution of new ideas, knowledge, or experiences is actively linked to past knowledge or experiences. It emphasises the construction of knowledge through social interaction as well as self-conscious structure. In this regard, Confrey (1990) stated that constructivism is the theory of human knowledge that explains the cognitive acts of human beings through which man builds his knowledge and experiences (p. 108). Therefore, the focus of teaching should be on developing an environment conducive to the construction of knowledge rather than the transfer of knowledge.

The National Curriculum Framework (NCF) 2005 has shifted the Indian classroom to a constructivist-based learning environment that focuses on knowledge construction rather than knowledge transfer. It emphasises student activity as well as knowledge construction that builds on pre-existing concepts and experiences involving content and activities (NCF-2005, p.17). In this environment, ICT can help promote innovation in the teaching and learning process as well as problem-based, authentic and meaningful learning.

1.1 Theoretical background of the study

The theoretical background of the study is very important for re-conducting the research work. In which all the aspects related to the study are highlighted. To provide a strong foundation for study,

In the present study, experimental research work will be carried out by adopting a pedagogical model related to the philosophy of constructivism or constructivist theory in order to study its effects on mathematics achievement. Therefore, it would be unfair if the entire study were based entirely on the theory of Jean-Piaget, Bruner and Vygotsky. So below are presented the theories that came into existence according to the three experts.

1.1.1 Theory of Constructivism

Constructivism is recognised as the theory of knowledge according to which it is impossible to transfer information or regulate it through the external environment, but it can be constructed through various activities. According to constructivist principles, man

tries to understand his surroundings in the light of his previous knowledge and experiences and either establishes a new concept related to it or rejects or accepts it, accounting for it on the basis of his previous knowledge. In this regard, Confrey(1989) stated that constructivism is the theory of human knowledge that explains the cognitive acts of human beings through which man builds his knowledge and experiences (p. 108).

In addition, Glaserfeld (1989) also conducted research to understand the information acquired by humans; in the light of which he came to the conclusion that constructivism is a theory of information that has its roots in philosophy, psychology, and cybernetics. According to this, information can be dynamically constructed and created through the perception of content, in which cognitive function is an adaptive process"(e.g., Grady, 2012, p. 38). This principle greatly influenced the teaching process of the classroom because before it was thought that man acquires information about the things that he acquires from the external environment, but this principle revealed that Man learns through his perceptual functions, according to which he first adapts the information obtained from the external environment to his mental outline and only then accepts or rejects this information.

Bruner's (1962) cognitive theory also supports the theory of constructivism, according to which learning is an active process by which children create new information by adjusting their knowledge. According to this theory, children's previous knowledge and experiences and their ability to be active play a key role in the creation of new information. It is therefore a multi-approach that discusses both the epistemological and pedagogical implications of teaching and learning. For example, the Endogenous Approach recognises the mind as a reservoir of beliefs, concepts, values, and expectations known as the basic attributes for developing new information and complex concepts. This approach makes it possible to create internal and personal information through cognitive conflict. The original source of cognitive constructivism is considered to be Piagetian Theory (Applefield, Huber & Moallem, 2000, p. 37). On the other hand, the exogenous approach believes in the principles of creating new knowledge and concepts based on previous knowledge. However, according to the principles of the Dialectical Approach, constructivism and the creation of knowledge are possible only

through social interaction in which both learner and teacher participate in the activities and build knowledge in collaboration with each other. This type of constructivism belongs to Vygotsky's Socio-Cultural Theory.

Constructivism: Constructivists believe that

1. Knowledge construct not transmitted.
2. Knowledge is constructed through activities.
3. Knowledge is based on perspective.
4. The constructivist of new knowledge is based on children's previous knowledge, ideas and experiences.
5. In this, the teacher is like a consultant, a guide and a provider of learning tools.

Although constructivists such as Piaget, Vygotsky, Novak, and Posner disagree on some aspects of the knowledge-constructing process, they all agree on the basic features of the constructivist ability, such as the meaning-making process. Problems need to be solved. The understanding of new information can occasionally be hampered by reliance on prior knowledge of learning, which is necessary for new learning. Learning entails reorganising conceptual frameworks. Learning is aided by social interactions. Meaningful learning occurs in authentic learning activities. Piaget believed that learning is strongly influenced by the developmental stages of learning. Learning is dependent on the learner's specific phases of physical, intellectual, emotional, and social development, which also dictate what can be learned and to what depths. When learning is almost complete, it occurs more effectively. Learning involves meta-cognation, which is reflected in one's learning process. The nature of the learning process is essential for learning to take place. Learning becomes more difficult as the difficulty, accuracy, and relevance of learning tasks increase. Challenging and innovative tasks help students increase their efforts.

1.1.2 Cognitive theory of Piaget

Jean Piaget was a zoologist as well as a psychologist. He worked on child development for over 50 years. Jean Piaget first began studying his own three children and later included other children in his research. Through his experiments, he presented a theory of cognitive development, which we know as the Piaget theory of cognitive

development. This theory states, children learn through a special process in which the child's own prior knowledge, experiences, and ideas are very important. His theory of cognitive development gave rise to a new field which is called cognitive constructivism. This is based on the theory of cognitive development. After much research and discovery on the activities of a child from birth to adulthood, i.e., how to think, understand right and wrong, how to talk, how to remember things, etc., Piaget divided the cognitive development into four stages.

Cognitive development according to Piaget's Theory

1. Sensory Motor Stage

This stage starts from birth to two years of age. The main feature of this stage is object permanence, i.e., the child has seen something, and at that moment, that thing is not in front of him, yet the child recognises its existence. If something is picked up in front of the child before this concept is born, he forgets it after a while. For a child at this age, there is no meaning to the existence or non-existence of things, that is, when an object disappears from sight, its existence ceases for the child. At this stage, he has no other way to express his experiences without verbal language except through his senses. The baby will cry when he is hungry. The child will have a steady and intent look. At this age, all the sensory and motor activities are included in the child's cognitive process.

2. Pre-Operational Stage

This stage starts from two years to seven years. During this period, the child's language is developing. At this age, the child learns to talk to the elderly, sing small songs, and also talk to himself. At this stage, a two-year-old child usually has an understanding of two to three hundred words at this stage. By the age of five, a child has a vocabulary. At this stage, the child's thinking ability changes. He begins to think about the things he sees around him. Symbols seem to help. At this stage, children ask a lot of questions.

3. Concrete Operational Stage

This stage starts from the age of seven to eleven. According to Indian background, this stage is also called primary education. At this age, children are more practical and realistic. Family relationships and an understanding of one's own society begin to be understood. During this period, children can measure and weigh things,

proportionally in small and large quantities. During this period, children become able to focus on the whole structure of the sequential changes occurring within the current process.

4. Formal Operational Stage

This stage starts from eleven years old to adolescence. During this time, children begin to think in a traditional way about any subject. Logic and reasoning are automatically incorporated into their ways of thinking. During this time, the child begins to understand right from wrong. During this time, children become more involved in social work and begin to understand their responsibilities. During this time, children begin to use their practical thinking openly and use practical experiences and changes to increase their knowledge.

1.1.3 Vygotsky's Socio-Cultural Theory

Leo Vygotsky was a Russian psychologist who worked in the field of psychology as well as other fields. According to this theory, children learn through social interaction in which the child's own language plays a very positive role. The theory of Zone of Proximal Development mentioned under this theory started a modern topic of discussion on the aspect of an application in the classroom. ZPD measures the gap between a child's actual ability and extra ability. Accordingly, if children are provided with support, they can achieve their learning goals.

The theory based on Vygotsky's socio-cultural theory is known as socio-cultural constructivism, which is based on socio-cultural theory.

Vygotsky's sociocultural theory focuses primarily on social interaction, according to which a person expresses his ability and ideas by interacting with the people of his culture and society, due to which the development of their minds is promoted. Vygotsky (1978) states: “Every function in the child’s cultural development appears twice: first, on the social level, and later, on the individual level; first, between people (inter-psychological) and then inside the child (intra-psychological). This applies equally to voluntary attention, to logical memory, and to the formation of concepts. All the higher functions originate as actual relationships between individuals.” (Vygotsky, 1978, p57) According to Piaget, every child is born with some motor reflexes and sensory abilities to

promote cognitive development. In contrast, according to Vygotsky, children are born with some basic abilities for mental or cognitive development, which are called attention, sensation, perception, and memory. According to Vygotsky (1978), children's mental development and education get through society, interacting with the more knowledgeable other (MKO), who may be a teacher, parent, or more knowledgeable peer. Vygotsky (1978) strongly believed that “the community plays a central role in the process of making money.” It is impossible to evaluate a child's intellectual growth without taking into account the social and cultural context in which it is embedded (S. K. Mangal & Shubhara Mangal, p. 178). Vygotsky's socio-cultural theory clearly emphasises that the language a child uses to express his or her ideas is learned through interaction and communication. Vygotsky also believed that changing the environment was necessary for mental development because the opportunity to interact with different people in different environments increased his language ability and the scope of his interaction expanded. Explaining this further, he said that mental or cognitive processes, cognitive development, and the creation and construction of information do not occur separately, but rather they are developed through the relationship between language and thought, and in this process, language plays an important role.

The teaching and learning processes greatly benefit from Vygotsky's theory. According to this theory, the student plays an active role in the teaching and learning environment while the teachers provide him with all kinds of guidance and facilities. In this way, education is a kind of mutual cooperation and reversal experience for students and teachers. Through which the construction and creation of information in the student is promoted, while in this process, the teacher provides facilities and support to the student. Social and cultural theory places great emphasis on language. The child uses language to express his thoughts. Language is recognised as the most important tool provided by society (Vygotsky, 1978) and this tool, i.e., language, develops the intellectual capacity which plays an important role in creating an idea about something in the mind. (Vygotsky,1962) To fully understand this theory, it is necessary to understand the concepts of MKO and ZPD.

Vygotsky's Concepts of More Knowledgeable Other (MKO) and Zone of Proximal Development (ZPD)

In Vygotsky's socio-cultural theory of cognitive development, MKO and ZPD are the two main principles which are central to this theory. It is explained below.

More Knowledgeable Other (MKO)

MKO refers to an individual who possesses a particular knowledge, skill, practice, understanding or higher level of ability and competence. MKO generally refers to teachers, coaches, parents, siblings, classmates or peers, and all those in the school who have more knowledge, ideas, abilities and practical skills and experiences than the learner and the computer can even be a mobile phone, tablet or other application. It is reciprocally related to ZPD.

Zone of Proximal Development (ZPD)

There is another aspect to Vygotsky's theory. Accordingly, the potential for cognitive growth depends on the Zone of Proximal Development (ZPD). This crucial idea demonstrates how a child's capacity for learning differs from his capacity for learning after receiving support or direction. The ZPD represents the area where a child can solve problems with the help or support of more knowledgeable people (scaffolding). According to Vygotsky (1978), the zone of proximal development refers to a specific type of place, area, or field associated with the mind where the most sensitive instructions or guidance are given to develop the ability in children may be possible. Therefore, children should be encouraged to use their skills to acquire other skills. From the diagram below, we can understand ZPD (S.K.Mangal & Shubhara Mangal, p180).

In other words, ZPD is a gap in a child's mind that bridges the gap between ability before and after guidance. Therefore, it is the duty of a teacher to guide the children by providing them with tasks related to the subject matter and trying to fill the mental gap.

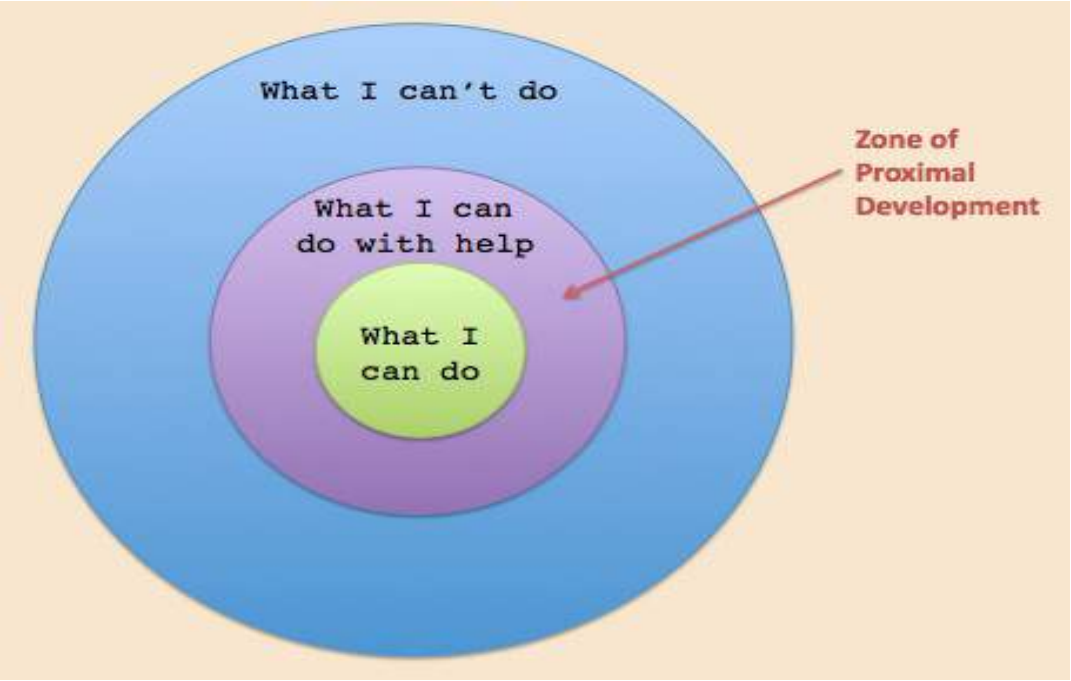

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Figure- 1.1 ZPD

1.1.4 Jerome Seymour Bruner's theory of Cognitive development

Bruner was an American psychologist who played an important role in revolutionising psychology in the 20th century. Bruner introduced the concept of cognitive development and learning theory. According to Bruner's learning theories, learning and development are interrelated and dependent on each other. In his book "Towards a Theory of Instruction", he has tried to clarify that teaching is a process that both the teacher and the students carry out together, and education does not mean transferring the content of a subject from one mind to another (khan, p-215). According to Bruner, when a child comes to school, he constructs new knowledge on the basis of previous knowledge. Bruner has done a lot of work on the development of the human mind. In 1966, he published a commentary on the development of human mental abilities. In this commentary, he does not divide the mental development of children in terms of age like Jane Piaget, but he speaks of the development of mental abilities of man from

that age when he begins to think, whatever he gets is based on his experiences and to what extent he understands it. When and how to apply the mental skills he has learned from experience (Aziz, p. 148). According to this theory, there are three basic levels of mind, the details of which are as follows.

1. Enactive Stage- Action Based
2. Iconic Stage – Image Based
3. Symbolic Stage – Language Based

Enactive Stage

At this stage, children establish concepts about objects by making connections between their limbs and their brains. For example, when children are presented with a toy, they first observe it by picking it up in their hands and trying to learn its features by shaking or throwing it. In this way, children store the properties of these objects in their minds. These levels are active during infancy and early childhood, but during infancy, children do not have the ability to speak. At this time, children establish concepts in the mind through their actions; they try to explain their words to others through their movements and gestures. At this stage, understanding begins to develop in children.

Iconic Stage

This stage begins at the end of early childhood. During this period, a child's sensory abilities like hearing, touching, smelling, and seeing are developed. The child tries to understand the objects by seeing and hearing them and the basis of this is the image of these objects in the mind. Once an image of an object is formed in the mind, he discovers his toy or any other object in its absence. On the basis of image, concepts are formed in child’s mind regarding the feature of objects. Which help him communicate his message to others. This is why this stage is also called the Imagery Stage.

Symbolic Stage

This is the last stage of Bruner's theory. This is the stage where children store information in the mind in the form of symbols and words. In this period, children express their imagination with the help of symbols and words. At this level, children store most information as words, mathematical symbols, or other symbolic systems. For example, a student in mathematics assumes that the plus sign (+) means to combine two numbers together, the minus sign (-) means to intersect, and the divisor sign (÷) means to

divide. The main feature of this level is that the children at this age have mastered the skills of expressing their ideas more effectively than the previous two levels.

Through these three levels, the person creates a relationship and harmony with his environment to adapt to his environment. He understands society by acquiring sensory and motor skills and then mastering the language, faces new situations or problems and creates his place in it.

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1.1.5 Summary of Cognitive Development Theories

The ideas of Jane Piaget, Vygotsky, and Bruner are very important in the field of children's intellectual and mental development. This remained a subject of debate among experts due to its approach and its theoretical aspects. In this context, Jean Piaget explains the development of human thought from birth to adolescence. According to Jean Piaget, every child is born with certain motor reflexes and sensory abilities to promote cognitive development. They have the ability to see, hear, reach, touch, hold, bend, etc. They use these same abilities to try to understand and adapt to the environment. A picture of what they see in the environment is formed in their mind. Piaget called this process "schema." According to this schema, that is, the basic mental outline, when it comes into contact with the external environment, produces adaptation through the processes of assimilation and accommodation, which is made possible by the process of equilibrium. Through this process, children ensure the creation of new information and ideas, and through these, children become acquainted with new experiences.

Piaget has divided cognitive development into four stages after a lot of research and discovery on the activities of a child from birth to adolescence, how they think, understand right from wrong, how they talk, how they remember things, etc. The first stage is the sensory-motor stage, followed by the pre-operational stage, the concrete operational stage, and the official operational stage. In which the first stage is from birth to two years of age, this period involves the child seeing, hearing, tasting, touching, holding, etc. The second stage is from two years to seven years. During this period, the child's language or speaking ability develops, and symbolic language such as words, signs, symbols, diagrams, etc. The third stage is from 7 to 11 years, in which the child develops the ability to think and solve problems logically through practical experiences.

The last stage is from age 11 to adulthood. During this period, children are thinking, forming their identity, being self-centered, etc. According to Jean Piaget, at every stage of life, the child repeats his thinking or mental process over and over again and creates knowledge. Piaget also advocated the development of language skills in children for the construction and creation of knowledge. Similarly, Vygotsky's socio-cultural theory mainly emphasises social interaction, according to which a person expresses his ability and ideas by interacting with the people of his culture and society, and due to which the development of his mind is promoted. In which he has laid great emphasis on social interaction and linguistic ability in the development of the mind. According to this theory, a learner who has a higher level of knowledge, skills, practice, understanding, or ability is called a KMO. In other words, the ZPD is the gap in the human mind that represents the difference in ability before and after providing facilitation and guidance. According to this theory, the student plays an active role in the teaching and learning environment while the teachers provide him with all kinds of guidance and facilities that play an important role in fulfilling the ZPD. In other words, ZPD is the gap in the human mind that reflects the potential difference between before and after providing convenience and guidance. According to Vygotsky, the teacher is an MKO, and his job is to fill in the students' ZPDs. In Jerome Bruner's theory, reinforcement is given so much importance role to ensure learning in children. According to Bruner, learning can only be accomplished through internal motives. That is why Bruner emphasises internal motivation more than external motives. Intrinsic motivation is self-rewarding. That's why Bruner says teachers need to help students find alternative ways of disclosure in order to maintain internal motivation. Bruner offered suggestions for alternative methods of disclosure. These include factors such as activeness, direction, maintenance, and motivation. In 1966, Bruner published a report on the development of human mental abilities. In this report he does not divide the mental development of children in terms of age like Jean Piaget, but he speaks of the development of the mental abilities of man from that age when he begins to think. Whatever he gets is based on his experiences and to what extent he understands it. When and how to use intellectual skills acquired through experience. Based on this, Bruner has divided the development of the human mind into three stages, which are the enactive, iconic, and symbolic stages. Changes occur in his

language abilities, observational ability, learning ability, etc, and thus he constructs new knowledge based on his own ability.

1.1.6 Nature of Knowledge in Constructivist Perspective

1. Knowledge is a constructive activity
2. Knowledge is co-operative activity
3. Knowledge is empowerment
4. Knowledge is interpretation
5. Knowledge learning is situated in context

1.1.7 Constructivist Teaching Approach

The constructivist approach was laid down by Jean Piaget. In addition, Jerome Bruner and Leo Vygotsky's theories are very much influenced by the development of causation. The source of the constructivist approach teaching philosophy is based on the principles of constructivism, so all the principles of the constructivist approach teaching also cover the basic principles of his theory. According to Jean Piaget, through the process of accommodation and assimilation, children construct and create new information from their experiences.

Constructivist learning theory is the foundation of constructivist teaching. The basic principle of the constructivist approach to teaching is that children should be provided with new information based on their previous knowledge and experiences, and this information should be manifested through constructivism and creation based on their inner abilities instead of being transmitted. It emphasises the learner's being active and dynamic and the teacher's role as a guide and facilitator to attract and motivate the student to construct and create knowledge and to remove obstacles in his way. NCF-2005 supports a constructivist approach to mathematics teaching and learning. In this teaching method, teachers do not give lectures, explanations, or otherwise transfer mathematical knowledge. Rather, the basic role of teachers is to create conditions for students that can promote their essential mental development. Students build knowledge by constructing models to answer questions and challenges that come from actively engaging with math problems and the environment. By encouraging the students to learn new material

through discussions, exercises, and asking questions, the teacher avoids giving them straight instructions.

Constructivist learning theory is the foundation of constructivist teaching. Constructivist learning is based on the notion that knowledge is acquired when students actively contribute to the creation of meaning and knowledge rather than actively seeking out facts. The learner creates meaningful and new knowledge. Students that receive a constructivist education develop critical thinking skills and are driven and self-reliant. According to this theoretical framework, instruction constantly expands on the knowledge that a learner already has. Schema is the name given to this early learning. Constructivist experts contend that since all learning is filtered through pre-existing schema, learning is more successful when students actively participate in the learning process as opposed to passively attempting to gain knowledge. Many different methods are asserted to be founded on constructivist learning theory. The majority of these techniques focus on some kind of guided exploration, where the teacher tries to steer the student through inquiries and exercises to learn new information, discuss, enjoy, and speak.

Regarding constructivist teaching, it can be said to provide an environment for student learning in which children, at an early stage, use their schema to create a mental diagram of the object in their mind by establishing the connection between their organs and their brain. After that, according to this mental diagram, they try to understand the new concept, which Piaget named assimilation. Children then feel the need to modify or change their mental diagram or to create a new mental schema, which Piaget called accommodation. When children establish equilibrium between previous and new information, this process is called Piaget's adaptation. In all of these processes, a child's linguistic skills help establish structure in the brain or strengthen social interaction and intellectual processes. Students try to get out of their zone of proximal development by building and making up information.

The constructivist teaching approach is centred on the student's teaching and learning process.

- Constructivist teaching approach helps construct new information based on previous knowledge and experiences.

- The construct or creation of information is more important than the product of information.
- The constructivist teaching approach constructs or creates new information through their own experiences and social interactions.
- Constructivist teaching approach strongly supports scaffolding technique.
- Investigation, discovery, exploration and activities are encouraged in constructivist teaching approach.
- Teachers act as a guide, facilitator and collaborative in constructivist teaching.
- Constructivist teaching is a democratic environment in which students have the opportunity to ask questions and construct new information.
- Creates a democratic learning environment rather than an autocratic learning environment in constructivist teaching.
- Students learn as much as possible by being active in constructivist teaching and enjoy learning.
- Learning is provided by guidance and facilities through teacher collaboration in a constructivist teaching approach which plays an important role in making peer group learning possible.
- The constructivist learning environment focuses more on experimental methods, problem solving, observation, etc., rather than rote learning.
- Constructivist approach encourages the use of experimental method, observation, inductive, disclosure, play-based method and imitation method.
- Constructivist teaching tends to promote higher order thinking in students.

Therefore, the constructivist teaching approach supports a child-centered learning environment in which students are expected to construct and create new information from their own prior knowledge and experiences with the help of their linguistic ability and competence, and to think abstractly and think, which includes analytical and reflective thinking, supports a learning environment that develops skills such as problem-solving ability as well as the ability to really use constructed information in a variety of settings and situations.

1.1.8 Principles of Constructivist Approach

The basic principle of the constructivist approach is that the student builds new information, promotes new ideas, and gains new experiences by actively participating in the learning environment based on previous knowledge and experiences. The following are the constructivist approach principles.

- In the constructivist teaching approach is student- centred teaching and learning process.
- In the constructivist approach, teachers support, guide, and motivate students in their learning process.
- In a constructivist approach, students construct new knowledge based on their prior knowledge, ideas and experiences.
- In constructivist approaches students find solutions to problems based on their own knowledge and concept.
- In a constructivist approach, learners construct knowledge through their own experiences and social interaction.
- In the constructivist approach, the learner is an active and reflective process.
- The constructivist approach involves cooperation and social interaction between learners.
- Conducts collaborative exploratory and learning processes in the constructivist approach.
- Constructs knowledge based on context and materials in a constructivist approach.
- Constructs new knowledge with integration and functionality of previous knowledge in the constructivist approach.

Also, the following are the six principles of the constructivist approach identified by Mary Burns, Marylu Menchaca and Vicki Dimock which are as follows.

- Individual past information, experiences, and beliefs are brought to the learning setting by learners.
- Knowledge is created in a unique and individual way using a variety of techniques, reliable tools, resources, experiments, and circumstances.
- Learning is a process that involves both activity and reflection.

- Learning is an evolutionary process in which new conceptual structures, meaningful representations, or the development of new mental models are accommodated, assimilated, or rejected.
- Social interaction reflects a variety of perspectives through the meaning of reflection, cooperation, dialogue and sharing.

1.1.9 Characteristics of Constructivist Classroom

In the constructivist classroom, the learner acquires knowledge through active participation in the classroom. Teachers do not give lectures, explanations, or otherwise transfer mathematical information. The primary role of teachers is to create an environment and conditions for students to develop their necessary mental development. Students build knowledge by building models in response to the questions and challenges they encounter while actively interacting with mathematical problems and their surroundings.

The following are the features of a constructivist classroom.

- The constructivist classroom is student-centred and the teachers act as a guide.
- The constructivist classroom democratic environment gives students the opportunity to question the material presented and explore different topics of interest to them.
- Constructivist classrooms are child-centred in which children use their analytical thinking, skills, and primary sources to construct information and create new concepts.
- In the construction classroom, students learn more and enjoy learning.
- It promotes collaborative learning.
- In the constructivist classroom, teachers guide and facilitate learning through collaboration, in which the peer group plays an important role in making learning possible.
- The student's linguistic skills in the constructivist classroom help to establish the mental structure in the brain or strengthen the social interaction and thought process. With the help of this, the student gets the opportunity to fill his zone of proximal development by constructing and creating.

- Students are active participants and self controllers.
- Students in a constructivist classroom are accountable for their own learning.
- Students learn new ways to learn in this classroom.
- In the constructivist classroom, information is constructed through active dialogue between students and teachers.
- Provides facilities for learning in the classroom through multiple representations.
- The constructivist classroom environment focuses on the learning system of process-oriented learning rather than product-oriented learning.
- The role of teachers in the constructivist classroom is to act as a guide, friend and facilitator.
- Teachers and students in the constructivist classroom promote mutual understanding and complete the teaching and learning process by being active in collaboration and integration with each other.
- In the constructivist classroom, teachers and students promote mutual understanding and active collaboration and integrate with each other to complete the teaching and learning process.
- The constructivist classroom places a more priority on learning about inquiry, discovery, exploration, heuristic and activities.

Also, according to Tam (2000), the constructivist classroom has the following advantages.

In the constructivist classroom, teachers and students share information.

- Teachers and students participate in the authority in the constructivist classroom.
- The role of teachers in the constructivist classroom is to provide guidance and facilitate.
- The learning process will involve a small number of heterogeneous pupils.

Honebein (1996) has classified various characteristics of the constructivist classroom as follows.

- Providing experience with information for knowledge construction.
- The constructivist classroom provides experience and appreciation or encouragement for multiple perspectives in the classroom.

- In the constructivist classroom, the teacher connects the teaching and learning with the real context.
- Learning process encourages wealth and voice. (Child-centred learning)
- The constructivist classroom encourages learning through social collaboration in the classroom.
- It encourages the use of different forms of representation (video, audio text, etc.).
- It encourages self-awareness or familiarity of information.

Audrey Gray has classified the various characteristics of a constructivist classroom as follows.

- Learners take an active role.
- The classroom setting in constructivism is democratic.
- Activities are engaging and student-focused.
- Teachers help students learn, which promotes responsibility and independence in them.

1.1.10 Role of Teachers in Constructivist Approach

Constructivist approach as stated in the previous points, the experiences of the external universe emphasize learning through intuition, linguistic ability, and the process of self-reflection and curiosity. Therefore, the role of the teacher in this approach is very important because it is considered a very difficult task to identify the inner potential of the students and use it to understand the external universe. The roles of the teacher in relation to the constructivist approach are described below.

- The main focus of teachers should be to guide the students by asking questions and they will draw their own conclusions on the topic.
- Teachers will encourage and facilitate students to engage in discussion.
- Want to provide relevance to real-life experiences through examples.
- The classroom should create a democratic environment so that students can be independent and expand information meaningfully from their own experiences.
- The main role of teachers is to create such environment and conditions for students. So that students can build knowledge by building models in response to

inquiries and difficulties brought about by actively interacting with mathematical environments and situations.

- Want to cover some key terms such as define, classification, and guess, which guide the students.
- Teachers are in the classroom as a guide who provides opportunities to work collaboratively and problem solving.

According to Ndon (2011),

- A teacher should offer engaging learning environments, opportunities, and activities that include facilitative, collaborative, problem-solving, and real work.
- Teachers teach students to classify, analyze, and create, to organize, to use, this helps in understanding one's scientific process by using the terms of perception.
- Teachers encourage student autonomy and initiative by adopting a democratic classroom.
- Teachers also provide raw data and resources.
- Teachers act as service providers for students with many resources, not necessarily a source of information.
- Strategies such as case study, project, collaboration, problem solving, etc. should be included.
- The main role of teachers is to make the classroom environment conducive and motivate the students towards learning.

Also, according to Brooks & Brooks (1993), the role of constructivist teacher is as follows (p.103-116).

- Constructivist teachers encourage students' self-efficacy and the work they do.
- Constructivist educators employ manipulative, interactive, and tangible materials in addition to basic sources and raw data.
- Constructivist teachers use cognitive terminology when classifying, analyzing, predicting, and creating.
- Constructivist teachers allow students to advance their lessons, change or transfer instructional strategies, and change content.

- He cconfirms understanding of a concept before sharing students' personal understanding of a concept.
- Constructivist teacher encourages students to participate in discussion with the teacher and others.
- Constructivist teacher encourages students to ask questions to their teachers and peers according to their own intellectual abilities.
- The constructivist teacher tries to describe the initial reaction of the students in detail.
- Constructivist teachers should engage students in experiments that in their initial assumptions could create contradictions and then there could create room for a new debate.
- The teacher gives adequate time to the students after asking the questions so that the students can express their responses thoughtfully.
- Teachers provide students adequate time to create relationships between concepts and create metaphors.
- Constructivist teacher uses the Learning Cycle Model in the classroom to maintain students' natural curiosity.

According to Catherine Chen (2003), the role of a constructivist teacher is as follows.

- The challenge for constructivist teachers is to provide instructional techniques that help students develop their understanding.
- Constructivist educators make ideas and phenomena engaging and significant for their students.
- Constructivist teacher uses different methods for investigation and provide different approaches.
- The concept should be linked to multiple implications and applications, the meaning should be linked to the context and there should be a correlation between the information components.
- Constructivist teachers provide opportunities for students to confront problems and situations, describe them in their own language, and develop strategies to solve them. Therefore, teachers should motivate students.

1.1.11 Role of students in Constructivist Approach

In a constructivist learning environment, students are expected to:

- Students are active participants and self-controllers.
- Constructivist students quench their academic thirst with mutual collaboration.
- Students who use the constructivist approach assume accountability for their own learning.
- Constructivist students learn new ways to learn.
- Constructivist classrooms are child-centred in which students independently construct new knowledge using their own abilities.
- Constructivist student's linguistic skill helps to establish the mental structure in the brain or strengthen the social interaction and thought process. With the help of this, the student gets the opportunity to fill his zone of proximal development through constructing and creation.
- Constructivist students construct new knowledge based on their current or previous knowledge.
- Have students reflect on their experiences and prove who they are.
- Learners should be able to appreciate the point of view of trial and error by asking questions and reviewing concepts through the activities of the real world.
- Constructivist students become independent and control their ability to learn what and how to learn

1.1.12 Educational Implications of Constructivism

- Teachers help, guide and encourage students in the learning process.
- Students construct new knowledge and discoveries based on their previous knowledge, ideas and experiences.
- The teaching process uses both skill based and open-ended methods
- In the constructivist learning environment, students are collaborative and cooperative not just individually.
- Constructivist learning environments connects students with experiential methods rather than rote learning.
- Students should be assisted in establishing the standards at which their work is evaluated or assessed.

- Information is shared between teachers and students.
- Teachers and students share authority.

Different forms of constructivist approaches have made many suggestions for teaching and learning in the classroom, including the following suggestions made by Paul Ernest (1996).

- Emphasis has been placed on creating a state of cognitive conflict in the minds of children to remove misunderstandings and misconceptions. For this, it was suggested to engage children in practical work. This will enable the children to identify their mistakes which will create mental conflict in their minds.
- Multiple Facilities should be provided for learning in the classroom through multiple representations. This process will provide opportunities to represent all the children in the classroom so that more and more children will be able to learn from their previous knowledge and experiences.
- Enabling children to become aware of different contexts of learning that complement different social structures. That is, to acquaint oneself with the means of acquiring, formally or informally.

1.2 Concept of ICT

ICT stands for Information and Communication Technology which refers to the use of a variety of technologies to collect, store, retrieve, process, analyze and transmit information.

Knowing the definition of information and communication technology is essential to understanding it (ICT)

Information: Information is basically informational material, which becomes information with the addition of learning. In other words, information is learning, finding information, accessing it, applying it, and information refers to the storing of information. The information includes the following capabilities (Hussain 2016 pp, 111).

- Being able to use information.
- Assessing the usefulness of information.
- Ability to critically analyze information.

- Being aware of the need for information.

Communication: Communication is a simple dialogue between people and cultures. This occurs on a subject when information is combined with technology.

Technology: Computer, Internet, Television, Telephone, Graphics Software, Tape Recorder, Spreadsheets, PowerPoint, Video Conferencing, Smart Board, Chat, Interactive White Board, Email, YouTube, Social Networking, Projector, Scanner, and other similar devices

ICT refers to the collection, storage, creation, transmission, and exchange of information. Tools used for this purpose include laptops, computers, the internet, software, email, video conferencing, satellites, printers, scanners, etc.

From an educational perspective, ICT can be defined as all digital tools, materials, and resources that are used to manage the educational system with the achievement of teaching and learning objectives (Hussain 2016, pp. 112).

ICT stands for information and communication technologies, which include mobile phones, the internet, social media, wireless networks, and telephones. It involves the integration of many forms of telecommunication, including wired and wireless signals, computers, necessary software, and storage devices. We can access, retrieve, save, transmit, and change information through audio and video systems, among other things. Information and communication technology in education is the processing of information using communication tools and features that help in some way with teaching, learning, and teaching.

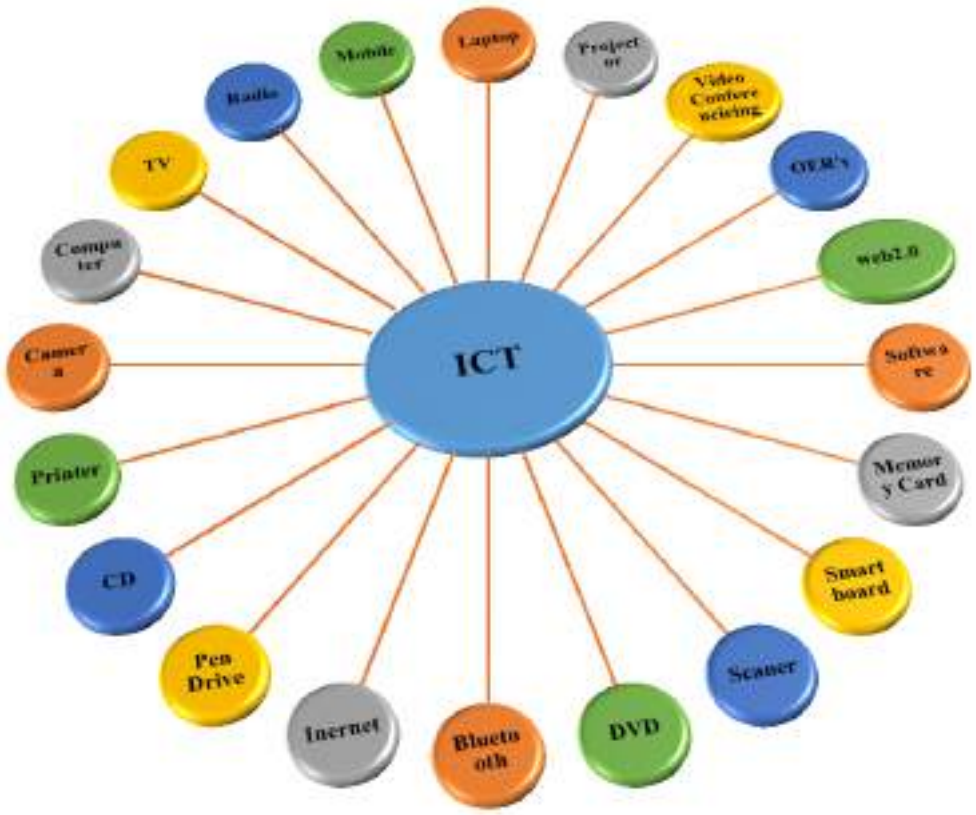


Figure -1.2 ICT Scopes

1.2.1 Characteristics of ICT

The following are the various characteristics of ICT.

- Students and teachers have the opportunity to expand their knowledge.
- Enhances learning opportunities.
- Immediate access to information.
- Complex to complicated topics or problems can be easily understood and explained through ICT
- ICT reduces psychological barriers.
- New information is readily available.

- ICT ensures a more flexible and intimidating environment.
- Fulfilling individual differences.
- Information is easily accessible anytime and anywhere through ICT.
- The use of ICT helps children to be confident, motivated and engaged.
- The use of ICT improves the concept and understanding of both children and teachers and increases their success in achievement.
- Develops higher-order thinking skills.
- It can provide both formal and informal education.
- It saves energy and time because the learner has control over the program and learns at his own speed.
- Through ICT, students and teachers can enhance their knowledge by using different libraries and dictionaries.
- Liberates education from school -centric and takes it towards learning-centric.
- Through ICT, students can establish communication links with teachers for homework, references, guidance and counselling.

1.2.2 Need of ICT in Education

Today we are stepping into the 21st century, or the modern era. The quality of our education has changed a lot. The main reason is that different types of educational technology and ICT are being used in the field of education. Especially in 2020, due to COVID-19, all educational activities have stopped. This has an impact on educational activities. Schools, colleges, and various educational institutions are closed due to COVID-19. In this COVID-19 era, there is only one ICT that has kept educational activities to some extent. Today, online teaching and learning are being done through ICT. Today, for example, through Google Meet, Webex, Pentablet, Zoom, Google Classroom, YouTube, Whatsapp, Telegram, Skype, etc., teachers are carrying out their teaching process and students are carrying out their learning process. The student is learning online. Teachers and students are sharing information through online conferencing. Students complete assignments, projects, presentations, etc. with the help of ICT and also submit them online. The student is also doing online teaching practice and micro-teaching. Therefore, the requirement of the time is that teachers and students

or anyone associated with the field of education, it has become imperative for them to have a basic knowledge of ICT. So that the individual can easily and better access education and the teaching process can be made effective. ICT has influenced every aspect of human life. Knowledge of ICT is a must for many professionals, including teachers. Education through ICT has benefited in different ways and at different levels. Developed countries are offering courses through technologies such as conferencing and the Internet, and the teaching and learning process is also being done through ICT. In contrast, underdeveloped countries are offering their courses and teaching through traditional methods.

Through ICT, teachers can easily express concepts with the help of animation and graphics. This can provide comprehensive information in a short period of time and energy. ICT plays an important role in enhancing learning opportunities for secondary students in the mathematics classroom. Various ICT devices are available which can be used for the construction and creation of modern knowledge. Radios, DVDs, CDs, TV, Internet, mobile phones, pen tabs, interactive keyboards, calculators, computers, laptops, tablets, projectors, printers, scanners, e-malts, video conferencing, and a wide range of software and mathematics software are examples of ICT devices. These tools can be used for teaching and learning. In particular, mathematics teachers can use math software to make math concepts and mathematics classrooms more effective. For online teaching and learning, they use laptops, cell phones, and math software anywhere, allowing students and teachers to collaboratively solve math problems and learn which can improve students' math achievement.

Knowledge of mathematics helps to develop the ability to understand and reflect on all kinds of sciences. Since today's world is totally dependent on science and technology, more and more knowledge of mathematics is required. Therefore, it is the responsibility of mathematics teachers to make maximum use of ICT so that teaching can be provided in a very efficient and easy language. Because the student will be able to perform better in mathematics only when the basic concepts of mathematics are clear. In contrast, if the teacher is not able to explain the basic concepts of mathematics well, then students' interest in mathematics decreases and, in this way, a negative attitude towards mathematics is developed in the students. Due to this the development of rationality,

logical thinking, reflection, ability to solve problems, and development of cognitive capability are missing in the students. As a result, their math achievement is affected.

1.2.3 Use of ICT for Teachers

The following are the various advantages of ICT for teachers.

- Through ICT, teachers can access and provide up-to-date information anytime and anywhere.
- Teachers can share their resources, skills, experiences, and advice through ICT.
- Through ICT, teachers can plan lessons and prepare teaching materials.
- Through ICT, teachers can record children's portfolios and their educational activities.
- Through ICT, teachers can easily remove the doubts of children.
- Through ICT, teachers can develop evaluation, aptitude, attitude, self-confidence and interest in children.
- Through ICT, teachers can easily and effectively present the most complex or problematic topics to the teaching process.
- Through ICT, teachers can expand their knowledge.
- Through ICT, teachers can design courses and materials and prepare syllabus

1.2.4 Use of ICT for Students

Following are the various benefits of ICT for students.

- Through ICT, students can learn from their own capability and speed.
- Students can learn according to their own convenience and time.
- Students can improve and expand their knowledge by using ICT.
- Students can easily complete their projects and assignments using ICT.
- Through ICT, students can develop their own learning styles to a higher level.
- Students make their learning interesting through ICT.
- Personality development is promoted through ICT.
- ICT helps students build their own identity.
- ICT promotes self-efficacy within students.
- ICT promotes self-confidence and self-discipline in students.

1.2.5 Limitations of ICT

While there are many advantages of ICT, there are also some limitations of ICT which are as follows

- It is difficult to believe in guidance through ICT.
- It is difficult to believe or trust information through ICT.
- Misuse of ICT.
- The cost of using ICT is very high.
- Negative effects on health from ICT based teaching.
- Students have less opportunity for oral and handwriting skills.
- Weak and special students may have difficulty using ICT and they may need the help of teachers.
- Today in the era of ICT anyone can start a blog or post something on a website and the information being posted is not necessarily reliable. Open source encyclopaedias, Wikipedia, etc. are considered as good sources of information but the information should be reliable. Therefore, it is not accepted as a reliable reference by educational institutions.
- Pay more attention to copying content from the Internet.
- Teachers have difficulty using ICT tools because they lack ICT knowledge and experience.

1.2.6 Challenges in use of ICT

The use of ICT involves the following challenges.

- Lack of ICT knowledge and skills in teachers
- Lack of basic ICT infrastructure in institutions
- Lack of self-confidence in teachers
- Lack of competencies of teachers in using ICT
- Lack of adequate time to use ICT in the classroom
- Electricity shortage, particularly in rural areas
- Lack of internet especially in rural areas
- Lack of computers, digital blackboards, printers, scanners, etc.
- Teachers have few opportunities to receive ICT training.
- Lack of funding for ICT

- Less digital training opportunities for teachers
- Negative attitude towards ICT in teachers
- Lack of training on when, where and how to use ICT
- Lack of management support in using ICT

1.2.7 ICT based teaching Strategies

Flipped Learning

The flipped learning is the opposite of conventional learning. In this, the students do not listen to the lectures given by the teachers but the teachers first record a video of their own lecture on a topic from their subject and then share it with the students for their viewing.

Merits of Flipped Learning

- The classroom is student-centred rather than teacher-centred, with students learning on their own and the teacher acting as a facilitator.
- Students carry on the learning process to the best of their ability.
- This method saves students' time as students attend video lectures at home instead of in the classroom.
- Students express their thoughts in the classroom with self-confidence and enthusiasm.
- Promotes collaboration between teacher and students.
- Establish collaboration within and outside of the teacher and students.
- Such learning is student-centred.
- This method gives students the opportunity to explore and discover.
- Students have the opportunity to use modern equipment and technology.

Blended Learning

Blended learning or hybrid learning brings together the best classroom and online learning opportunities with the help of information and transmission technologies (ICTs) to promote practical and independent learning (Hussain, pp. 281). Blended learning combines both classroom teaching and online learning. Blended learning is a method that uses both face-to-face and online instruction.

Merits of Blended Learning

- Makes teaching and learning effective and efficient.

- Students learn their own capability and speed.
- Promotes collaboration between teacher and students.
- Establish relationships within and outside of the teacher and students.
- The Learning of the represents a learning model that combines both traditional classroom and online courses.

E- Learning

E-learning is a learning process in which the learning process is effectively managed using electronic media. Computers and the Internet are an important part of e-learning. E-learning uses a variety of resources such as email, the internet, websites, YouTube, online video conferencing, smartphones, software programs, CDs, DVDs, etc. E-learning is commonly used in distance education, but today, due to COVID-19, e-learning is used in formal education or face-to-face learning processes.

The following are the various characteristics of e-learning.

- E-learning is dynamic.
- E-learning can be learned anytime and anywhere.
- E-learning is individual and learner centred.
- E-learning is collaborative and interactive.
- E-learning promotes the use of multi-sensory interaction.
- E-learning reduces time & cost in training.
- E-learning helps to enhance personal experience through inclusive language.
- Comprehensive language learning has helped to create a sense of personal experience and an emotional connection with the material.
- E-learning content is created with the help of subject experts.

M- Learning or Mobile Learning

Today, in the 21st century, mobile phones have become an important part of the lives of people of all ages, especially young people. Today, people of all ages fulfill their needs using mobile phones. Today, young people complete their learning process through mobile phones. A mobile is a portable device that can be easily pocketed. Using mobile devices is a new way to access learning materials. As long as your mobile device is connected to the Internet, you can expand your information whenever and wherever you

want. Mobile learning enhances students' learning in real contexts and creates a new learning environment. Students develop their skills and abilities through mobile phones.

Characteristics of M-Learning

The following are the various characteristics of mobile learning**.**

- Information can be accessed anytime anywhere from mobile learning.
- Mobile learning is accessible or readily available.
- Mobile learning promotes students' diverse thinking skills.
- Mobile learning promotes self-confidence and self-efficacy in students.
- Mobile learning reduces the cost of teaching and learning.
- Mobile learning can be used to complement a wide range of information and experiences with collaboration and independence.
- Students can easily complete their projects, homework, assignments etc. through mobile.
- Teachers can effectively complete their teaching process through mobile.

Web 2.0 Learning

Web 2.0 is a type of learning based on the Internet that enables individuals to work collaboratively, express ideas, and increase concepts and information. "Web2.0" is a web-based technology tool and utility that focuses on social, collaborative, user-oriented content and alienation, such as blogs, wikis, multi-media sharing services, content syndication, podcasting, and content tagging services. Emerging technologies, especially those with maximum functionality, interoperability, and connectivity, contribute to the creation of knowledge through open communication and collaboration. Users can easily publish their thoughts and ideas as online content. Teachers can use technology in the classroom to achieve their teaching goals and develop students' learning skills and abilities. Today, in the modern era, Web 2.0 tools are becoming more and more common for use in the classroom. Technology enables us to collectively submit our content and find content easily.

Web Based Learning

Learning is when the learning process is carried out using the World Wide Web (WWW). This is called web-based learning, or we can say, in other words, that the learning activities are carried out through the internet using www. A WWW is a

repository of information that provides information from every field or area related to the acquired life, allowing a person to increase his knowledge and conduct research. Through www, teachers try to present their teaching process in a better way so that it can be presented in an efficient manner and the traditional teaching process can be completed with an innovative teaching process. The information and content available on the World Wide Web are in different forms, such as text, sound, images, animation, etc., which improve the learning and teaching process. Through the World Wide Web, information can be accessed anywhere at any time. Through the World Wide Web, students and teachers can carry out the educational process at their own pace and ability.

1.2.8 Open Educational Resources

Concept of OER

Open Educational Resources (OER) refers to educational software that is licensed to all people at no cost to allow them to freely access, modify and share content with others.

"OER are materials for teaching or learning that are either in the public domain or have been released under a license that allows them to be freely used, changed, or shared with others." (Open Educational Resources (OER): Overview and Definition (edweek.org).

According to UNESCO "OER are teaching, learning and research materials in any medium digital or otherwise that reside in the public domain or have been released under an open license that permits no-cost access, use, adaptation and redistribution by others with no or limited restrictions. OER form part of open solutions alongside Free and open source software, Open Access, Open Data and crowd sourcing platforms." (Open Educational Resources (OER) (unesco.org).

Advantages of OER

The various features of OER are as follows.

According to McGill et al (2008)

- Students can easily access content and information anywhere and at any time in the world and they can access the content again and again.
- Through OERs, on a large scale at little or no cost content can be shared with others.

- OERs can be complimentary to textbooks and lectures where the lack of information and concepts is obvious.
- For instance, text can be used to supplement multimedia content or content like videos. Providing information in a variety of formats might make it easier for pupils to understand what is being taught.
- Information published in books or journals takes months or years to reach others while OER information can be easily accessed by others in a matter of moments or minutes.
- Students can expand their knowledge and develop skills through OER.
- Students can effectively complete their research work through OERs
- OER provides materials for teaching and learning, enabling teachers to carry out their teaching effectively and create a conducive classroom environment.
- OER is more engaging for both students and teachers as it provides customized, timely, and various content.

1.2.9 Open Educational Resources for Mathematics

OpenStax Math Textbooks

It contains textbooks on statistics, calculus, algebra, pre-algebra, and trigonometry. These textbooks are provided free of charge by Rice University. Users can download content (https://openstax.org/subjects/math)

Open Textbook Library

Open Textbook Library provides free, peer-reviewed and openly licensed books (http://open.umn.edu/opentextbooks/).

Bookboon.com- Statistics & Mathematics

Free e-books and textbooks can be downloaded in pdf format. It does not require registration (https://bookboon.com/en/statistics-and-mathematics-ebooks).

MIT Open Courseware- Mathematics

This web contains all virtual content from the web-based MIT course (https://ocw.mit.edu/courses/find-by-topic/#cat=mathematics).

Khan Academy

The Khan Academy provides free math videos, photos, practice exercises, and a personal dashboard for students and teachers (https://www.khanacademy.org/math).

PhET Interactive Simulations

In 2002, Nobel Prize Carl Wieman created material on free interactive math and science simulations under the PhET Interactive Simulations project at the University of Colorado Boulder (https://phet.colorado.edu/).

1.2.10 Use of ICT Tools in Classroom

Interactive Whiteboard

An interactive whiteboard is also called a smart board. A smart board is a digital touch screen that connects to a projector and computer so that images, animations, and graphics can be easily created on the board using fingers or a digital pen. By using a smart board, teachers can easily explain complex to complex topics to students through different types of images and graphics in mathematics and science. The Smart board is used at all levels, like in a classroom, corporate sector, coaching, and sports coaching; it is done in broadcasting, etc.

Digital Equipment

Digital devices such as scanners, smart phones, rooms, and projectors can be used in the classroom. The classroom atmosphere can be made pleasant and efficient by using this device. Students and teachers work in collaboration with each other. Students can experiment and demonstrate using digital tools.

Digital Library

Today, in the era of ICT, national and international libraries have become small devices. We can easily access national and international libraries from home. We can read, download, and print from a digital library. For example, the National Digital Library (NDL)

Pen Tablet

A computer input device is something like a pen tablet or a graphics tablet. This makes it easy to manipulate images, animations, and graphics by hand. The way a person draws pictures with a pencil and paper with this pen tablet, you can also input pdf files, images, word files, etc. This will make your teaching process more efficient.

1.2.11 Use of Software in Mathematics

Geogebra

This software is open-source software that can be easily installed on mobile phones, laptops, and desktops. This software works offline. This software makes it very easy to understand and understand 3D concepts of different structures in mathematics, such as geometry, algebra, calculus, and especially geometry. Using this software, the classroom environment can be adapted, which helps to make the teaching process more effective.

Robocompass

It is online software that is available for free from open sources on the Internet. You must have Internet connectivity to run this software. With this software, students can perform geometric construction very easily and efficiently in which he participates with interest, dynamism, and autonomy and brings the learning process to completion. Teachers can use this software to eliminate children's confusion and improve their teaching strategies.

Microsoft Mathematics

This software has been developed by Microsoft. It is open source and it works on iOS and Android, which means it is a mobile app. This software can be downloaded from

the play store and Microsoft site. This software solves various mathematical problems like algebra, statistics, trigonometry, calculus, arithmetic, real numbers, complex numbers, LCM, etc. with great ease. In this software, just write the problem on the screen or click the photo of the math picture and upload it to this app. The math problems will be solved step-by-step in front of you.

Geometry Pad

Geometry Pad is an open-source app, available on the Play Store. It is a dynamic geometry application that allows teachers to help students easily understand geometric concepts and their intricacies. Students can also complete their geometry assignments and homework using the Geometry Pad themselves. The Geometry Pad is another math tool that helps students learns geometry. This tool also helps students learn how to use numbers, measure, draw and solve various geometric shapes easily.

Math Blaster

This software is free and open source**.** This is a mathematics video game designed for primary school kids. Through video games, subjects like addition, subtraction, multiplication, fractions, percentages, and decimals are introduced, and children learn the basic concepts of mathematics with great ease through playing games.

Sugar Math

This software is free and open source and was developed for children from primary to secondary school. This app can be downloaded from the play store. This app is available in different languages such as Hindi, Bengali, Gujarati, Telugu, Punjabi, Marathi, and Malayalam. The basic concepts and rules of mathematics can be learned easily as well.

Cabri 3D

Cabri 3D is open-source and free software. This software works on Windows or Mac OS. With this software, we can perform the concepts of geometry and trigonometry with great ease and with the teaching and learning process.

Scientific Workplace 5.5

This software is free and open source. This software works on Windows or OS. With this software, we can easily type mathematical terms, equations, formulas, etc.

1.3 Concept & Introduction of Mathematics

The word mathematics is derived from the two Greek words "Manthanein" and "Techne". Manthanein means to learn, while Techne means art or synthesis. Thus, mathematics means the art of learning. According to the dictionary, mathematics means either the science of numbers or atmosphere or the science of measurement or quantity. Mathematical science is the study of amounts, measurements, and relationships. It is, in fact, a quantum fact that relates to solving atmospheric problems. It is a logical study of different shapes, forms, quantities, etc., while another place is that mathematics is taken from the Greek word "Mathema" which means learning or education/study.

Different thinkers have given different definitions of mathematics, which are as follows:

According to Angels, *"Mathematics is a science whose subject matter is special forms and quantitative relationship of the real world."* (Das, 2020)

According to Gauss, *"Mathematics is the queen of science, and arithmetic's are the queen of all mathematics"* (Munaf, p.16).

According to Comte, *"Mathematics is a science of indirect measurement".* (Bharathidasan University)

According to Bacon, *"Mathematics is the gateway and key to all science"* (Munaf, p.16).

According to Hogben *"Mathematics is the mirror of civilization".* (Habicht, 1963)

According to Srinivasa Ramanujan *"Mathematics is a pattern connected with Numbers, Calculus, Geometry, Trigonometry etc. combined together to form a solution."* (Das, 2020)

According to Courant and Robin, *"Mathematics is the study of art in reality and the expression of beauty"* (Munaf, p. 16).

According to Lindsay *"Mathematics is the language of Physical Science and certainly no more marvellous language was created by the mind of man".* (Bharathidasan University)

1.3.1 Need and importance of mathematics

Ever since man has stepped into the world, that is, ever since man has existed in the world, man has been connected with each other, and mathematics has been called the mother of all science. If we want to work in the rapidly changing world of technology and ICT, it is necessary to be mathematically literate and understand mathematics. It has extensive facilities and can find its place in the industry. The Kothari Commission (1964–1966) emphasised the importance of mathematics in the school curriculum and said that the basic teaching of mathematics in schools should be done in a better way. Young says that mathematics is a subject that encourages logical thinking and helps students identify what is necessary and what is not. Mathematics helps students recognise facts and draw conclusions, and mathematics is the subject that helps in learning concrete causes.

The features of mathematics are as follows.

- The study of mathematics stimulates the ability to solve problems in everyday life, reason, thinking and reasoning.
- The study of mathematics increases logical thinking, curiosity and creativity.
- To meet the challenge of today's advanced technology and ICT, it is important to know the concepts, ideas and information of mathematics.
- Mathematical learning helps to apply mathematical concepts to problems in new situations.
- Mathematics learning increases abilities such as autonomy, endurance, self-confidence and open mind.
- Mathematical learning helps students to develop a positive attitude.
- Mathematics enhances the ability to solve problems in a systematic and systematic way.
- Mathematics learning stimulates the ability to apply the information and skills learned through mathematics to many other occasions in daily life.
- Mathematics helps promote social and cultural values.
- Mathematics helps in learning other subjects.
- The mathematics learning helps in the development of moral values.

Mathematics is a subject whose importance has always been and always will be. Learning not only takes time, but it also ensures progress and keeps up with the times.

The need for this subject is not because it is an important part of the school curriculum, without which basic education will be considered incomplete, but because by studing it, children develop logical thinking, analytical thinking, and problem-solving skills, and it provides ease in understanding all other scientific and non-scientific subjects. Therefore, mathematics teachers should not only master the mathematical concepts and their teaching techniques but should also be familiar with the technological tools of today. With the help of this, abstract concepts of mathematics can be presented to children in a concrete form. When it comes to new teaching strategies, the teaching method based on constructivist principles is very special. He believes that man does not learn any information from the information presented by others, but he forms the basic outline in his mind in the light of his previous knowledge and experiences and connects these formed concepts with new experiences by trying to learn by doing or comparing. In this strategy, the students can get guidance from the teacher, and the teacher provides the basic facilities in the classroom. This teaching technique is also considered new compared to all other teaching methods. But since the invention of new technology in the field of ICT, a new teaching technique has been introduced in the field of teaching mathematics or other subjects. This is called the ICT-mediated constructivist teaching method. All of the above ICT devices or software will be required to be implemented in the classroom. This technique also falls into the category of child-centered teaching methods and carries out its work keeping in mind the basic principles of constructivist teaching methods. But the difference is that in this new method of teaching, children learn with the help of ICT devices, and the teacher provides guidance to these children.

1.3.2 The objectives of mathematics at the secondary level

The objectives of mathematics at the secondary level are as follows.

- To explain to students the related concept of numbers.
- To introduce each student to the four basic functions of numbers and the need for numbers in their daily life.
- To enable every student to be able to perform addition, subtraction, multiplication, and division as well as other elementary operations.

- To enable every student to apply mathematical knowledge in their daily life and to solve problems.
- To introduce each student to measurements such as length, weight, temperature, volume, area, and speed.
- To creating a positive attitude towards mathematics in students
- To develop math skills in students so that they can meet the demands of everyday life.
- To promote self-confidence, reality and creative thinking in students.
- To provide opportunities for students to practice mental discipline.
- To introduce students to aesthetic and intellectual hobbies and satisfying methods.
- To provide students with opportunities for creative expression.
- To helping students acquire social and moral values for an adaptable and successful life in society.
- To develop character in students through systemic and positive habits.
- To develops constructivist and creative abilities in students.

NCF (National Curriculum Framework) -2005 of vision for School Mathematics (NCF 2005, pp-43).

- Children learn to enjoy math instead of being afraid of it.
- Children pick up essential math lessons, such as the fact that math is more than just rules and formulas.
- Children do a lot of math. Let's see if there is anything to be talked about, talked about, discussed or exchanged with each other, and work together.
- Children show meaning and solve problems.
- Children use abstract intelligence to understand relationships, see structure, think things through, and prove or disprove statements.
- For children, the fundamental building blocks of mathematics are arithmetic, algebra, geometry, and trigonometry, which all emphasise abstraction, structuration, and generalisation techniques.
- Teachers interact with every student in the classroom because they believe that everyone can learn math.

1.3.3 Issues of teaching Mathematics at secondary school level

Problems of Mathematics at Secondary level

- Mathematical formulas are difficult to understand and remember.
- It is difficult to change the mathematical formulas to a proper form.
- It is difficult to understand the correlation between the steps used in solving a problem.
- Students are not able to solve the problem quickly due to not knowing the mathematical concepts and reasoning hidden in the problem.
- Making more mistakes while solving math problems.
- More difficult topics in mathematics textbooks.
- The examples given in the textbook have very little to do with the lesson.
- There is no guidance in teaching mathematics at home and no help in doing homework.
- A bad school environment also makes it hard to learn math.
- Students also have difficulty learning due to the ineffective teaching methods of teachers.
- The subject does not have a proper foundation in mathematics; there is a problem in the learning of mathematics.
- Inadequate interpretation of certain theorems and axioms is insufficient.
- Not giving the student the opportunity to speak freely.
- Non-participation of children in the class.
- Negative reinforcement instead of encouraging class children.
- Not conducive to a mathematical environment in class.
- Student interest and curiosity have no place in teaching mathematics.
- Do not associate mathematics with the student's life and do not know the importance of mathematics in their lives.

According to the NCF 2005, the following are the mathematics problems at school level (NCF2005, pp-42).

- Teaching mathematics without considering the level of children.

- Ignoring children's interests and curiosity in teaching mathematics.
- In math class, children get negative reinforcement instead of positive reinforcement.
- Instead of giving children a fair chance to learn, we drizzle information on them.
- Children's participation in math class is only by listening to and following the instructions given by the teachers.
- Lack of confidence in teachers' mastery and preparation in the mathematics subject
- Most children feel like they will fail at math and are afraid of it. So, he gets discouraged by mathematics and turns away from learning mathematics.
- The form of instruction that disappoints both the bulk of non-participants and the talented minority is described.
- They present outdated methods of reviewing the perception of mathematics as a mechanical calculation.
- Teachers are also lacking in how and when to present the content of the subject.
- The entire phase of evaluation is mechanical or the entire phase of evaluation is a pass failure.

1.3.4 Problems faced by students in learning mathematics

- Lack of interest in and aptitude towards mathematics in students.
- Students do not get full freedom and opportunities in the classroom.
- Students have difficulty understanding and memorising formulas.
- More difficult topics in mathematics textbooks.
- The examples given in the textbook have little relevance to the lesson and are insufficient.
- Not being able to guide the student in the right direction.
- There is an atmosphere of fear and dread among the students regarding mathematics.
- The subject does not have a proper foundation in mathematics; there is a problem in the learning of mathematics.
-

1.3.5 Problems faced by teachers in teaching mathematics

- Difficulty in teaching due to a large number of students in the classroom.
- There is difficulty in teaching mathematics due to differences in students' social, cultural, and family environments.
- There is difficulty in teaching mathematics due to a lack of basic mathematical knowledge in children.
- Lack of opportunities for teacher training programs.
- Lack of knowledge about new teaching techniques and inventions
- Lack of opportunity to participate in seminars and workshops in mathematics.
- Lack of refresher training to teach difficult and complex topics
- Lack of a mathematics lab in school
- Lack of a library and a lack of mathematical magazine, journals, and references
- Lack of mathematics-related teaching materials
- There is a lack of facilitation, appreciation, and recognition for good performance.

1.3.6 NCF- 2005 recommends the curriculum of Secondary School

Students start to comprehend how mathematics is organised as a discipline. They become accustomed to the quirks of mathematical communication, including the carefully chosen terminology and concepts, the use of symbols to represent them, the suggestions made in accordance with those symbols, and the supporting data used to support the assertions. This aspect has been particularly important in the area of geometry. Students equip themselves with algebra, which is important not only in the application of mathematics but also within mathematics to provide justification and proof. At this stage, students combine many of the concepts and skills they have developed into problem-solving abilities. At this stage, teaching mathematical modelling, data analysis and interpretation can help people learn more about advanced math skills.

1.3.7 Role of teachers in Mathematics Learning

Mathematics is a subject that has always been and will continue to be important, but the importance of a math teacher is even greater. because the teacher tries to explain

and teach effectively. The main task of a mathematics teacher is to try to teach mathematics effectively, which is a big problem. No mathematics teacher can truly teach mathematics unless the teacher is proficient in mathematics. Of course, two or three things are equally important in teaching mathematics. The first is that the math teacher should be an expert in mathematics, and the second is that the math teacher should be able to teach according to the abilities and needs of the students. If either of these two weaknesses is found in the math teacher, then he can never teach effectively. To become a successful teacher, one must first devote one's time to acquiring knowledge of mathematics and getting acquainted with the methods of teaching mathematics. In this day and age, new changes in mathematics subject matter, new techniques, and new methods also need to be aware of new ways to teach and learn.

Similarly, the math teacher should always try to keep the classroom environment pleasant, sensitive, and interesting at all times and also try to explain it to the students through practical tasks. By providing it, they should also be encouraged to move forward and generate interest. In addition to the above, mathematics teachers need to be able to read different mathematics journals, modern textbooks, and new teaching methods. By making contact with them, we should also try to learn something from the school teachers and experts. Similarly, curriculum reorganization, the inclusion of appropriate and reasonable textbooks, selection and recommendation of various teaching aids, presentation of articles of department and suggestions for the process of association, arrangement of standard examinations, and answer numbers must be counted.

In summary, in light of the above points, we can say that the teacher of mathematics should make the teaching environment effective and pleasant, keeping all these things in mind. Similarly, if the above-mentioned points are followed, then the students will be more inclined towards mathematics, interest, etc., and they will be more inclined towards the process of learning, and hence they can perform better in mathematical learning.

1.3.8 Pedagogical shift: from Behaviourist to Constructivist Approach

Mathematics is a subject that has always been and will continue to be important. Mathematics has always been the subject of talk about its benefits, usefulness, and

importance. It develops logical thinking in children, develops analytical thinking and problem-solving ability, and makes it easier to understand all other scientific and non-scientific subjects. Making decisions is heavily reliant on mathematics. As children learn, it is difficult to understand how functions, equations, geometry shapes, trigonometry, etc. help in everyday life. For this reason, mathematics is considered a difficult and complex subject. Even today, they are struggling to learn and understand this subject like in the past. Today, in the modern era, there are various ways to learn mathematics better and more effectively. In the past, mathematics was taught in schools through traditional methods such as direct instruction and rote memorization. There are two ways to learn mathematics. He is practical and constructive.

Skinner and Watson was follower of behaviorism. J. B. Watson is often called the founder of behaviorism. According to behavioural experts, all behaviours are the result of an individual's reaction to external stimuli. This means that the external environment is conducive to learning. It takes precedence over the effects of rewards and punishments, such as external stimuli in learning. "Behavioural learning is a theory that focuses on external events that cause students to observe and change attitudes." (McLerney & McLerney, 2010) It focuses more on behaviour and ignores mental activity. Behavioural experts support deductive approaches. It carries out instruction-based teaching and learning, and the learner's role is simply to absorb information and content. The practice focuses on how the learner responds to the encouragement and financial support provided by the teacher.

Piaget, Vygotsky, and Bruner, all three psychologists, were strongly in favour of constructivism. According to constructivist experts, children build new information on the basis of previous knowledge and experience. They build new information through discussion, engagement, problem solving, and collaboration. Teachers act as guides and facilitators and strive to connect them to real life. Find different topics of interest. In the constructivist classroom, teachers and students promote mutual understanding and complement the teaching and learning process by cooperating and integrating with each other. In the constructivist classroom, the group focuses more on research, discovery, and invention, exploration, and activities. Constructivists support an inductive approach. The

teacher guides the students in the classroom using problem-solving methods that include problems to be analysed and interpreted according to their context (Simon et al. 2013).

Behavioural learning is a theory that focuses on external events that cause students to change observable attitudes. There are two ways to learn mathematics (Mclnerney & Mclnerney, 2010). It is both practical and constructive. Behaviour refers to a theory of learning that focuses on electronically occurring phenomena as a result of students' observable behaviour change (McInerney & McInerney, 2010). Classic AS Conditioning Leads to Learning This means that any stimulus provided will trigger a specific response and is to learn the operating condition that makes a voluntary behaviour stronger or weaker than the resultant or previous (McInerney & McInerney, 2010). Direct instruction or teacher-centered lessons are used to teach students. It is more likely that students will find the procedure material than imaginary material. This type of teaching also encourages students to be bourgeois. Constructivism is the opposite. In order to gain new knowledge and understanding, students actively participate in the lessons by posing questions based on Peggy's information. The knowledge he imparts will be an instrumental element that will allow him to make it more meaningful for the students. Simone, Beswick, Brady, Clark, Faragher, & Warren (2011) define constructive methods so that students can imagine themselves actively participating in their physical, social, and psychological environments. Therefore, meditate as an agent as an active person. Compile mathematical meanings based on their previous knowledge and experience. Students can view content more realistically through inquiry or problem solving as they evaluate and address issues (McInerney & McInerney, 2010). From this point of view, the master becomes the facilitator of the learner, as opposed to the learner. Both methods can be combined with mathematics as they are useful in different ways. Direct instructions are useful for organising operations, teaching new methods, and modifying procedures that have been taught previously. Inquiries are used to solve problems by asking questions, where students work towards a solution using their knowledge.

These methods can be applied in math classrooms, either through explicit tutoring or tutorial lessons. Clear teaching (also called direct instruction) involves teachers who start the lesson by spending time learning the required lessons for the lesson or

introduction that clearly articulates the lesson process. The teacher then guides the students using instructional problem-solving methods on classroom problems, which involves a problem to analyse and interpret according to the precedent' (Simon et al. 2013). This is consistent with a behavioural perspective in which teachers monitor their student's responses to the content as they engage with mathematical topics and deepen their conceptual knowledge and understanding. Queries, on the other hand, are based on the principles of the constructivist approach. It usually involves an introductory activity that provides a link between the student's previous knowledge of math content and strategies so that the teacher can gauge the expected level of learning from the students. In addition, an inquiry lesson includes a reflection of the student, which provides the student development teacher with another opportunity for personalization. Even though the two methods are different, it is best for teachers to use both of them to get the best results from their students and to teach a diverse classroom well.

On the other hand, the constructivist approach focuses on learning more and can solve these problems. As was already said, the constructivist method is learner-centered and encourages students to participate and gain new knowledge. Consequently, even if it doesn't include responding to explanations based on the subject, this indicates that students are learning at their own pace and in accordance with their own interests. It also means that students can develop their own understanding of concepts and ideas. Students focus on their own interests instead of asking for work in return. This means that student results may not be achieved, or will not be achieved at a higher level. Because this approach focuses on constructivist learning, there are plenty of opportunities for students to work in pairs, groups, or whole-class discussions can lead to a lack of student participation and boredom (2010, page 137). During group projects or exercises, it is relatively simple for pupils who are confident to beat out less confident classmates. As we shall see in this essay, the effects of these techniques are both positive and negative.

1.4 Rationale of the Study

Schooling is a very important step in the development of every child. Every student develops different qualities such as creativity, problem-solving ability, logical thinking, and convergent thinking. These qualities are very important for the teaching and

learning of mathematics in school. The main purpose of teaching mathematics in school is to inculcate mathematical thinking in children. In its report, NPE 1986 states that "mathematics should be logically conceived as a vehicle to articulate something and also as an analysis and reasoning."

In the secondary stage, students understand the structure of mathematics where the mathematical terms are very strict and the students explain the mathematical terms, concepts, symbols, etc. very carefully. Due to this feature of mathematics, there is always an increase in the level of confusion, fear, and anxiety. As a mathematics student, it is observed in and out of the classroom that people try to solve problems by looking at or copying and memorising examples, not by thinking well. Some students memorise the problems without understanding the special theorem. They do this only to pass the annual exam. When students do not understand a problem well, they learn and remember, but do not try to understand. For these reasons, mathematics has become a difficult subject.

At the school level, there are various reasons for low-achievement in mathematics, including instructional strategies that a math teacher uses in the classroom, which may be the most important reason for low-achievement in mathematics. The main reason behind this is that teachers mostly use traditional methods in the classroom to teach mathematics. In this context, widespread use of technology can help solve this problem. Therefore, the proposed research work is designed to develop a framework through an ICT-mediated Constructivist Approach of teaching to obtain answers to the following research questions.

1.5 Research Question

- How effective is the ICT mediated constructivist approach in teaching and learning to improve mathematics achievement in secondary school students?

1.6 Title of the study

"Impact of ICT mediated Constructivist Approach on Teaching Mathematics Achievement of Secondary School Students"

1.7 Objectives of the study

Major Objectives

1. To study the impact of ICT-mediated Constructivist Approach of teaching on mathematics achievement of experimental group students.
2. To compare the mathematics achievement of ICT-mediated Constructivist Approach group and Traditional Method group.

Concomitant Objectives

1. To develop pre-test and post-test tools for Mathematics achievement tests.
2. To prepare lesson plan based on ICT mediated Constructivist Approach of teaching.
3. To prepare lesson plan based on Traditional Approach for teaching.
4. To develop Mathematics achievement tests for previous knowledge in mathematics

1.8 Delimitation of the study

1. This study was limited to Co-education secondary school of Darbhanga district of Bihar.
2. This study was limited to Urdu medium school of Darbhanga district of Bihar.
3. This study was limited to Government Secondary School, Darbhanga District, Bihar.
4. This present study was limited to class ninth students of Darbhanga district of Bihar

CHAPTER-II

REVIEW OF THE RELATED LITERATURES

2.0 Introduction

In the previous chapter, the conceptual and theoretical aspects of the study are highlighted, including constructivism, ICT, and mathematics. In which the rationale of the study, research questions, and objectives of the study, statement of the problem, operational definitions, and delimitation of the study are described. While the present chapter reviews the relevant material, which has been helpful in framing the conceptual framework of the present study,

A review material related to the previous research is an important part of this research. It helps in prepare and move it forward. Without studying the relevant material, research is like shooting an arrow in the dark. In its absence, it will not be able to take a single step in the right direction unless the researchers know how much research there is in this field has been done and what method has been used and what are the results. Without reviewing the relevant material, one can neither select the issue nor start one's own research.

According to John W Best

“Any research cannot be completed without considering previous research”.

Usefulness and importance of related material:

This phase of the research refers to the research done in the relevant field as relevant material, which shows the status of the research in the scope of this issue. Where and who have conducted research on it. Through this study, the study plan of the

researcher is easily prepared. It provides information on required study surveys, research methods, instruments used and methods used in interpreting data.

Relevant material also reflects the fact that the research conducted will be successful and the results obtained will be useful. It also helps in the selection of assumptions.

2.1 Studies related to mathematics achievement

Maamin & et al. (2022) present an article on "The Influence of Student Engagement on Mathematical Achievement among Secondary School Students." The primary goal of this was to investigate the relationship between secondary school student's mathematics achievement and engagement. The researcher adopted the survey method to complete his research. 227 schools were selected from Selangor, Malaysia, using random sampling, and the researcher selected a total of 1000 students from 227 schools using stratified random sampling. The researcher included students' previous year's mathematics achievement for data acquisition and developed 57 questions for student engagement in mathematics, which were based on 5-Likert scales. Using Pearson correlation, multiple regression, and ANOVA techniques, we concluded that there is a positive relationship between secondary school student's mathematics achievement and engagement. In particular, there is a positive relationship between behavioural engagement and affective engagement in math achievement. A negative relationship was found between math achievement and cognitive engagement.

Rashid & Singh (2021) wrote a research paper on "Analysing mathematical achievement among students." The main objective of this study was to find out the mathematics achievement of public and private school students, and the researcher formulated the null

hypothesis that there is no significant difference between the mathematics achievement of government and private school students. The researcher adopted the descriptive survey method to complete his research. The researcher selected a total of 200 students from Class IX using random sampling techniques. The researcher used the instrument developed by Sharma, S. S (2015) to collect the data. The collected data were analysed using descriptive and comparative analysis techniques, and it was determined that there is no significant difference in the mathematics achievement of public and private school students.

IIIilyas & Charles (2017) presented an article on "Interest in Mathematics and Academic Achievement of High School Students in the Chennai District." The main purpose of this article was to study the interest in mathematics and the academic achievements of secondary school students. Researchers used the survey method to complete their research. With the help of a stratified random sampling technique, 9 schools were selected from the Chennai district that included urban and rural schools. The researchers enrolled 300 students from 9 schools. The researcher used two types of tools to collect the data; one is an interest in mathematics and the other is the Academic Achievement Inventory. There was a significant difference in the interests of secondary school students in mathematics and in their management of higher education. There was no significant difference in interest and mathematical achievement between male and female students, i.e., there was no difference between them on the basis of gender. There was no significant difference in math achievement between rural and urban school students.

Anjum (2015) wrote a research paper on "Gender differences in mathematics Achievement and its relation with Reading comprehension of children at the upper primary stage." The main purpose of study the basis of gender in the mathematical achievement of Western UP students. To study on the basis of gender in the reading comprehension of Western UP students.The researchers adopted descriptive research. Researcher included 307 students from four city of Western UP, Aligarh, Buland Shahar, Khurja and Jahagirabad out of which 147 boys and 160 girls were included in the study. Researcher used standard instruments Mathematics Achievement Test and Reading Comprehension Test developed for data. Using mean, SD, t-test and correlation statistical techniques to analyze the collected data, researcher concluded that there is a difference in math achievement between boys and girls at the upper primary school level. At the upper primary school level, there was a significant difference in reading comprehension between girls and boys, and there was a positive correlation between math achievement and reading comprehension.

Santosh (2015) presented an article on "A study on the effectiveness of the computer aided learning (CAL) programme on the Achievement of learners in Mathematics." The main objective is to test students' achievement in mathematics as an effect of the CAL programme. Experimental method was used in conducting this research. 50 students a sample were selected by using an unplanned sampling technique for data. In two groups placed 25 students in one control group and 25 students in the other experimental group.

Various tools for collecting data

i. Teacher made Achievement Test

ii. School Profile

iii. Students Schedule

iv. Learners Information Schedule

v. Interview Schedule for teacher & Headmaster

vi. Interview Schedule for community members & parents used.

And average, standard deviation, and T-ratio techniques were used to analyze the data. The researcher concluded by analyzing that mathematical achievement is better than the experimental group control group and the experimental groups work in collaboration.

Jantan (2014) presented a research paper "Relationship between Students' Cognitive Approach (Field-Dependent and Field-Independent Cognitive Approach s) with their Mathematic Achievement in Primary School." Identify the punctuation method in the student, identify the student's average score in mathematics and find out the relationship between mathematical achievement and punctuation method. The researcher adopts a survey method for their research 150 primary school students were selected as samples and the tools were used: Group Embedded Figures Test (GEFT). Found that 74.7% of students have field-dependent (FD) intermittent methods and 25.3% of students have field-independent ant (FI) intermittent methods. In mathematics, 26.7% of students got grade, 25.3% of students get a B grade, 40% of student were found to have a C grade, 9% of student was found to have a bad score and 2% of student were found to have very bad score and 8% student was found to have failed.

Sklrbekk & Weber (2014) presented a research paper "Across-country comparison of Math Achievement at teen age and cognitive performance 40-year letter." Its main objectives are to determine the cross-national variation in brain function from younger to an older age. The researcher used the Quasi-Longitudinal method to advance the research

process. The sample selected from Germany, Israel, France, Australia, Finland, Belgium, England, Sweden, Scotland, the Netherlands, and Japan. Researchers used the first international mathematics study (FIMS), a tool developed by the International Association for the Evaluation of Educational Achievement (IFA) (Husen, Wolf 1962), and another Cognitive test performance at mid-life in 2004, to collect their data. in the survey of health aging and retirement in Europe used the tool. Average, standard deviation, and percentage statistical techniques were used to analyze the collected data. Researchers have found in their research that intermittent performance is much better in mid-age.

Sonar & Patankar (2013) published an article on a "study of the relationship between mathematics aptitude and achievement of secondary school student." The main purpose of studying the mathematical tendency of upper secondary school students is to compare the mathematical tendency of upper secondary students on the basis of gender. Researchers have adopted narrative method in their research. Researchers selected talukas using a purpose sampling technique and selected boys and girls by the lottery technique. Researchers used the Mathematical Aptitude Test tool to collect the data. Researchers used Mean, SD, percentage, and t-test to analyze the data obtained and concluded that there was no difference in mathematical tendency between the boys and girls of the secondary school. The differences in mathematical tendency between rural and urban secondary school students because of rural students were weak in understanding the basic concepts of mathematics.

Sobha (2012) presented the research title “Effect of Folk Mathematics on Achievement.” The researcher used an experimental method for his research. The researcher selected 60 vii students of a government Tamil school as a sample to collect data. Used pre-test & posttest and plan tutorial to collect data and used average, standard deviation, t-test, and ANOVA statistical techniques to analyze the data. The researcher found in his research that the use of the Mathematical Folklore method in the learning of mathematics is more effective than the traditional method and the knowledge, understanding, application, and skills have been found to be better in the experimental group compared to the control group.

Jha & Bhutia (2012) wrote a research paper entitled “Study Habits and Achievement of Students in Mathematics in Secondary School.” And to find out the relationship between the secondary level student's mathematical achievement and study habits. Researchers used the survey method to conduct the study. Researchers included 85 male and 70 female students out of 155 students as a sample for collecting data. "Study Habits Inventory tool developed by Prof. M. Mukhopadhyaya & Prof. D. N. Sananwal and using Summative Assessment for the mathematical achievement of Mathematics analyzed the accumulated data using statistical techniques like Average, Standard Deviation, T-Test and Relation, and analysis resulted in the non-Tribal student has better math achievement than Tribal student.

Kaur & Sharma (2011) published their article entitled “Effect of the Abacus Technique on Achievement in Mathematics at Elementary Stage”. The main purpose of this research is to find out the effect of the abacus technique on effective mathematical achievement of the fifth grade students. Researchers used an experimental method to apply their research.

Researchers selected 120 fifth graders from three schools as sample using unplanned sampling for his data. These included 60 male and 60 female students. Researchers used "Advanced Progressive Matrices" developed by J.C.Raven for intelligence gathering to collect data and selected Pre-test and Post-test. The researchers used the average, standard deviation, coefficient of correlation, T-test, and F-test statistical techniques to analyze the collected the data. Researchers found that the experimental group that was taught by the abacus technique performed better and the control group that was not taught by the abacus technique did not perform well.

Mahmood & Khatoon (2011) on influence of school and students factors on Mathematics Achievement presented research title Researchers used descriptive methods to conduct the research. For this sample, 863 (52.24%) students and 789 (47.6%) female students from 15 upper secondary schools of western U.P. were selected as the sample. Researchers used self-developed instruments, Mathematics Achievement Test (MAT) and Mathematics Anxiety Scale (MAS) to collect his data. Researchers analyzed the data through Pearson product moment, T-Test and F-Test statistical techniques for the analysis of the collected data and concluded that mathematical achievement was very high among AMU and Missionary school students. In the same government school and government aided school student's math achievement is found to be low. The student has less mathematical anxiety and better math achievement.

Sarsani & Maddini (2010) Presented research title “Achievement in Mathematics of secondary school students in selected variables.” The major goals of this study are to find out the difference between the mathematical achievements of secondary school students in terms of gender, caste, different school, birth and source of education. Researchers

used the survey method to apply his research. Researcher selected 480 Telugu and English medium students as a sample using a simple probabilistic sampling for data. The researchers used self-developed instruments Mathematics Scholastic Achievement Test (M-SAT) and Scholastics Aptitude Test (SAT) to collect the data. The researcher used average, median, multiplicity, standard deviation, coefficient of skewness, kurtosis, T-test and ANOVA statistical techniques to analyze the collected data. Researchers concluded that mathematical achievement is more common in girls than in boys. Caste has no effect on mathematical achievement. Mathematical achievement is affected by different schools and medium of instruction.

Karimi & Venkatesan (2009) published their article entitled "Mathematics Anxiety Mathematics Performance and Academic in High School Students." The main objectives of the study were to determine the relationship between Mathematical Anxiety, Mathematical Teaching and Academic Hardiness in Secondary School in Karnataka and the sexual effects of students' Anxiety Mathematics on Mathematical Teaching and Academic Hardiness. We selected 284 eighth-grade students from Mysore and Bangor secondary schools, including 144 boys and 140 girls.

Researchers used the following tools to collect the data.

(1) Mathematics Anxiety Rating Scale-India (MARS-)

(2) Academic Hardiness Scale (AHS)

(3) The pupils' final exam scores were used to determine their math performance score.

Researcher used statistical techniques such as Mean, SD, t-test to analyze the collected data. Researchers found in their research that there was a significant relationship between math and mathematical performance in high school students, and positive relationship

between math performance and academic hardiness of students and a significant difference between math anxiety in boys and girls.

Ravanana & Mary (2007) had studied entitle "Attitude towards Mathematics of xi standard students in Trichy Districs." It has several important objectives. To differentiate between the attitudes of boy and girl students of mathematics. Researchers proceeded their work by applying the descriptive method. Researchers had selected a group of 450 students out of 10 schools using simple random sampling for data collection. A tool developed by Dr. C.D. Dandapani namely the Mathematics Attitude Scale, has been used with the purpose of data collection. Researchers used various techniques, such as chi-square, ANOVA, t-test and karl pearson's product moment, for data analysis. In their research, researchers determined that there is no difference between the attitudes of boy and girl students of mathematics and the medium of instruction plays no significance role in mathematics.

Lavanya & Vijayalakshmi (2006) had studied entitled "Relationship between stress and Mathematics Achievement among intermediate students." The main goal of this study was to determine the connection between stress and students' higher secondary school mathematics performance. The researcher also examined the effect of demographic variables such as gender, year of study, medium of instruction, parental education, management and locality on students' stress and their mathematics achievement. A survey method was used for this study. To collect data researchers prepared 'Stress Inventory' and Last mathematics achievement. Using stratified random sampling, 180 students were chosen as the study's sample. Mean, SD, t-test, F-test statistical were used to analyze the data. It was found that 60% students felt highly stressed. Male students are

more stressed than female students. Mathematics Achievement of urban students is better than Semi urban & rural Students. Locality, management and medium of instruction don't affect student stress. There is no significant difference among students in their mathematics achievement on the basis of gender, year of study, management, medium of instruction and level of parental education.

Subramanian, et al. (2006) had studied entitled "Relation between Self-Concept, Achievement Motivation and Achievement in Mathematics A gender comparison." 80 students of class viii from government Sardan Patel School and world Champion Middle School were selected as the sample of the study. The self-concept scale for children prepared by Dr. Hozmohan Singh and Saraswati (1977) was administered. To collect data on Students' achievement motivation, the researcher himself prepared achievement motivation Scale .Correlation and t-test were applied to analyze the objective data. The findings of the study state that there is no relationship between male students' self-concept and their achievement motivation, while there is a positive relationship between female students' self-concept and their achievement motivation. There was a positive relationship between achievement motivation and mathematics achievement among male and female students.

Fisherman & Wither (2003) presented their research paper on "Mathematics Anxiety and Mathematics Achievement." Researchers studied the relationship between anxiety mathematics and mathematical achievement. - The main objectives of this study were to find out if math disorder impairs mathematical achievement. Find out if math treatment can restore math achievement or if anxiety occurs at the math level. The researchers observed the group of students twice a year for five years to apply their research.

Suburban Adelaide in South Australia was selected from three schools with 289 students taking eight consecutive examinations each year for five consecutive terms. The researcher used the following tools to obtain data

(2) Mathematics Achievement Test

(2) Mathematics Anxiety Test

Researchers found in their research that increasing math anxiety and math achievement decreases maternal anxiety.

2.2 Studies related to constructivist approach

Kaur & Kaur (2022) examined the "Effect of constructivist approach on achievement in mathematics in relation to problem solving ability." Its main objectives were to compare the constructivist approach and the traditional methods taught to mathematics groups and to compare the problem-solving abilities of high and low-achieving groups of students. An experimental method was used to carry out this research. In this, math achievement is the dependent variable and problem-solving ability is the independent variable. The researcher made 12 lesson plans based on data on different math topics and constructivist ways of looking at them. used the tool developed by Dr. Kawaljit Kaur (2017) for testing mathematics knowledge and the tool developed by L.N. Dubey (2011) to test problem-solving ability. The researcher used descriptive statistics, three-way analysis of variance (2×2), and F-test and t-test techniques for data analysis. His researcher analyzed the data and concluded that the achievement of students in mathematics taught by the constructivist approach was more effective than the traditional method and that there was no difference between a high and low-achieving group of students in problem-solving ability.

Majumder (2022) presented the research paper “Review of literature on Constructivist Approach.” Their main objectives were to analyze the review of constructivist theory according to different strata and to understand the trend of constructivist theory. The documentary analysis method was used to carry out this research. The researcher reviewed a total of 56 papers for data collection in this study. The researcher concluded that a constructivist approach is a modern learning approach. It is a child-centred approach where students are actively involved in constructing information. Most research findings have indicated that the constructivist approach was more effective than any other approach. When compared to behavioural teaching, the constructivist approach worked just as well for boys and girls, and it helped teachers learn and get better at what they do.

Sandhu & Rani (2017) examined the “effect of constructivist approach on the academic achievement of an elementary school student.” and had two main objectives. The first objective is to construct a constructivist approach to teach the concepts of Hindi grammar to seventh grade students and the second objective is to find out the effect of constructivist approach in elementary school students' Hindi learning. Researchers chosen experimental research to carry out his research. One is the control group and the other is the experimental group. The researcher selected 60 students from the seventh grade through Purposive Sampling in which he placed 30 students in the experimental group and another 30 students in the control group. The researcher first took pre-test of both the groups. The experimental group was then taught a lesson plan based on the constructivist approach and the control group was taught a lesson plan traditional method. Researchers then found that the Hindi achievement of the experimental group was significantly higher than the control group.

Adak (2017) published an essay on the "Effectiveness of constructivist approach on academic achievement in science at secondary level." The main purpose of study to find out the effect of constructivist theory on the traditional method for learning physical science of students and the second purpose was to find out the effect of constructivist theory on the traditional method for learning physical science in terms of students' intelligence. To compare the researcher adopted quasi-experimental pre-test, post-test control group design. The researcher selected a secondary school with a purposeful sampling technique to enable his research to be successful, which included 58 students. Out of these, two groups were formed, one experimental group and the other control group. The research was limited to Bengali medium students, physical science and ninth grade. The researcher used two types of tools to collect the data, one is the project lesson based on 7E model and the other is Reven Progressive Matrices. The researcher analyzed the obtained data using ANOVA, t-test, SD, Mean statistical techniques. The researcher concluded from his research that no significant difference was found in the attainment of high, average and low intelligence students by constructivist theory on traditional teaching methods. Constructivist theory is an effective and efficient means of learning that has a significant impact on students' scientific achievement.

Seridevi (2013) examined the "effect of constructivist approach on the student's perception of the nature of the science at secondary level." The main purpose of this study was to develop science lessons based on a constructivist approach in science and to examine the effectiveness of the constructivist approach on student's achievement in science and scientific attitude. She used the purposive sampling techniques and adopted the quasi experimental design and select the two schools Demonstration Multipurpose

School (DMS) RIE, Mysore and Kendriya Vidyalaya, Mysore for this study. The 8th standard students belonging to DMS were treated as the experimental group where students of Kendriya Vidhayalaya were treated as the controlled group. In this study 68 students (31girls and 37 boys) were selected for both the experimental and controlled group. The main conclusions of this study are that a constructivist approach is effective in demonstrating the accomplishments in science, perception of the nature of science, processing skills, scientific attitude, and attitude towards science of eighth-grade students. It is equally effective for both boys and girls in improving their achievement in science, science processing skills, and attitude towards science.

Tyagi & Verma (2013) presented essay on "Influence of constructivist in teaching on academic achievement of primary students." Their main objective was to study the effect of constructivist teaching on the academic achievement of EVS in fourth grade subjects. His two variants are constructivist teaching, one is independent variables and the other is academic achievement as a dependent variables. This research is based on pre-test and post-test of quasi-experimental method. Researcher selected schools using purposive random sampling and cluster sampling techniques and selected a total of 75 students as sample by random sampling of fourth grade students. Researcher carried out their research for 56 days through constructivist teaching to the experimental group and traditional teaching to the control group. After taking the group's post-test for days, the researcher analyzed the data using statistical techniques and concluded that the traditional teaching has a significant effect on the student's academic achievement through constructivist teaching.

Chitanana (2012) presented the research paper "A constructivist approach to the design and delivery of an online professional development course: A case of the iEarn online course." Standard approaches including questionnaires, interviews, empirical experimentation, etc. were used to conduct this research. 28 educators out of which 13 female and 15 male were selected as sample for data collection. Their average age is 35 years. The sample included science, math and technology teachers selected from Cameroon, Pakistan, Zordan, Iran, Indonesia, China, Romania and others. The researcher carried out instructional work with online activities, discussion forums and delivery via email for 8 weeks. He then used the holistic approach to reach his conclusions. The researcher concluded that the results of the study confirm the findings of previous research that designing and using a course based on constructivist Approach helps create a dynamic learning environment that in turn enhances professional skills among educators.

Cakici & Yavuz (2010) "investigated the effect of constructivist science teaching on 4th grade students understanding of matter." The main objective of the researchers was to determine the effect of constructivist and traditional methods on fourth grade students and a comparative evaluation between the two methods was to be done. Researchers adopted quasi experimental design of experimental research. Researchers included a total of 33 primary school students for the sample, including 16 students in the experimental group and 17 students in the control group. After that, the pre-test of both groups was taken. Researchers carried out the teaching work for four weeks. The experimental group was taught the construction method and the control group was taught the traditional method. Researchers first conducted a post-test on both experimental and control groups

to analyze their data. Researchers analyzed the data and found in his study that according to the results of the pre-test, there were no significant difference between the control and the experimental group. While in the results of the post-test, the scientific achievement of the experimental group of students has been found to be better compared to the control group.

Mahmood (2007) conducted a study entitled "Elementary school science teachers' belief about science and science teaching in constructivist landscape." and purpose of which was to find out the science-related beliefs and teaching of science teachers of Pakistan and Japan in relation to constructivist approach and to compare the results with reference to both countries. In this study, questions related to the five domains of the teacher were arranged in a questionnaire which includes lesson planning, behavior towards students, classroom testing and classroom dynamics. The study was based on a survey method in which data was obtained by selecting 314 teachers as a sample. 159 samples were taken from different districts of Japan, 85 samples were taken from Teacher Trainee under TG University and 70 samples were taken from Lahore, Pakistan. The obtained data were analyzed through ANOVA which revealed that Japanese teachers tend towards constructivist approach as compared to Pakistani teachers.

Padmanabhan (2007) conducted a research work entitled "Effectiveness of constructivist approach on the achievement and problem-solving ability in science of vii standard students." The purpose of which was to promote a lesson plan based on the principles of constructivist theory and to find out its impact on students' scientific learning. In this study, Randomized Pre-test and Post-test Experimental Design were selected for the experimental work for which 40 students of Section A and 40 students of

Section B were included as experimental and control group respectively. The children of both groups were taught by the researcher himself while the children of the experimental group were taught based on constructivist techniques while the children of the control group were taught using traditional techniques. As a result of this study, it became clear that constructivist practices have a positive effect on children's scientific learning.

Kim (2005) presented his article entitled "The Effects of a Constructivist Teaching Approach on Student Academic Achievement, Self-concept and Learning Strategies." The main goal of this was to examine how a constructivist teaching strategy affected students' academic performance, self-concept, and learning strategies. This study was an experimental study. This study is based on the non-equivalent control group of pretest/post-test sketch The researcher included 76 children in grade six in his study, of which 38 students were in the experimental group among them (21 boys and 17 girls) and 38 students in the control group (22 boys and 16 girls). The researcher developed a design lesson for treatment based on Yager (1991) constructivist instructional approach that has the following steps.

1. Inviting ideas
2. Search Exploring
3. Proposing Proposal
4. Explanation and Solution
5. Taking action

The second is traditionally planned lesson. The researcher treated the experimental group with a tactical approach-based project lesson and the control group was treated routinely. The study came to the conclusion that students do better academically when constructivist teaching strategies are used. The learning skills and self-concept of pupils

are not improved by constructivist teaching. This has a positive effect on the motivation for learning. Learning that is self-monitoring.

Cook, et al. (2002) conducted a research work entitled "Problem in developing a constructivist approach to teaching: one teacher's transition from teacher preparation to teaching." and the case of such a teacher under this title. The study was conducted which was the first job in K-12 schools after completing the teacher education program run under the university. The information was gathered using pre-teaching interviews, group concept mapping exercises, interviews with administrators and supervisors, and school-related artefacts. As a result of the study, it is clear that the teacher places more emphasis on promoting what Vygotsky said than on using constructivist practices to promote ideas and sustainable development.

2.3 Studies related to Mathematics and Constructivism

Walia (2016) presented an article on "Effect of constructivist approach on mathematical creativity and achievement of eighth grade students." The main purpose of the study was to compare the effects of a constructivist approach and a traditional approach on the mathematical creativity of eighth-grade students. This study is limited to one private school and mathematics subject. The researcher adopted the pre-test-post-test control group quasi-experimental research outline. The researcher selected an English medium private school using the purposeful sampling technique and enrolled a total of 92 eighth grades. The researcher randomly created one control group and another experimental group. The researcher has used two types of data collection tools which are as follows.

1. Instructional Tools:

- ❖ Lesson plan based on Constructivist Teaching

- ❖ Lesson plan based on traditional methods

2. Measuring Tools:

- ❖ Mathematical Creativity Test (MCT)
- ❖ Mathematical Achievement Test (MAT)

The researcher first took a pre-test of both groups. The researcher then treated the experimental group with the constructivist method and the control group with the traditional method. After giving treatment, post-test of both groups was taken. The researcher analyzed the data obtained using Mean, SD, dispersion, t-test statistical techniques and concluded that a significant difference was found between the scores of the experimental and control group mathematical creativity. The experimental group scored better than the control group did. This means that teaching through constructivist approaches performed better than traditional methods. Therefore, in order to improve the creativity of mathematics, the teaching process should be done through constructivist approach.

Aydisheh & Gharibi (2015) presented a paper entitled "Effectiveness of Constructivist Teaching Method on Students 'Mathematic Academic Achievement." The main purpose of study the effect of constructivist teaching method on students' mathematics achievement. Quasi-experimental design and control group were used to complete this research. Researchers selected the schools using cluster and multistage sampling technique. Researchers sample a total of 70 students, including 35 in the experimental group and 35 in the control group. Researchers first took a pre-test of both groups. The experimental group was taught by the constructivist method and the control group the traditional method. After that both groups took post-test. The researcher analyzed the

obtained data using mean, t-test, statistical techniques and concluded that teaching mathematical achievement was improved by constructivist approach to teaching.

Bhimarao (2014) presented a research paper on the "effectiveness of constructivist learning and traditional teaching in mathematics." The aim of this article was to discuss the effect of ninth grade Marathi medium students on mathematics achievement through Constructivist teaching and traditional teaching. This research is an experimental research. The researcher selected 80 students as a sample using a simple random sampling to collect data. The researcher used self made tool, Constructivist learning (CL) strategies on mathematics. The researcher conducted two tests, one pre-test before Constructivist teaching and the other post-test after constructivist learning. After analyzing the data, the researcher concluded that mathematics learning is more effective at teaching mathematics through constructivist teaching than conventional teaching.

Ilyas, et al. (2013) presented the "effect of teaching of algebra through Social Constructivist Approach on 7th grade learning outcome in Sindh (Pakistan)." Their main objective was to find out the effect of mathematical algebra by teaching through constructivist methods and traditional methods and to find out the difference between the results of mathematical algebra taught by both methods. Researchers adopted quasi-experimental design to carry out his research work. Researchers conducted two tests, one pre-test which was done before constructivist teaching and traditional method and the other post-test which was done after constructivist and traditional teaching. Researchers did a total of 12 days of treatment after taking the pre-test, including 6 days on the experimental group and 6 days on the control group. The researcher, after analyzing the

data, concluded that teaching mathematics through constructivist teaching is more effective in achieving algebraic mathematics than traditional teaching.

Lata & Sharma (2013) presented a research paper on the "effect of constructivist approach on academic achievement of seventh grade learners in mathematics." The main objective of the researchers was to study the achievement level after the experimental termination and to compare the two methods by teaching through Constructivist method and traditional method. In which 30 students were placed in experimental group and 30 in control group. Researchers used a self-made tool procurement test to collect the data. Researchers first pre-examined the experimental and control group and then taught the experimental group through the constructivist method and taught the control group through the traditional method. He then did the post-test and then compared the two groups. The achievement of the experimental group is high and the achievement of the control group is low.

Nayak (2011) presented his research paper entitled, "A study on the effect of Constructivist Pedagogy on students Achievement in Mathematics at elementary level." Their main objectives were to find out the effect of constructivist approach teaching on the elementary school's mathematics achievement and the achievement of different structures of mathematics. This research is an experimental study using non-equivalent pre-test quasi experimental design. Researcher selected three urban schools in Bhubaneswar using purposive sampling to collect data and selected 249 students from class V through random sampling. Researcher included 123 students in the experimental group (72 boys and 54 girls) and 123 students in the control group (63 boys and 60 girls). Researcher used self made tools to collect the data, one for the Constructivist Approach

(CA) for the experimental group and the other for the Traditional Method of Teaching (TMT) for the control group. Researcher first performed a pre-test of both groups, then for 20 weeks the experimental group underwent the teaching process using the 5E instructional model of constructivist approach and the control group through the conventional method. After taking a post-test of both groups, the ANCOVA (one-way analysis) statistical technique for their analysis concluded that there was no significant difference between the first control group of treatment and the experimental group mathematics achievement. After treatment, however, it was found that there was a significant difference between the control group and the experimental group in mathematics achievement.

Tripathy (2010) presented a paper on "Effects of experimental learning activities on learner's achievement in mathematics: A constructivist approach." Based on the pre-test and post-test design, a total of 27 third grade students from Kandhamala district of Odisha were included in the study as a sample. Used of variety of techniques to including demonstration, discussion, observation, Constructivist, group work, etc. Post-test the students after the end of the experiments and concluded that the level of mathematical achievement of the learners in the post-test was significantly higher than that of the pre-test.

Ojose (2008) entitled "Applying Piaget's theory of cognitive development to mathematics instruction." This is the development of children. They used different ways to understand world. This stage of the sensory motor stage involves seeing, hearing, tasting, touching, holding, and so on. The second is the development of the child's language or speaking ability during this stage of the pre-operational phase and the sign

language such as words, gestures and posture, sign, diagrams, etc. The third is during the concrete operational phase. The child develops thinking through practical experiences, the ability to solve problems logically and the ordering of solid objects. Serial ordering develops. As well as developing the ability to reason logically. This article illustrates these steps in the light of mathematics education. In general, knowledge of the steps of the page helps teachers to understand the child's cognitive development as teachers intend to take appropriate activities to keep students motivated.

2.4 Studies related to ICT- mediated Constructivist Approach

Kumari (2021) writes in her article that Constructivist Approach of communication is an emerging Approach of teaching and learning process which is basically student centric. This theory is based on the premise that students build their creation of knowledge and new information with the help of their previous knowledge, understanding, experience and mental perception. Today, in the modern age, ICT has become an important part of all aspects of life. ICT always provides a wide platform for student self-learning. In this article, the researcher concludes that in the present era, ICT is affecting all aspects of life, including education. Learning style, learning environment, transfer of information and teaching methods are being promoted. The use of ICT facilitates the learning environment to be more active, collaborative, creative, and integrative and to evaluate. Constructivist Approach is a student-centred in which students actively involved in the creation of knowledge based on their mental cognition. Constructivist approach promotes students to be more active, critical thinking, decision-making, knowledge-seeking, and more. In this way, in the process of teaching and learning, it creates knowledge by making the students passive and active.

Manas (2020) write in his article that technology refers to the design and environment that engages the learner. The researcher based his study on two areas. The first concern is to promote constructivist learning in ICT in the classroom today and the second is the educational and professional development of the teachers especially for the implementation of constructivist approach in the classroom. Constructivist approach is student-centred learning and supports student participation. From which the student builds new information or creation with the help of his previous knowledge. Teachers are less hesitant to use ICT because they know that it helps them to design or instruct teaching methods that support their theoretical approach. The ICT and the constructivist approach used better together and can effectively integrate technology tools into the classroom.

Viquarunnisa (2019) writes in his article that ICT has affected the education system and every aspect of life, which has made teaching in the classroom easier and more effective. ICT has made an impact in the teaching and learning process and ICT is being used from primary education to higher education. The main objective of the researcher in this article was to find out the effect of ICT mediated Constructivist and accessibility approach through ICT on the success of secondary students of Hyderabad. The purpose of this research was to investigate whether ICT mediated constructivist approach or traditional methods of teaching improve achievement in science of students. This study's design, which included an experimental group and a control group, was based on pre- and post-testing. The control group received traditional instruction whereas the experimental group received ICT-mediated constructivist instruction. After that, post test of both groups was taken. The study concluded that students who were taught ICT mediated Constructivist

teaching approach significantly improved their skills in science, knowledge, understanding, application and science skills.

Chand (2018) published an article entitled "Constructivism approach towards integration of ICT for collaborative learning." This article focused the point of Constructivist approach by integrating ICT for collaborative learning. The process of learning through constructivist approach builds new information by changing the mind from passive to active mind. ICTs provide learning opportunities in which learners formulate their ideas, test and draw conclusions and convey their knowledge in a coherent learning environment. ICT provides collaborative learning techniques to help learners develop content knowledge, critical thinking, and problem solving skills. ICT-integrated tools facilitate collaborative learning opportunities in the constructivist approach.

The constructivist classroom environment promotes in social and communication skills. Students should express their ideas, communicate with others and participate in a socially acceptable manner. ICT integrated tools offer an unlimited gift, challenging human intelligence, imagination and a variety of learning initiatives. It will guide the student towards a better and higher standard of living.

Chaudhary (2018) writes in her article that "Information and Communication Technologies (ICT) has become a common entity in all aspects of life." Today, the use of ICT has basically changed the way businesses, educational institutions and governance work in almost all areas. As the world continues to move faster in the media and information, the role of ICT in education is becoming more important and day by day importance is increasing. In this article, the researcher highlights the various effects of

ICT on contemporary higher education and explores the potential for the future. Through this article, the researcher explores the role of ICT in transforming teaching and learning and seeks to explore how it affects the way future University and colleges deliver and deliver programs. Mobile Technologies and Smooth Communication Technologies support 24x7 teaching. The use of ICT in education will continue to grow in the years to come as it will become a powerful agent of change in many educational ways and will help increase the temporal and geographical opportunities that are currently being experienced. Increasing students' access to ICT will also create opportunities.

Asamoah (2017) presented a article on "Constructivist tenets applied in ICT-mediated teaching and learning: higher education perspectives." In this study, the researcher described how the MA program professor instructor in contemporary issues in the adult education classroom applied Constructivist theories to ICT mediation teaching and learning. The researcher used qualitative, descriptive and case study methods. The researcher selected all 14 MA students of the University of Ghana as sample using conventional sampling. The researcher reviewed, observed and interviewed the document to collect data. In this article, it is concluded that the use of ICT was a unique and successful achievement.

Nayak (2015) presented an article titled "ICT Integrated Constructivist Pedagogy on Science Achievement and Process Skills of Secondary Level Learners." This article is the result of a study on students learning in the ICT Integrated Constructivist Environment and its impact on students' success as well as their ability to process science. This study was based on pre-test post-test quasi experimental design and purposive sampling technique was used. For example, four different schools in Odisha have been selected

through purposive sampling. In which 150 ninth grade students have been included. The researcher developed two groups, a control group and an experimental group, to complete his research. The researcher took a pre-test of both groups. The researcher then taught the experimental group the Collaborative Inquiry Approach (CIA) and the control group the Traditional Method of Teaching (TMT). The researcher then took a post-test of both the groups and performed the hypothesis by means of a T-test at P <0.05 level. The researcher found that the science achievement of the experimental group was significantly higher than that of the control group.

Padhi & Dash (2015) this article focuses on "Constructivist-based physical science to make the teaching process more efficient through ICT." Nowdays, the teaching of science is becoming a very important field of research in all over the world. There is a must to follow an active, competent, committed inquiry methodology to strengthen the quality of science education at all levels, which will make science education an enjoyable experience for students. . Modern experts claim that the formation of knowledge takes place when the students understand the focus of the experiments found in world. Do it Constructivist is one of the new theories that has greatly influenced the teaching process. The basic premise of the Constructivist theory is that students build new knowledge based on previous knowledge. A Constructivist classroom is a student centre and teachers act as a guide. New knowledge is built by combining previous information with new experiences through activity-based, interactive. The role of ICT is becoming more and more important in the age of development as it seeks to maximize the inclusion of science students. In this developing world, ICT has the potential to enhance the educational experience of children who live in rural and remote areas, have special

learning needs and whose purpose is health and they the narrator is not satisfied with the education system. The purpose of this article is to analyze the integration of Information and Communication Technology with a Constructivist model of teaching and learning of science.

Tiwari (2015) published a research paper on "Facilitating Personal Learning Environment in an English Class through Constructivist learning design and Web 2.0." In India, English often makes teachers anxious in the classroom because language learning is demanding and challenging, especially when English is the second language. Most of the learners come from different backgrounds and only a few manage to compete in English. The Vygotsky model is adopted. The NCF-2005 has also advocated for Constructivist and advocates Constructivist attitudes towards the English language teacher in the English classroom. Collaboration of learners facilitates meaningful expression and expression in the English classroom. The personal learning environment (PLE) creates all the different tools and resources from which the learner's can fulfil the teaching process according to their needs. It can include a variety of items, including books, movies, software, online resources, electronics, and even the environment to learn where and how to learn, whether alone or in collaboration. They make it easy and create an environment.

Pattanaik (2010) in his article studied the "use of ICT in the Constructivist Approach Classroom." ICT is largely based on Constructivist theory, observation and scientific study of how people learn. ICT has brought more learning resources and composting facilities in the classroom. Teachers and learners can benefit from each other's cooperation, autonomy and shared learning. Since the Constructivist theory is a

psychological theory of knowledge, the implication of which is that man builds knowledge and meaning from his experiences, promotes active learning. The learner of the Constructivist Approach puts himself in the background. Leaning is an active process and interface between learner and facilitator, both are equal partners. Lemming theory is the interaction of ideas, events, and activities with which learners interact. Most of the time the child builds his knowledge while engaging in the learning process. Children's anxieties are triggered by their daily experiences or exposure to mud. Learners form their own understanding of the various variables (knowledge, attitudes, interests and socio-cultural influences that children have on the learning situation) and the results of interactions between experiences. ICT is an important tool for improving the quality of teachers as well as the wider education system for children and adolescents. In the current context, various strategies and ICT measures have been taken for the training of retarded teachers, classroom processes and access to children. Use of ICT for Classroom Transaction Therefore, it is imperative that a study be started on the use of ICT in classroom transactional manipulation of the classroom.

Paily (2010) Researcher has presented his article on the “Role of web2.0 technology in creating a Constructivist learning environment.” Modern teaching encourages teaching methods based on the principle of constructivism. The learner constructs new knowledge individually and by using a variety of methods, tools, resources and contexts based on previous knowledge and experiences. The new developments in the field of ICT and especially web2.0 make a variety of tools and resources available for the design and delivery of instruction based on constructive principles. "web2.0" is a web-based technology tool and utility that focuses on social, collaborative, user-oriented content and

e-learning, such as blogs, wikis, multimedia sharing services, and content syndication podcasting and content tagging services. Emerging technology that is characterized by maximum functionality, interoperability and connectivity facilitates the creation of knowledge through open communication and collaboration. The level of adaptation of emerging obligatory or correct technologies is increasing in the environment. There are also numerous or different instructional design models based on constructivist Approach that allow you to integrate most of the web's Web2.0 technology. This article focuses on the breadth of the various Web 2.0 tools and their integration, in which a constructivist learning environment enables the teaching and learning process through Web2.0 to be effective and the learning environment to be enjoyable.

2.5 Studies related to mathematics and ICT

Sarmah, et al. (2020) presented an article on "Role of ICT in teaching and learning Mathematics- An overview." The main purpose of which is to investigate the various roles of ICT in the teaching of mathematics in the secondary classroom and to study the functions of tools as well as the skills of teachers and the effective use of ICT in the teaching of various subjects of mathematics in the classroom. ICT is the ability to provide more interactive skills to enhance the mental and creative abilities of the users. The digital education system makes students more efficient and effective than the traditional education system. Digital technology is changing the way concepts are learned in school. The traditional chalk and talk method has adapted itself to interactive teaching and the rapidly evolving technology and change of ICT. ICT is an important tool in the modern education system. Therefore, proper use of ICT is essential to make the teaching process effective and efficient. The math classroom needs to be integrated with ICT and advanced

planning. Proper ICT infrastructure is required and the result is an effective learning environment and maintaining what is being taught.

Pandey & Pandey (2020) writes in their essay that the use of Information and Communication Technology (ICT) has been widely acknowledged for decades. The impact of ICT is an interesting place in teaching that should be known in order to find the output. The main objective of researchers is to get an overview of the use of ICT in teaching and learning in India. Researchers collected data with the help of Internet, Institutional Library, Google and Google Scholar to complete his research. The study was limited to India. Researchers found in his study that the use of ICT in various research articles has shown a positive effect on the quality of education. ICT is more prominent in urban areas than in rural areas. The researcher has studied the role of ICT in this article from secondary school to higher education. Based on the published data, it is observed that studies in the southern, eastern and northern zones of India use ICT more. In contrast, it is very rare in Central India. It has also been observed that the use of ICT in India among developing countries is less than in developed countries. Researchers conclude that there is a lack of such studies, so more studies are needed to know the global impact of ICT in the future.

Das (2019) the main objective of this research is to explore the "Role of implementation of ICT tools in teaching mathematics." Technologies (ICT) are now an essential component of daily life in the processes of teaching, learning, and communication. The science of mathematics is revered as the supreme discipline. For a very long period, mathematics was used exclusively in academic settings. But the use of mathematics nowadays is not just restricted to the academic world. It has entered the field of

technology and industry. In this paper, the researcher seeks to emphasize the importance of integrating Information and Communication Technology (ICT) into the teaching and learning of teacher training college and school-level mathematics. The researcher has used different methods and techniques, which includes secondary sources of communication, discourse, observation, and study, which collected its data through books, articles, dissertations, university news, expert opinions, and websites. The researcher found in his study that the integration of ICT in mathematics education has a positive effect on both teaching and learning process. The researcher also found that there are barriers to the integration of ICT in the teaching and learning of mathematics at the level of colleges and secondary schools.

Suparman, et al. (2019) presented an article on "The Use of ICT in Mathematics Learning." The main purpose of this article was to find out the potential of teachers in ICT field before and after training. In this study, Researchers has adopted non-experimental pre-test / post-test design. Researchers selected 25 math teachers through Purposive Sampling. Researchers used the questionnaire to collect the data. To analyze the data obtained, the researcher used descriptive statistics and Wilcoxon rank sum test technique. Researchers analyzed the data and concluded that in the field of ICT, there is a difference in the abilities of teachers before and after training. After training teachers in the field of ICT, their ability improves.

Dhakal (2018) writes in his article that "ICT is an integral part of teaching and learning process." The researcher has studied the use of ICT in teaching mathematics at Mid-Western University, Nepal and the attitudes of teachers towards the use of ICT. The researcher concluded in his study that teachers use ICT for their professional

development and have a positive attitude towards ICT. The researcher found in his study that the use of learned ICT has encouraged them to increase their efficiency and the teaching process. Researchers has found that lack of knowledge, resourcefulness, lack of teachers and inadequate teacher training arrangements for integrating devices are the major obstacle to the use of these ICTs.

Rani & Anisha (2017) presented an article on "Role of ICT to enhance mathematics teaching and improving educational standards." The main purpose of this article was to study relevant research on the use of ICT by teachers at primary and secondary school level. ICT is considered an important tool in understanding the concepts of mathematics. ICT is widely used in education for gathering information, managing and analyzing data. This includes computers, CD-ROMs, e-mail, the Internet, Word processors, photo-graphic software, projectors, projectors, PowerPoint, and many. In India, there is an urgent need for teachers and students to develop information and learning skills through ICT.

Sengamalaselvi, et al. (2017) the researcher writes in his article that information and communication technology is an important tool, which in the current learning environment, shifts from teacher centre, book centre to student centres. ICT stands for Interactive Learning Environment. The main objectives of the study were to study the implementation of ICT among the high school students of ST. Mary's Matriculation High School in Mamallapuram and to develop two and three dimensional analytics especially in the field of mathematics to highlight on the field of geometry. Researchers compares traditional teaching include focused and without ICT. Based on the results obtained with the help of F-test during the comparative study, it is concluded that both teachers and

students benefit from incorporating ICT in the traditional way. ICT plays an important role in helping students understand and develop mathematical concepts. Geogebra, like ICT, is excellent mathematics software that helps in learning and understanding high school math topics. This technique enables students to complete the process of memorizing mathematical concepts in 2 and 3 dimensional. This software helps you to see 3D mathematical shapes, find angles, find areas, find slope, etc. and clearly understand the concepts of mathematics. In the traditional method, students depended only on rote memory. But using ICT with the traditional method can enhance your skills, knowledge development, and expansion. This helps to motivate the students and helps them to understand the math problem easily.

Sivakonet, et al. (2017) in their research paper, they write that the range of information and communication technology (ICT) in pedagogical mathematics is unlimited. The main purpose of this research is to determine the impact of the implementation of ICT education programs in the study of mathematics from first to fifth grade. Researchers used descriptive method to complete this research. Researchers selected 16 primary schools as a sample in which 242 primary teachers were included in his research. In his research, Researchers included various topics in first to fifth grade mathematics such as integers, geometry, and problem solving and working with data. Researchers analyzed the collected data and concluded that this teaching and learning process was effective and to improve the teaching process, the teaching of mathematics from the first to the fifth grade will serve as an incentive for the repeated use of ICT teaching programs. It will help to improve the teaching of mathematics from first to fifth grade. According to the results obtained from the monitoring done in the classroom, ICT educational programs are used

in the teaching of mathematics from first to fifth grade when they are processing materials on topics, geometry, and problem solving, and students are often trained to work with data. It enables students to adopt mathematical concepts and methods and easily identify and solve math problems.

Bozkurt (2016) presented an article entitled “Mathematics teachers and ICT: Factors affecting pre-service use in school placement.” The main purpose of the study the effect of the use of ICT in teaching mathematics to the students and to find out the obstacles faced in the use of ICT. The researcher adopted the mixed method, that is, he carried out his research through both quantitative and qualitative methods. The researcher included students in his postgraduate degree in education (PGCE) mathematics. Out of a total of 38 students, 22 boys and 16 girls were selected a sample. Questionnaires used for data collection which included both open and closed questions. Analyzed the collected data through SPSS. The researcher found in his study that the use of ICT in the mathematics classroom by the teacher students found them to be supportive and confident. The researcher pointed out the barriers to the use of ICT by teacher students. These included poor access to ICT facilities, limited encouragement from teachers and other staff in the field of mathematics, irregular use of ICT by teachers, lack of coherence in work plan and time. Therefore, teachers should give appropriate resources and time to the students where they can develop their ICT teaching skills and make the most benefit of ICT.

Sreedevi (2015) has presented this paper on the “Attitude of teachers and students towards the integration of E-learning in mathematics teaching.” Mathematics is "a part of everyday life." Students are given exceptionally powerful skills to comprehend and change the world through mathematics. These abilities include logical thinking, problem-

solving techniques, and the capacity for abstract thought. In daily life, work, science, technology, medicine, economics, environment, development, and public policy, mathematics is crucial. Learning maths can increase interest and ability in a variety of subjects. The study of mathematics promotes clear and logical thinking. Learning mathematics requires special skills and instincts. It is the only subject that encourages and develops logical thinking and reasoning skills. Educational technology promotes interest and attitudes towards the learning process through integration. Mathematics teachers use ICT and technical equipment to streamline the teaching process. ICT is a great technology that lot of collaborates to make the teaching process easy and significance meaningful. E-learning is an emerging technique that facilitates the learning process.

Thomas & Suryavanshi (2015) presented their article on "Geogebra: A powerful Learning ICT tool in Mathematics." ICT has changed the nature of teaching and the education of mathematics. With the help of ICT, users are able to perform tasks quickly and easily of complex work. There is a range of portable devices that allow teachers and students to collect data and manipulate it using spread sheets and databases. Dynamic and interactive software that focuses on specific study units of Geogebra and other multimedia software programmes, which makes the teaching and learning process dynamic and efficient for teachers and students. ICT can be used to provide mathematics in a more engaging and interactive way to enhance students' morale in mathematics subjects. Geogebra geometry software is available for free download from the Internet and can be used on any computer or mobile device.

This software can be used to create graphs, shapes, plot points and so on. Geogebra provides an excellent opportunity to discover your ideas, which can be used to improve the teaching of mathematics ICT. In this article, the researcher highlights a number of occasions, for example how Geogebra can be used to discover some basic concepts in mathematics in the classroom. With the help of Geogebra there are many possibilities for students to gain intuitive feeling and visualize the proper process of mathematics. Using this software facilitates students to explore a wide range of function types, and students have the opportunity to make connections between symbolic and visual representation.

Dutta (2015) highlights an educational movement in the process of teaching free and open source software (FOSSE) for education. The Indian has initiated an national mission in education through ICT in which it seeks to connect every education institution through networking. NMEICT has launched various projects that could change the teaching conditions in the Indian classroom, especially at a higher level. Because we have a lack of trained and qualified teacher and at the same time lack of educational materials available to our students. NMEICT has free and open source software (FOSSE) for education. FOSS usually means software that allows users to use it freely. This means that users are free to run programs as they see fit, modify software, redistribute copies to others, publish modified versions and share users. Recently, MHRD has launched a number of education initiatives using FOSS such as scilab, python, lab migration and more. The main purpose of using FOSS is to create information using the learner's own capacity. More and more FOSS-based education projects will enable students to study in remote areas.

Wilson (2014) Researcher presented the article “Prospective Mathematics teacher’s perception about ICT integration in mathematics instruction in Ghana”. The main purpose of which is to find out the teachers' perceptions about ICT integration and their future plans for the use of ICT. The second important purpose is to find out the perceptions of mathematics teachers regarding the use of ICT in the teaching and learning process. The researcher used the survey method to complete his research. The researcher selected a total of 126 third year undergraduate students from the Department of Instrument as a sample through purposive sampling. The researcher used a questionnaire in which five point likert scales. The Cronbach's Alpha values for the survey tool are 0.726. The researcher analyzed the collected data with the help of SPSS and statistics descriptive for standard data. The researcher concluded that there was a positive correlation between teachers' perceptions and their abilities to use ICT in their future instructional practice. Data analysis involves a positive correlation between descriptive statistics and potential teachers' perceptions of the perceived importance of technology and readiness to integrate ICT. The Curriculum Research Development Division (CRDD) of the Ghana Education Service should review the mathematics curriculum as needed and revise the existing curriculum.

Kumud (2013) writes in his article that the present age is dominated by science and technology. Traditional teaching methods do not cater to the needs of the students (the interest and the classroom) and do not meet the intellectual, psychological and emotional needs of the students, so there is a need to change the teaching and learning methods of mathematics. Mathematics is greatly influenced by the rapid development of ICT. ICT Promote maximum collaboration between students and encourage communication and

knowledge sharing. ICT gives students quick and accurate feedback and positive motivation. ICT also allows students to focus on strategies, interpretations and answers. It has made it quite interesting for students to get to know and learn. Teaching Information and Communication Technology (ICT) and introducing this issue to real and virtual classrooms has become a thing of the past. There is a growing interest in teaching research in ICT. Alternative and more effective teaching and learning tools has the power to make idols. Experts in the field of research point out that ICT has a powerful and significant effect on learning in terms of emotional and academic outcomes as students learn any subject of their choice.

Agyei & Voogt (2010) presented his article on "ICT use in the teaching of mathematics: Implications for professional development of pre-service teachers in Ghana." The various objectives were to study the difficulty of using ICT in teaching mathematics at SHS in Ghana. Study of opportunities to use ICT in mathematics teaching at SHS in Ghana. It focused to out the need for pre-service and in-service mathematics teachers to teach mathematics through ICT at SHS in Ghana. Researchers adopted the survey methodology to further his research. Researchers enrolled a total of 180 educators out of which 60 were in-service and 120 were in pre-service studies. Researchers included a variety of questionnaires in his research to collect the data which are as follows.

1. Demographic or demographic data
2. Availability and accessibility of ICT
3. Current pedagogical practices

Researchers also used the interview technique. Their purpose was to study in depth the data collected through the questionnaire. The purpose of the study interview data was to provide in-depth details about the data collected through the questionnaire. Analysis concluded that Ghana has a positive policy regarding the need for ICT in mathematics curriculum in upper secondary schools. Despite this, researchers found in their research that math teachers could not integrate ICT in the teaching process. Lack of ICT knowledge in integration, lack of knowledge in adopting ICT integration methods in lessons, lack of training opportunities for ICT, lack of ICT infrastructure, Lack of mathematics software and lack of access to ICT were found. More attention needs to be paid to enabling teachers to use ICT to mathematics education. This will help teachers to skilled the methods of integrating ICT in their teaching process. Effective use of ICT needs to be improved through extensive programs of teacher support to improve mathematics and science education.

2.6 Summary

In this chapter, Indian and foreign research and research papers on mathematics achievement, the constructivist approach, mathematics with constructivism, the ICT-mediated constructivist approach, and mathematics with ICT are discussed or published on all of them Unpublished articles, books, and material from other sources were reviewed. In which a total of 64 research articles, research papers, etc. from the country and abroad from 2003–2022 have been studied from the review of relevant materials, it was found that there is a lack of research work in the field of mathematics teaching and learning incorporating ICT-mediated constructivist approaches. Therefore, in the field of mathematics teaching and learning, there is scope to explore the role of instructions based

on the principle of constructivism by mediating ICT with constructivist approaches to improve students' mathematical achievement. There have been studies on variables such as constructivist access, mathematics achievement, and ICT, but the mediation of ICT with constructivist access has not been studied in the field of mathematics, particularly with Urdu-medium students. Such research is lacking. Moreover, no such study has been conducted on secondary-level Urdu-medium students. The researcher identified a research gap in the ICT-mediated constructivist approach teaching mathematics achievement to secondary-level Urdu-medium students and chose this topic as a result.

Chapter – III

Methodological Procedure

3.0 Introduction

The previous chapter reviewed the relevant material from the present study, which highlights the constructivist approach, mathematics achievement, ICT, and mathematics teaching and learning, as well as various investigations conducted in these fields.

The present chapter describes the research methodology used to carry out the study under discussion. It explains the statement of the problem, hypotheses and objectives of the study, variables of the study, methodology of the study, and research design. Apart from this, the experimental design and the internal and external validity of this design have also been described. Further, in this chapter, the preparation of teaching aids, the development of research tools, and their validity and reliability are also presented, and at the end of the chapter, statistical techniques used for data analysis and interpretation are also included.

3.1 Statement of the Problem

Mathematics is an important and compulsory subject at the secondary school level and is widely used in science, social sciences, technology, and almost all fields of life. Despite its usefulness, the level of mathematical achievement is very poor. Educationists and researchers are concerned about how to improve this poor performance in mathematics. Constructivist teaching is a new approach to teaching and has been found to be effective in some foreign countries. Today is the era of ICT, so the researcher has

included ICT along with a constructivist approach to teaching. Therefore, strategy is a relatively new method of teaching and has been effective in some foreign countries. It can be equally effective for Urdu-medium students in the Bihar state of India. So how effective is the ICT-mediated constructivist approach to teaching and learning mathematics to improve student achievement in secondary school?

3.2 Research question

- How effective is the ICT mediated constructivist approach in teaching and learning to improve mathematics achievement in secondary school students?

3.3 Objective of the study

Major Objectives

- To study the impact of ICT-mediated Constructivist Approach of teaching on mathematics achievement of experimental group students.
- To compare the mathematics achievement of ICT-mediated Constructivist Approach group and Traditional Method group.

Concomitant Objectives

- To develop pre-test and post-test tools for Mathematics achievement tests.
- To prepare lesson plan based on ICT mediated Constructivist Approach of teaching.
- To prepare lesson plan based on Traditional Approach of teaching.
- To develop Mathematics achievement tests for previous knowledge in mathematics

3.4 Hypothesis of the Study

H_{01}: There will be no significant difference in the mean of mathematics achievement of the students of experimental and control group before treatment.

H_{02}: There will be no significant difference in the mean of mathematics achievement of experimental group students before and after the treatment.

H_{03}: There will be no significant difference in the mean of mathematics achievement of control group students before and after the treatment.

H_{04}: There will be no significant difference in the mean of mathematics achievement of the students of experimental and control group after treatment.

3.5 Variables of the Study

Before beginning any experimental research, all variables must be identified so that an appropriate experimental design can be formed based on their nature and that the results obtained are completely valid and reliable. Therefore, the study under discussion has the following types of variables.

1. **Independent Variables**

   The present study was selected with the objective of finding out the effect of ICT-mediated constructivist approach teaching on students' mathematics achievement. Therefore, in the study under discussion, the ICT-mediated constructivist approach and the traditional teaching method are independent variables.

2. **Dependent Variable**

   The present study seeks to determine the effect of independent variables on students' mathematics achievement. Therefore, students' mathematics achievement in the present study is a dependent variable.

3. **Intervening Variables**

Intervening variables are those variables that are not included in the objectives of the researcher, but they somehow influence the results of the research and question the validity of the results. Therefore, before conducting experimental research, it becomes necessary to identify all these elements so that they can be controlled by appropriate measures. The following are the intervening variables in the present study.

- Student's pervious knowledge of Achievement.
- Subject related control variable
- Medium of Instruction
- Subject and Content
- Standard

4. **Moderate Variables**

In the present study, the gender of students has been recognized as a moderate variable.

5. **Confounding Variables**

- Interaction between experimental and control groups students
- Interest and Enthusiasm towards learning Mathematics.
- Fatigue
- Motivation
- Novelty of Teaching Aspects

3.6 Operational definitions

1. **ICT- mediated Constructivist Approach**

It is an instructional program developed on the principle of a constructivist approach to teaching, which includes various teaching and learning tools of information and communication technology (ICT).

2. **Traditional Approach**

   The teaching program which is based on Herbert's teaching plan is considered a traditional teaching program.

3. **Experimental Group**

   The group of students who will be given the experiences gained through the constructivist teaching program will be called the experimental group.

4. **Control Group**

   The group of students who were taught under Herbert's traditional teaching program was called the control group.

5. **Pre-Test**

   Before giving the learning experiments, the researcher conducted a test on the experimental and control group which is called a pre-test.

6. **Post-Test**

   After giving the learning experiments, the researcher conducted a test on the experimental and control group which is called post-test.

3.7 Methodology

An experimental method was implemented to conduct the present study. Some tools and teaching models were developed before using the experimental process in this study, and in the later stage, they were used to obtain data from the students involved in the experiment, which is described in detail in the form of two steps below.

1. **Developmental Phase**

   In this phase, teaching materials based on the principles of constructivism were developed, for which the 5E model was used. Furthermore, pre-test and post-test types of the Mathematics Achievement Test were prepared for data gathering.

2. **Implementation Phase**

   In this phase, all the research tools and prepared teaching materials were applied to the classroom, and the experimental process was completed and data were obtained from the students.

3.8 Population & Target Population

In the present study, all the secondary schools of Darbhanga district have been assumed to be the population, and Urdu-medium students here have been recognized as the target population.

3.9 Sample & Sampling Techniques

The purpose was to select one of these Urdu-medium schools in which the experiment could be conducted. For this, the researcher first prepared some conditions, keeping in mind the study, so that the researcher could get reliable and valid information. Such a school was selected for the purpose of conducting an experimental process under the present study that met the following conditions.

- Its management staff is willing to carry out experimental procedures.
- Schools that have Urdu medium students.
- An adequate number of children available in the class.
- There should be an electricity facility in the classroom.
- Modern technology available in the classroom like a computer, OHP, internet
- Classrooms should have basic facilities like a blackboard, lights, laboratory, chair table, classroom cleaning, etc.

Based on all the above criteria, all the secondary schools in the Darbhanga district were surveyed, and on the basis of this survey, Kamran MANUU Model School was selected through the purposive sampling technique.

3.10 Design of the study

The experimental procedure was carried out on the ninth-grade students selected before starting. The general mental ability of ninth-grade students was ascertained through P.N. Mehrotra's standard tool, the Mixed Type Group Test of Intelligence (Verbal & Non-Verbal), only through Verbal Intelligence. After that, the students of both sections of this class were compared on the basis of T-Scores, as a result of which 30 and 30 students were selected for the experimental process. After then, two groups of students were formed through the randomization technique, one of which was named the experimental group and the other the control group.

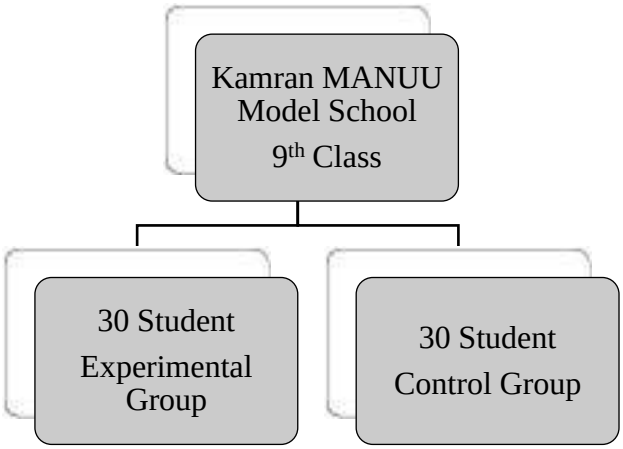


Figure No. 3.1 Group of Student

Thus, under the True-Experimental Design, Randomized Pre & Post Test Matched Group Design was selected to carry out the present research work. This can be understood from the following diagram.

Table No. 3.1 ***True- Experimental Design***

Random Group	Pre- Test	Treatment	Post-Test
Experimental Group	O_1	X_E	O_2
Control Group	O_3	X_C	O_4

O_1 & O_3: Mathematics achievement of students in the experimental and control group was tested before starting the treatment.

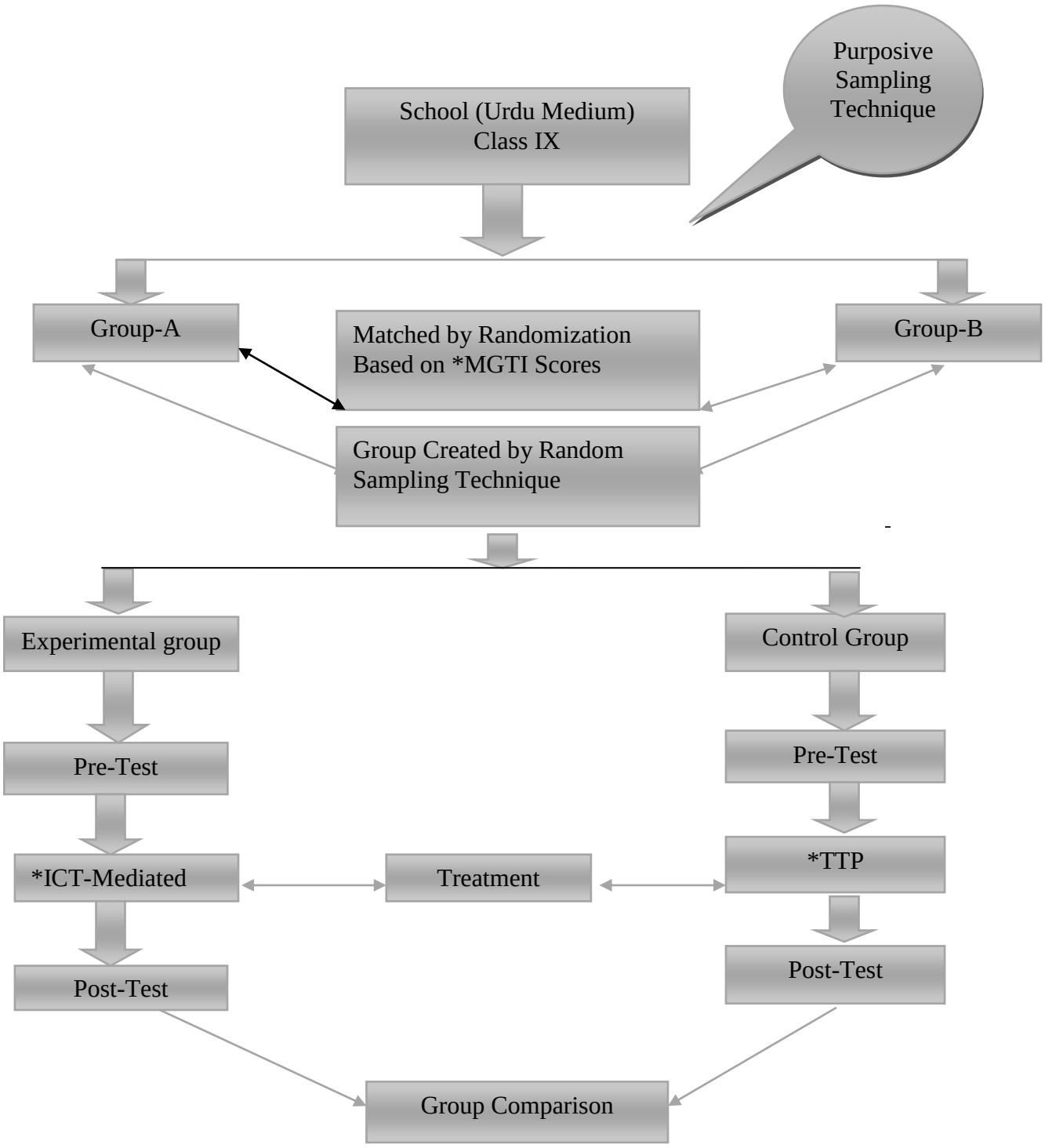
O_2 & O_4: Mathematics achievement of the students in the experimental and control group was tested after the treatment, that is, at the end of the experiments.

X_E: This refers to an experimental group in which students were taught the principles of the ICT-mediated Constructivist approach.

X_C: This refers to the control group in which the students involved were taught in the traditional way.

Thus, the experimental process was carried out based on the above experimental design. All these steps can be clearly understood with the help of the following design.

Figure No:3.2 Research Design



*TTP- Traditional Teaching Program, *ICT- Mediated Constructivist Approach

*MGTI- Mixed Type Group Test of Intelligence

3.11 Validation of the research design

When conducting experimental research, it is important to consider the accuracy and reliability of the data collection tools, and experimental research is expected to be both internally and externally reasonable. Be valid Internal validity is related to controlling intervening variables, while external validity is related to the generalization of findings. But both types of rational analysis affect research. These are called threats to validity, and these risks must be controlled. The explanation is as follows.

3.11.1 Threats of internal validity

Experimental research has found that in addition to independent variables, elements are excluded from the research objectives, yet those elements form their effects on the subject variables. This is termed "a risk to esoteric rationality. Research has controlled the following types of threats.

I. History

These are specific events that occur between the first and second measurements that have the potential to affect the results of the subject variables. In the present study, an Experimental and Control Matched Group were selected to control the historical limitations, which led to the removal of the following risks:

- **Medium of Instruction:** The students of both the groups belonged to Urdu medium.
- **Subjects:** Students in both groups were taught mathematics.
- **Teaching:** In both groups, the researcher performed the self-teaching process.
- **Content:** Students in both groups were taught the same subject matter.

- **Treatment Duration:** Equal time was provided in both groups for a period of 20-20 lesson Plan.
- **Evaluation Duration:** The pre- or post-test of students in both groups was completed at the same time.

II. Maturation

Maturity affects the results of experimental research, especially when it is done on humans. In the experimental process, changes in students' age, mental structure, environment and their experience affect the results, so two group matched designs were used to control threats. The average age of the students in both the experimental and control groups was found to be around 14.90 and the average age of the control group was around 14.45 which was already similar in terms of age. The effect is considered as no

III. Regression

When the researcher examines the students beforehand and includes the best-performing students in the experimental group, it affects the results, i.e., when the experimental group is formed on the basis of high scores. Dependent variables seem to influence, which always proves to be better than the experimental group's control group. Therefore, a randomized matched group design has been used in the present study to avoid these threats.

IV. Testing

In the present study, only the mathematics subject has been taught in which the results are repeatedly tested with the same tools due to which it seems to affect the subject variables. To avoid this threat, the researcher formed two groups for

the treatment and the pre-test and post-test sketches were accepted to obtain the data.

V. Instrumental

Experimental research tools were used to obtain the data. When the same material or two completely different tests are used in the preparation of pre and post-test achievement, it has a reasonable effect on the results. To avoid this threat, the researcher created items from two different concepts of geometry, algebra, statistics, graphs, menstruation, and arithmetic, and through this process, the effect of instrumentation in the present research was eliminated.

VI. Experimental Mortality

The attendance of all students in the experimental and control groups was made mandatory, and it was tried that no student should be absent during the experiment. Through this process, threats to experimental mortality were eliminated from existing research.

VII. Selection of Subjects

In the present study, the experimental and control groups were created by Matched by Randomization due to which this threat was eliminated.

VIII. John Henry Effect

The students involved in the experiment get to know that the experiment is being carried out, which affects the outcome of the experiment. To avoid this, the research was carried out without any change in the natural system of the classroom. For this, the mental ability of all the children in Section A and Section B was tested. Since there was homogeneity in the sample, there was not much

difference in the intellectual ability of the children in the two sections. Therefore, the two sections were divided into two groups through the matched-by-randomization technique. In this way, the children were not allowed to experience any kind of experiment in the classroom-

3.11.2 Threats of external validity

Threats of external validity refer to the situation where the results of experimental research may not be generalizable to all populations. In fact, this situation arises when the experimental design used in the selection and the apparent rationality of the experimental management experiment begins to affect it. Therefore, an attempt was made to control all these threats to maintain the apparent rationality in the present research.

Interaction of Selection and Treatment

There are various threats, including the gender, race, socioeconomic background of the students, home environment, religion, parents 'educational qualifications and parents' income involved in the experimental process. All these threats are controlled in the following ways.

- **Gender:** Both were included because the number of male and female students was reasonable.
- **Religion:** The religion of all the students involved in the experiments was almost the same.
- **Race:** All the students involved in the experiments were of the same race.
- **Socioeconomic Background:** The selected school is located in a backward area due to which the socio-economic condition of all the students studying in this school was almost the same.

- **Home Environment:** All the students belonged to the same backward area, and their socio-economic backgrounds were almost the same, so the home environment of all these students was also the same.
- **Parent's Educational Qualifications:** In the present study, it was assumed that due to backwardness, the educational qualifications of all the parents of the students are almost the same.
- **Parents Income:** Due to the backwardness of the area, the student's parents used to do almost one type of work like running a tea shop, stall, selling vegetables, etc., while their mother stayed at home. Therefore, the household income of all the students included in the present study is assumed to be the same.

Interaction of Testing and Treatment

It is often observed that the outcome variables are affected by the interaction between the control and experimental groups during treatment. But it was impossible to control this threat. Therefore, it was neglected. Because this pre-test & post-test design helps to reduce other threats,

Multiple Treatment Inference

The same treatment was given in the present study. Multiple treatments given to a single group will affect the subject variables and make it difficult to generalize the results; so to some extent the results can be applied to the target population.

3.12 Intervening Variables

There are different types of intervening variables, including prior mathematics knowledge of the students involved in the experimental process, standards, subject-

related variables, and control variables, medium of instruction, subject, and content. All these intervening variables were controlled in the following way.

Subject-related control variable: To control this variable, both groups were taught the same subject.

Previous Mathematics Knowledge of Students: Before conducting the experimental process, it is necessary to control the prior mathematical knowledge of the students. Therefore, the researcher found out the previous mathematics knowledge of both groups. For which the researcher created a mathematics achievement test tool to determine the previous mathematics knowledge through which the previous mathematical knowledge of the students was determined. In this way, the intervening variable was controlled, the detail of which are given in the table below.

Table No. 3.2 ***Showing Previous Knowledge of Mathematics Achievement***

Group	N	Mean	SD	df	t-value	Table value	Level of significance	Remarks
Experimental Group	30	31.37	5.654	58	0.157	2.00	0.05	NS
Control Group	30	31.13	5.841					

Standard: Both groups belong to the same groups. Therefore, the quality of both groups is the same. Thus, this variable was controlled.

Medium of Instruction: The medium of instruction for both groups is Urdu. In this way, this variable was controlled.

Subject and content: Both groups were taught the same content. In this way, this variable was controlled.

3.13 Tools of the study

Two types of tool have been used in the study.

1. Instructional Tool
2. Measuring Tool

3.13.1 Instruction Tools

Instructional tools were used to teach the experimental and control groups. The researcher developed a lesson plan based on the ICT-mediated constructivist approach for the experimental group and the traditional teaching methods for the control group. Various materials were selected from N.C.E.R.T.'s ninth-grade mathematics. graph, coordinate geometry: formula of distance, linear Equations (two variables), laws of force, polynomial algebraic expression, statistics, area, and perimeter of equilateral triangles and triangles developed 20-20 plan lessons for the group.

- Lesson Plan based ICT- mediated Constructivist Approach
- Lesson Plan based Traditional Approach

3.13.2 Instructional Materials based on ICT- mediated Constructivist principle

The purpose of the present research is to find out the effect of ICT-mediated constructivist approaches to teaching on students' mathematics achievement. Therefore, teaching materials were developed based on the ICT-mediated constructivist approach to be implemented in the classroom, which has been completed through the following stages.

I. Selection of Content

In the present research, two methods of teaching were used to manipulate the independent variable. In which the constructivist principle was used to teach the concepts of mathematics to the experimental group. For this purpose, the researcher personally obtained permission from the principal of the selected school and asked the mathematics teacher, who had already taught mathematics in the 9^{th} - grade and had the information about the part, to go. In this way, the selection of the subject to be taught was carried out. According to the syllabus, this subject covers Graphs, Allocation Geometry: Distance Formula, Linear Equations (Two Variables), Power Laws, Polynomial Algebraic Quantities, Multiplicative Components, Statistics, Area, and Cover of Triangles and Equilateral Triangles, Circumference. The perimeter or area of the circle and the area of the circle were listed as the title. Thus the above topic was selected for the present research.

II. Content Analysis

The topic was chosen with the help of your supervisor. Thus, a total of 10 topics were recognized. Details of which can be seen in the table below.

S.No	Topics
1	Graph
2	Co-ordinate Geometry : Distance Formula
3	Linear Simultaneous Equation
4	Laws of Indices
5	Polynomial
6	Factorisation
7	Statistics
8	Area & Perimeter of Triangle & Quadrilateral
9	Circumference of Circle
10	Area of Circle

III. Stating Instructional Objectives

Instructional objectives basically define the child's outcomes clearly in advance. It not only helps the learner to study in the right direction but also helps the teacher to perform his teaching duties better. Along with this, the teacher can make the teaching process more effective in terms of student outcomes.

Therefore, before conducting the experimental process for the present research, the selected subject mathematical unit set the instructional objectives that are as follows. After completing this lesson, children will be able to:

1. **Graph**

- To be able to describe the coordinate plane in their own words.
- Explain the concept of the abscissa and ordinate.
- To be able to form a quadrant and centre the identity of any coordinate plane.
- To be able to plot any point on graph paper.
- To be able to plot any equation on graph paper.

2. **Co-ordinate Geometry: Distance Formula**

- To be able to co-ordinate geometry distance formula.
- To be able to solve problems by applying distance formula.

3. **Linear Simultaneous Equation**

- Linear equations (two variables) can be plotted on graph paper.
- Two variables will be able to describe the concept of a linear equation as a method of elimination.
- Two variables will be able to solve the equation using the Method of Elimination.

- Two variables will be able to solve the equation using the Method of Cross Multiplication.

4. Laws of Indices

- To be able to explain the concepts of laws of indices.
- Recognize the Index and the Base.
- To be able to explain the formulas of the laws of indices.
- Value of algebraic will determine with the help of the law of indices.
- will be able to solve various problems related to index

5. Polynomial

- To be able to explain the concept of polynomials.
- Algebraic numbers will be able to indicate polynomials.
- Algebraic numbers will be able to indicate the degree of the polynomial.
- To be able to find the coefficient of the polynomial.
- To be able to multiply the polynomial to determine their value.
- Will be able to find out their value by dividing the polynomials.

6. Factorisation

- Ingredients will be able to tell different formulas of factorisation.
- Polynomials will be able to resolve in factorisation.
- Polynomials will be able to resolve in factorisation with the help of formula.
- To be able to solve problems given in exercise.

7. Statistics

- To be able to explain the concepts of statistics.

- To be able to describe variables, discrete variable, continuous variables, frequency, the tally mark, and range.
- Will be able to know the class interval, class size, frequency, class limit from the given data.
- To be able to create a frequency distribution table from the given data.
- To be able to describe different types of graphs.
- Will be able to draw a histogram graph from the given data.

8. Area & Perimeter of Triangle & Quadrilateral

- Will be able to explain the formula of the diagonal of the rectangle.
- To be able to explain the formula of the diagonal of square.
- Will be able to explain the formula of area and perimeter of the triangle.
- Be able to find the value of the area of the triangle by applying its formula.
- Be able to find the value of the perimeter of the triangle by applying its formula.
- Be able to find the area of the equilateral triangle.
- Be able to find the perimeter of the equilateral triangle.
- To be able to solve problems in a given exercise.

9. Circumference of Circle

- Will be able to explain the formula of the circumference of circles
- To be able to determine its value by applying the formula of the circumference of a circle.
- To be able to find the value of the radius of the circle.
- To be able to find the value of the diameter of the circle.

10. Area of Circle

- To be able to describe the formula of area of the circle.
- To be able to find the value of a circle by applying its formula.
- To be able to solve problems in a given exercise

3.13.3 Constructivist Approach based Lesson Plan

The constructivist approach emphasizes the construction of new information or concepts based on previous knowledge and experiences. In this method of teaching, students move towards the world according to their interests and intellectual ability through dynamic techniques such as experience, collaboration, discussion, and observation. The constructivist approach to lesson planning differs from the traditional lesson plan. The building classroom is a democratic environment in which students actively create new information through collaboration, discussion, observation, experiments, and questions and answers. The aim of the teachers was to create a democratic and conducive classroom environment. That can facilitate experiments and various learning materials for independent learners. The researcher developed a lesson plan based on the 5E instructional model of constructivist to make the constructivist room environment democratic and conducive.

3.13.4 5E Instructional Model

The 5E instructional model is one based on constructivist theory and experimental activities. This model was developed by Roger Bybee in 1995. According to Llewellyn (2007), “the 5E teaching model can help students move from understanding solid experiences to applying principles.” This model gives students the opportunity to recall with depth and meaning what they already know. According to Ergin et al. (2008), “the

5E instructional model is considered one of the recommended best practises for teaching a constructivist teaching approach". The 5E instructional model is originally credited to J. Myron Atkin and Robert Karplus (1960). Who used to work for the Science Curriculum Improvement Study (SCIS). This instructional model was based on three steps. One is exploration, the second is invention, and the third is discovery. Later, the Biological Science Curriculum Study (BSCS) programme incorporated two additional phases, engagement and evaluation, and modified the model phases of SCIS to design a new model called the 5E Instructional Model. The modified model can be seen in the table below(Bybee, et al., 2006).

Comparison of BSCS Instructions Model (5E) and SCIS

SCIS Model	BSCS 5E Instructional Model
	Engagement (New Phase)
Exploration	Exploration (modified from SCIS)
Invention (Term Introduction)	Explanation (modified from SCIS)
Discovery (Concept Application)	Elaboration (modified from SCIS)
	Evaluation (New phase)

The 5E instructional model involves students in activities at each stage, encourages students to organize their own concepts and ideas, and enables them to try to understand concepts. According to Martin (2000), this model allows for teaching a new concept or trying understanding a concept and includes skills and activities that enable the student to actively research information and understand. Enables focus. According to the 5E instructional model, the student makes sense of his/her own thinking by discovering new concepts based on his/her prior knowledge and experiences. The 5E educational paradigm encourages participation in class. As they learn to ask questions, observe, model, analyse, explain, draw conclusions, discuss, and share openly about their

learning, kids in this approach do more than just listen and read. Students collaborate with classmates to design and carry out projects, explain concepts, and solve issues. Following are the five steps of the 5E instructional model.

1. Engagement
2. Exploration
3. Explanation
4. Elaboration
5. Evaluation

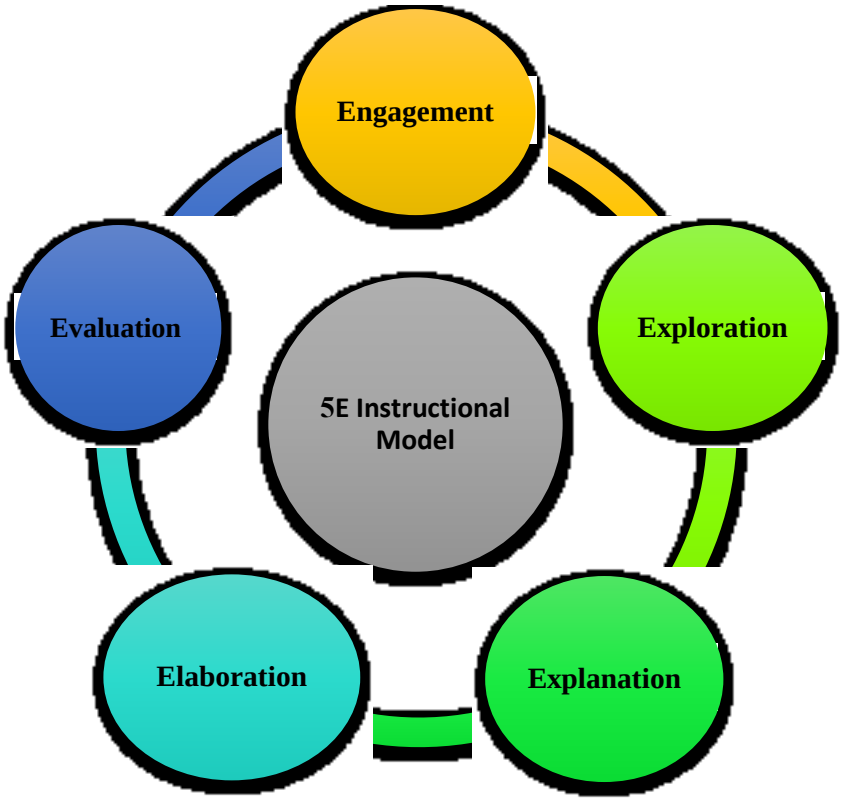


Figure No: 3.3 5E Instructional Model

1. Engagement

During this phase, the teacher draws on the learners' prior knowledge and engages them in engaging with a new concept through the use of short activities that pique their interest. The activity gives them an opportunity to express what they already

know about the topic, making connections between past and present learning experiences..

2. **Exploration**

   During this phase, students are provided with an experience for identifying and developing concepts, processes, and skills that enable them to actively explore their environment or manipulate content to generate new ideas. Helps find questions and possibilities, design preliminary research, and use previous information.

3. **Explanation**

   During the phase, students describe the concepts, action skills, or behaviors they are discovering or exploring and provide opportunities to express their conceptual understanding or to develop new skills or behaviors. Teachers can guide them in describing the process

4. **Elaboration**

   In this phase, the teacher helps the students develop their conceptual understanding and practice skills. The new experiments provide students with an in-depth understanding, a broader understanding, more information, appropriate skills, and a chance to hone their skills.

5. **Evaluation**

   During this time, students are able to assess their understanding and abilities based on what they have learned. And at this stage, It gives teachers the chance to gauge their students' motivation for pursuing greater goals and helps students to evaluate their knowledge and skills.

3.13.5 ICT- mediated Constructivist Approach based Lesson Plan

The researcher selected the 5E model based on the constructivism of the experimental group for teaching and constructed a lesson plan using the 5E model. The researcher completed the lesson plan by incorporating ICT into it. The lesson plan used ICT as a PowerPoint, projector, projector screen, pen tablet, laptop, photo, animated video, etc.

3.13.6 Validity of Lesson Plan

The 5E model was chosen to conduct the teaching and learning process in the classroom based on the architectural style and with this model, the preliminary outline of the lesson plan was prepared based on ICT-mediated. Following that, my supervisors and experts, Prof. Sajid Jamal (AMU), Prof. Abdul Rahim (MANUU, CTE - Bhopal), Dr. Naushad Hussain Assistant Professor (MANUU), Dr. Musha Ali Assistant Professor (JMI), Dr. Zafar Iqbal Zaidi Assistant Professor (Manu CTE - Darbhanga), and Dr. Danish Nadeem Assistant Professor (MANUU,CTE - Darbhanga), reviewed the sketch. Apart from this, useful suggestions were obtained from the expert mathematics teachers of MANUU Model School and after that, the lesson plan was finalized under the guidance of the research supervisor.

3.13.7 Measuring Tools

Measuring tools were used to group students, perform in mathematics achievements, and test previous knowledge. Which are as follows.

1. Mathematics Achievement Test for Pre- Test

2. Mathematics Achievement Test for Post- Test
3. Mathematics Achievement Test for Previous Knowledge
4. Mixed Type Group Test of Intelligence (Verbal & Non Verbal)

3.13.8 Preparation of Mathematics Achievement Test

3.13.8.1 Pre –Test

The present research seeks to determine the effect of ICT-mediated constructivist approaches to teaching on students' mathematics achievement. For this purpose, mathematics achievement testing tools were developed to find out the level of completion through the following steps.

First Stage: Planning and Writing of measuring test

1. **Planning of the Test**

   Planning the test helps in the right direction, avoiding time wastage and confusion. Mathematics achievement tests are based on knowledge, understanding, application, and skills. The test covers the content of the syllabus prescribed by NCRT and Bihar Board Standard IX Mathematics. It was decided to arrange questions of objective and subjective nature to cover the entire syllabus. The researcher developed the blueprint keeping in mind the curriculum, objectives, nature and importance of mathematics.

2. **Preparation of the Test**

   Pre-test & post-test true experimental design has been selected under the experimental design to complete the present research. in which the student's pretest is assumed as a covariate. Under this objective, the researcher developed a pre-test, the details of which are given below.

2 Construct of Items

A different topic was chosen from the mathematics textbook of class IX for the preparation of the pre-test. In which a total of 29 items were prepared. In which 16 items were included from objective questions, 08 from short answers, and 05 from long answers the details of this can be seen in the following.

Table No. 3.3 ***Weightage of Content (Initial Draft)***

S. No	Topic	Questions	Marks
1	Graph	3	5
2	Co-ordinate Geometry : Distance Formula	2	4
3	Linear Simultaneous Equation	3	8
4	Laws of Indices	3	5
5	Polynomial	3	3
6	Factorisation	2	7
7	Statistics	2	4
8	Area & Perimeter of Triangle & Quadrilateral	4	9
9	Circumference of Circle	3	6
10	Area of Circle	4	9
Total		29	60

Table No: 3.4 ***Weightage for formation of questions***

S.No	Types of questions	Marks of each questions	No. of questions	Total Marks
1	MCQ	1	16	16
2	SA	3	08	24
3	LA	4	05	20
Total			29	60

Table No: 3.5 ***Weightage of objectives (Initial Draft)***

S.No	Objectives	Marks	% of marks
1	Remembering	12	20
2	Understanding	10	16.66
3	Applying	24	40
4	Skill	14	23.33
Total		60	100%

Table No: 3.6 ***Blueprint of Mathematics Achievement (Initial Draft)***

S.No	Topics	Objectives												Total
		Remembering			Understanding			Applying			Skill			
		MCQ	SA	LA	MCQ	SA	LA	MCQ	SA	LA	MCQ	SA	LA	
1	Graph	1					1					1		3
2	Co-ordinate Geometry : Distance Formula	1							1					2
3	Linear Simultaneous Equation					1	1				1			3
4	Laws of Indices	1			1	1								3
5	Polynomial	2												
6	Factorisation								1	1				2
7	Statistics	1										1		2
8	Area & Perimeter of Triangle & Quadrilateral	2							1				1	4
9	Circumference of Circle	2								1				3
10	Area of Circle	2							1	1				4
Total		12			4	2			4	3		2	2	29

M.C.Q = Multiple Choice Question, S.A = Short Answer, L.A = Long Answer

3 Content Analysis

After creating the items, the face validity of the device must be established. Under which the basic structure and language of the tool is examined, and on the other hand, the text of each item must also be analyzed to find out the purpose for which the tool has been developed. Does not the pre-mathematical achievement test prepared in this regard must be checked. For math and language experts were given, and it was said that you can retain, delete, or modify the item. After that, advice and suggestions are received from the experts. The tools were then modified and finalized as required by the research supervisor. In this way, the face validity of the tool was established.

Second Stage: Try Out

This is an important step in the construction. The following element is required at this stage.

I. Selection of Sample
II. Age and Class
III. Duration of test
IV. Administration of test
V. Scoring Method

I. Selection of Sample

The researcher selected a total of 50 students from Urdu Medium School using simple random technique for validity of the tool.

II. Age and Class

Ninth classes were required to use the mathematics achievement test as a sample for construction and the students ranged in age from 14 to 16 years.

III. Duration of test

Duration is a very important factor in any test. Therefore, 2 hours was allotted for this test which was manageable and not tiring for the students.

IV. Administration of test

The researcher first met the mathematics teachers to obtain the research content and introduced himself, explained the purpose of the research to them, and assured them that whatever information would be obtained was only for research. will be used for this purpose, and permission has been obtained from them. Then, they were told that they could leave the classroom so that the classroom could have a relaxed or conducive atmosphere. The children were then given a copy of the letter, except for the instruction to complete it, and were given 120 minutes to solve the questionnaire.

After 2 hours, the students submitted their answer sheets. The researcher then thanked the children and the administration.

V. Scoring Procedures

Students entered their answers on the answer sheet. Answer sheet checked according to answer key.

Third Stage: Analysis of Data

Item analysis is an essential step in test construction. This phase mainly measures the difficulty of the item, item discrimination index, validity, and reliability of the item. It basically relates to item difficulty and items' discrimination index. The difficulty of the item is taken as proportional to the number of people who have successfully completed it. The discrimination index refers to the degree to which it differentiates between high and low scorers. Item analysis was based on the scores of 50 students.

Item analysis was conducted in two sections. Section A includes items that were created objectively. Their acceptance and rejection were determined by assessing item difficulty and item discrimination. Section B includes items that were created subjectively. Their acceptance and rejection were determined by assessing the item's difficulty (DV).

Section- A: Items 1 to 16 can be scored objectively. The formula proposed by Kelley (1939) was used to test the difficulty of all items included in the test and the level of discrimination of the items based on the data obtained, which can be seen below (Mahajan, Gourav.2015, p.54-60).

Difficulty Value (DV) = $\frac{(RU+RL)\times 100}{NU+NL}$ *%*

Discrimination Index (DI) = $\frac{(RU-RL)\times 100}{NU}$ *%*

Where:

RU = No. of correct responses in Upper group

RL = No. of correct responses in Lower group

N = Size of Sample in Upper and Lower group

With the help of the above-written formula, the items included in the test items' difficulty level and the level of discrimination index of the items is presented in the following table.

Table No: 3.7 ***DV & DI of Mathematics Achievement***

Items .No	Correct Response		DV	DI	Items DV Evaluated	Items DI Evaluated	Remarks
	U - Group	L- Group					
1	11	8	0.68	0.21	Easy	Average	Revised
2	14	5	0.68	0.64	Easy	Excellent	Revised
3	12	8	0.71	0.29	Easy	Average	Revised
4	12	7	0.68	0.36	Easy	Good	Revised
5	13	6	0.68	0.50	Easy	Excellent	Revised
6	8	3	0.39	0.36	Good	Good	Retain
7	13	5	0.64	0.57	Easy	Excellent	Retain
8	8	5	0.46	0.21	Excellent	Average	Retain
9	13	8	0.75	0.36	Easy	Good	Revised
10	10	4	0.50	0.43	Excellent	Excellent	Retain
11	11	3	0.50	0.57	Excellent	Excellent	Retain
12	11	5	0.57	0.43	Excellent	Excellent	Retain
13	10	3	0.46	0.50	Excellent	Excellent	Retain
14	13	8	0.75	0.36	Easy	Good	Revised
15	9	5	0.50	0.29	Excellent	Average	Retain
16	12	3	0.54	0.64	Excellent	Excellent	Retain

Section- B : Item No. 17 to 29 can be scored subjectively. The formula proposed by Nitko (2004) was used to test the difficulty level of all the items included in the test based on the data obtained which can be seen below (Juridah, et al. 2011, p.72).

$$\textbf{Average Score} = \frac{Total\ Score}{Total\ Number\ of\ Students}$$

$$\textbf{Difficulty index} = \frac{Average\ Score}{Range\ of\ Full\ Marks}$$

With the help of the above written formula, the difficulty level value of all the items included in the test is presented in the table below.

Table No: 3.8 ***DV of Mathematics Achievement***

Items .No	Sum of Marks	Maximum	Minimum	Average	DV	Items DV Evaluated	Modification Results
17	45	3	0	0.9	0.30	Moderate	Accept
18	59	3	0	1.18	0.39	Moderate	Accept
19	37	3	0	0.74	0.25	Too Hard	Modify
20	65	3	0	1.3	0.43	Moderate	Accept
21	34	3	0	0.68	0.23	Too Hard	Modify
22	48	3	0	0.96	0.32	Moderate	Accept
23	47	3	0	0.94	0.31	Moderate	Accept
24	36	3	0	0.72	0.24	Too Hard	Modify
25	56	4	0	1.12	0.28	Too Hard	Modify
26	53	4	0	1.06	0.27	Too Hard	Modify
27	48	4	0	0.96	0.24	Too Hard	Modify
28	45	4	0	0.9	0.23	Too Hard	Modify
29	47	4	0	0.94	0.24	Too Hard	Modify

Table No: 3.9 ***DV of items of the Achievement***

S. No.	DV	Frequency	Item No.	Remarks
1	Above 0.80	00		
2	Between 0.20 and 0.80	29	1, 2, 4, 5, 6, 7, 8, 9, 10 ,11 ,12 ,13 ,14 ,15 ,16 ,17 ,18 ,19 ,20 ,21 ,22 ,23 ,24 ,25 ,26, 27, 28, 29,	Accepted
3	Below 0.20	00		

Fourth Stage: Final draft of Mathematics Achievement Test

For the final design of the test, the items were rearranged according to the markings assigned to the content areas and items. The final test consisted of 29 items with a maximum score of 60 marks. The test was scheduled to take two hours to complete. The weightage in terms of content and level are given in table 3.10 respectively.

Table No: 3.10 ***Blueprint of Mathematics Achievement Test (Pre-Test)***

S.No	Topics	Objectives												Total
		Remembering			Understanding			Applying			Skill			
		MCQ	SA	LA	MCQ	SA	LA	MCQ	SA	LA	MCQ	SA	LA	
1	Graph	1					1					1		3
2	Co-ordinate Geometry : Distance Formula	1							1					2
3	Linear Simultaneous Equation					1	1				1			3
4	Laws of Indices	1			1	1								3
5	Polynomial	2												
6	Factorisation								1	1				2
7	Statistics	1										1		2
8	Area & Perimeter of Triangle & Quadrilateral	2							1				1	4
9	Circumference of Circle	2								1				3

10	Area of Circle	2							1	1				4
Total		12			4	2			4	3		2	2	29

M.C.Q = Multiple Choice Question, S.A = Short Answer, L.A = Long Answer

Fifth Stage: Validity and Reliability of Test

The researchers have established the validity of the content through the experts in this field of content validity. The researcher tested the reliability of 16 items of this mathematics achievement test through Cronbech's Alpha Test that, which has a value of 0.62.

3.13.8.2 Post- Test

First Stage: Planning and Writing of the tool

In the present study, post-test outline of the data gathered has been selected. The experimental group was taught ICT-mediated constructivist approaches and the control group was taught traditional method. Post-test was carried out to test its mathematics achievement. In the post-test, the same topics that were in the pre-test were included and their level was separated from the pre-test, which formed the post-test through the following steps.

Planning of the test

Planning the test helps steer things in the right direction, reducing time waste and confusion. Mathematics Achievement Testing is based on information, understanding, application, and skills. This test covers the proposed syllabus content of NCERT and Bihar Board Standard IX Mathematics. It was decided to develop questions of objective and thematic nature to cover the entire curriculum. The researcher prepared a blueprint keeping in mind the curriculum, objectives, nature, and importance of mathematics.

Preparation of the Test

True experimental design has been chosen to carry out the present research to completion under the experimental design. Experimental and control groups should be essentially tested after the experimental process is over. For this post-test is required to be developed. Keeping this in mind, a post-test was carried out, the details of which are as follows.

1. **Construction of Items**

   A different topic was chosen from the 9th-grade mathematics textbook to prepare for the post-test. Details of which can be seen in the following diagram.

Table No: 3.11 ***Weightage of content/ unit (Initial draft)***

S. No	Topic	Questions	Marks
1	Graph	3	5
2	Co-ordinate Geometry : Distance Formula	2	4
3	Linear Simultaneous Equation	3	8
4	Laws of Indices	3	5
5	Polynomial	3	3
6	Factorisation	2	7
7	Statistics	2	4
8	Area & Perimeter of Triangle & Quadrilateral	4	9
9	Circumference of Circle	3	6
10	Area of Circle	4	9
Total		29	60

Table No: 3.12 ***Weightage for formation of questions***

S.No	Types of questions	Marks of each questions	No. of questions	Total Marks
1	MCQ	1	16	16
2	SA	3	08	24
3	LA	4	05	20
Total			29	60

Table No: 3.13 ***Weightage of objectives (Initial Draft)***

S.No	Objectives	Marks	% of marks
1	Remembering	12	20
2	Understanding	10	16.66
3	Applying	24	40
4	Skill	14	23.33
Total		60	100%

Table No: 3.14 ***Blueprint of Mathematics Achievement (Initial Draft)***

S.No	Topics	Objectives												Total
		Remembering			Understanding			Applying			Skill			
		MCQ	SA	LA	MCQ	SA	LA	MCQ	SA	LA	MCQ	SA	LA	
1	Graph	1					1					1		3
2	Co-ordinate Geometry : Distance Formula	1							1					2
3	Linear Simultaneous Equation					1	1				1			3
4	Laws of Indices	1			1	1								3
5	Polynomial	2												
6	Factorisation								1	1				2
7	Statistics	1										1		2
8	Area & Perimeter of Triangle & Quadrilateral	2							1				1	4
9	Circumference of Circle	2								1				3
10	Area of Circle	2							1	1				4
Total		**12**			**4**	**2**			**4**	**3**		**2**	**2**	**29**

M.C.Q = Multiple Choice Question, S.A = Short Answer, L.A = Long Answer

2 Content Analysis

After constructing the items, the face validity of the tools must be established. The basic structure and language of the tool are examined, but the text of each item must also be analyzed to determine whether or not the tool was developed to reflect the

purpose. The pre-mathematics achievement test prepared in this regard must be checked. Math and language experts were given, and it was said that you can retain, delete, or modify the item. After that, advice and suggestions are received from the experts. The tool was then modified and finalized as required by the research supervisor. In this way, the face validity of the tool was established.

Second Stage: Try Out

This is an important step in the construction. The following element is required at this stage.

I. Selection of Sample
II. Age and Class
III. Duration of test
IV. Administration of test
V. Scoring Method

I. Selection of Sample

The researcher selected a total of 49 students from Urdu Medium School using simple random technique for validity of the tool.

II. Age and Class

Ninth classes were required to use the mathematics achievement test as a sample for construction and the students ranged in age from 14 to 16 years.

III. Duration of test

Duration is a very important element in any test. Therefore, two hours were allotted for this test which was manageable and not tiring for the students.

IV. Administration of test

The researcher first met the mathematics teachers to obtain the research data and introduced himself, explained the purpose of the research to them, and they were assured

that whatever information is obtained will be used only for research purposes, and then permission was obtained from them. Then, they were told that they could leave the classroom so that the classroom could have a relaxed or conducive atmosphere. The children were then given a copy of the letter except for the instruction to complete it, and they were given 120 minutes to solve the questionnaire. After 2 hours, the students submitted their answer sheets. The researcher then thanked the children and the administration.

V. Scoring Procedures

Students entered their answers on the answer sheet. Answer sheet checked according to answer key.

Third Stage: Analysis of Data

Item analysis is one of the essential steps construct of the test. This phase mainly measures the items difficulty, item discrimination index, validity and reliability of the item. It basically relates to item difficulty and items' discrimination index. The difficulty of the item is taken as proportional to the number of people who have successfully completed it. The discrimination index refers to the degree to which it differentiates between high and low scorers. Item analysis was based on the scores of 49 students.

Item analysis was conducted in two sections. Section A includes items that were created objectively. Their acceptance and rejection were determined by assessing item difficulty and item discrimination. Section B includes items that were created subjectively. Their acceptance and rejection were determined by assessing the item's difficulty (DV).

Section- A: Items 1 to 16 can be scored objectively. The formula proposed by Kelley (1939) was used to test the difficulty of all items included in the test and level of discrimination of the items based on the data obtained which can be seen below (Mahajan, Gourav.2015, p.54-60).

Difficulty Value (DV) = $\frac{(RU+RL)\times 100}{NU+NL}$ *%*

Discrimination Index (DI) = $\frac{(RU-RL)\times 100}{NU}$ *%*

Where:

RU= No. of correct responses in Upper group

RL = No. of correct responses in Lower group

N = Size of Sample in Upper and Lower group

With the help of the above formula, the items included in the test items' difficulty level and the level of discrimination index of the items is presented in the following table.

Table No: 3.15 ***DV & DI of Mathematics Achievement***

Items .No	Correct Response		DV	DI	Items DV Evaluated	Items DI Evaluated	Remarks
	U – Group	L- Group					
1	10	7	0.65	0.23	Easy	Average	Revised
2	10	5	0.58	0.38	Excellent	Excellent	Retain
3	13	5	0.69	0.62	Easy	Average	Revised
4	13	6	0.73	0.54	Easy	Good	Revised
5	12	6	0.69	0.46	Easy	Excellent	Revised
6	13	5	0.69	0.62	Easy	Good	Revised
7	8	3	0.42	0.38	Excellent	Excellent	Retain
8	12	5	0.65	0.54	Easy	Average	Revised
9	9	1	0.38	0.62	Good	Good	Retain
10	12	3	0.58	0.69	Excellent	Excellent	Retain
11	12	7	0.73	0.38	Easy	Excellent	Revised
12	11	4	0.58	0.54	Excellent	Excellent	Retain
13	10	5	0.58	0.38	Excellent	Excellent	Retain
14	12	4	0.62	0.62	Easy	Good	Revised
15	12	3	0.58	0.69	Excellent	Average	Retain
16	5	2	0.27	0.23	Difficult	Excellent	Retain

Section- B: Item No. 17 to 29 can be scored subjectively. The formula proposed by Nitko (2004) was used to test the difficulty level of all the items included in the test based on the data obtained which can be seen below (Juridah, et al. 2011, p.72).

$$\textbf{Average Score} = \frac{Total\ Score}{Total\ Number\ of\ Students}$$

$$\textbf{Difficulty index} = \frac{Average\ Score}{Range\ of\ Full\ Marks}$$

With the help of the above formula, the difficulty level value of all the items included in the test is presented in the table below.

Table No: 3.16 ***DV of Mathematics Achievement***

Items .No	Sum of Marks	Maximum	Minimum	Average	DV	Items DV Evaluated	Modification Results
17	36	3	0	0.73	0.24	Too Hard	Accept
18	114	3	0	2.33	0.78	Moderate	Accept
19	69	3	0	1.41	0.47	Moderate	Accept
20	82	3	0	1.67	0.56	Moderate	Accept
21	72	3	0	1.47	0.49	Moderate	Accept
22	45	3	0	0.92	0.31	Moderate	Accept
23	33	3	0	0.67	0.22	Moderate	Accept
24	36	3	0	0.73	0.24	Too Hard	Modify
25	46	4	0	0.94	0.23	Too Hard	Modify
26	46	4	0	0.94	0.23	Too Hard	Modify
27	60	4	0	1.22	0.31	Moderate	Accept
28	53	4	0	1.08	0.27	Too Hard	Modify
29	44	4	0	0.90	0.22	Too Hard	Modify

Table No: 3.17 ***DV of items of the Mathematics Test***

Sl.No.	DV	Frequency	Item No.	Remarks
1	Above 0.80	00		
2	Between 0.20 and 0.80	29	1, 2, 4, 5, 6, 7, 8, 9, 10 ,11 ,12 ,13 ,14 ,15 ,16 ,17 ,18 ,19 ,20 ,21 ,22 ,23 ,24 ,25 ,26, 27, 28, 29,	Accepted
3	Below 0.20	00		

Final draft of Mathematics Achievement Test (Post-Test)

For the final layout of the test, the items would be rearranged according to the markings assigned to the content areas and the items. The final test consisted of 29 items for a maximum score of 60. It took two hours to complete the test. In terms of content and level, the weightage in tables 3.18 are catapulted.

Table No: 3.18 ***Blueprint of Mathematics Achievement Test –Post-test (Final draft)***

S.No	Topics	Objectives												Total
		Remembering			Understanding			Applying			Skill			
		MCQ	SA	LA	MCQ	SA	LA	MCQ	SA	LA	MCQ	SA	LA	
1	Graph	1					1					1		3
2	Co-ordinate Geometry : Distance Formula	1							1					2
3	Linear Simultaneous Equation					1	1				1			3
4	Laws of Indices	1			1	1								3
5	Polynomial	2												
6	Factorisation								1	1				2
7	Statistics	1										1		2
8	Area & Perimeter of Triangle & Quadrilateral	2							1				1	4
9	Circumference of Circle	2								1				3
10	Area of	2							1	1				4

	Circle													
Total		**12**			**4**	**2**			**4**	**3**		**2**	**2**	**29**

M.C.Q = Multiple Choice Question, S.A = Short Answer, L.A = Long Answer

Fifth Stage: Validity & Reliability of Test

The researchers have established the validity of the content through the experts in this field of content validity. The researcher tested the reliability of 16 items of this mathematics achievement test through Cronbech's Alpha Test that has a value of 0.719

3.13.8.3 Mathematics Achievement Test for testing Previous Knowledge

To conduct the current research until the completion of the research, the researcher developed his own mathematics achievement test tool to gain previous knowledge of mathematics. The test included an eighth-grade math subject. Anderson & Carth Wohl (2001) reviewed Bloom's classification to include the purposes of remembering, understanding, and applying. The researchers prepared this test by following different steps.

1. Planning and writing of the test items
2. Try- out
3. Item Analysis
4. Selection of Items for the Final draft
5. Determination of Reliability and Validity of the test

First Stage: Planning and writing of the test items

This test was developed using objective questions (MCQ). Initially, the test was based on 55 questions. This test was designed with three objectives in the cognitive domain, remembering, understanding, and applying. This was followed by his research supervisor and expert Professor Sajid Jamal (AMU), Professor Abdur Rahim (MANUU,

CTE-Bhopal), Dr. Naushad Hussain, Assistant Professor (MANUU), Dr. Muhammad Javed, Assistant Professor (JMI), and Dr. Danish Nadeem, Assistant Professor (MANUU, CTE - Darbhanga) from which useful suggestions were obtained, and after that, the achievement test was finalized under the guidance of the research supervisor. A total of 55 questions were then placed in the test, which can be seen in the blueprint outline below.

Table No: 3.19 ***Weightage of content/unit***

S.No	Topics	Questions	Marks
1	Square and Square Roots	5	5
2	Cubes and Cube Roots	6	6
3	Rational Number	4	4
4	Ratio and Proportion	2	2
5	Multiplication and Division of Polynomial	7	7
6	Rule of Three	1	1
7	Percentage	4	4
8	Mixture	1	1
9	Time and Work	3	3
10	Algebraic Number	8	8
11	Complementary Angles Supplementary Angles and Adjacent Angles	3	3
12	Area of Square and Area of Rectangle	7	7
13	Formation of an Equation and its Solution	4	4
Total		**55**	**55**

Table No: 3.20 ***Weightage of Objectives (Initial Draft)***

S.No	Objectives	Marks	% of Marks
1	Remembering	12	22%
2	Understanding	13	23%
3	Applying	30	55%
Total		**55**	**100%**

Table No: 3.21 ***Blueprint of Mathematics Achievement Test (Initial Draft)***

S.No	Topics	Objectives			Total
		Remembering	Understanding	Applying	
1	Square and Square Roots	2	-	3	5
2	Cubes and Cube Roots	1	2	3	6
3	Rational Number	1	1	2	4
4	Ratio and Proportion	-	-	2	2
5	Multiplication and Division of Polynomial	2	2	3	7
6	Rule of Three	-	-	1	1
7	Percentage	-	1	3	4
8	Mixture	-	-	1	1
9	Time and Work	-	1	2	3
10	Algebraic Number	3	2	3	8
11	Complementary Angles Supplementary Angles and Adjacent Angles	-	2	1	3
12	Area of Square and Area of Rectangle	3	1	3	7
13	Formation of an Equation and its Solution	-	1	3	4
Total		**12**	**13**	**30**	**55**

Content Analysis

A tool for face validity must be established after the items are constructed. Under which the basic structure and language of the tool are tested, and on the other hand, you need to look at the text of each item to see if it fits the purpose for which the tool was made. The test is mandatory for developed mathematics achievement tests. Mathematics and language experts were given and said that you can retain, delete, or modify. After that, advice and suggestions are received from the experts. The tool was then finalized with the help of a supervisor. In this way, the face validity of the tool was established.

Second Step: Try Out

This is an important step in the construction of the test. The following element is required at this step.

1. Selection of Sample
2. Age and Class
3. Duration of Test
4. Administration of Test
5. Scoring Procedures

1. Selection of Sample

The researcher selected 126 students from the Urdu Medium School using a simple random sampling technique to validity the tool.

2. Age and Class

The ninth class was required to use the mathematics achievement test as a sample for construction and the students ranged in age from 14 to 16 years.

3. Duration of Test

Duration is an essential element in any test. Therefore, 2 hours were allotted for this manageable test and not trying for the students.

4. Administration of Test

The researcher first met the mathematics teachers to obtain the research data and introduced himself, explained the purpose of the research to them, and assured them that whatever information would be obtained was only for research. Will be used for this purpose, and permission has been obtained from them. Then, they were told that they could leave the classroom so that the classroom could have a relaxed or conducive atmosphere. The children were then given a copy of the letter, except for the instruction to complete it, and were given 120 minutes to solve the questionnaire.

After 2 hours, the students submitted their answer sheets. The researcher then thanked the children and the administration.

5. Scoring Procedures

Students wrote their answers in the answer sheet. The answer sheet was checked according to the answer key.

Third Step: Analysis of Data

Item analysis is an essential step in test construction. This phase mainly measures the difficulty of the item, item discrimination index, validity, and reliability of the item. It basically relates to item difficulty and items' discrimination index. The difficulty of the item is taken as proportional to the number of people who have successfully completed it. The discrimination index refers to the degree to which it differentiates between high and low scorers. Item analysis was based on the scores of 126 students. The formula proposed by Kelley (1939) was used to test the difficulty of all items included in the test and the level of discrimination of the items based on the data obtained, which can be seen below (Mahajan, Gourav.2015, p. 54–60).

$$\textit{Difficulty Value} \quad (D.V) = \frac{(RU+RL)\times 100}{NU+NL}\,\%$$

$$\textit{Discrimination Index} \quad (D.I) = \frac{(RU-RL)\times 100}{NU}\,\%$$

Where:

RU = No. of correct responses in Upper group

RL = No. of correct responses in Lower group

N = Size of Sample in Upper and Lower group

The difficulty of all the items included in the test with the help of the formula above and the value of the level of distinction of the items are presented in the following table.

Table No: 3.22

DV and DI of Previous Knowledge of Mathematics Achievement Test Items

Items No	Correct Response		DV	DI	Accepted/Rejected
	RU	RL			
1	34	27	0.90	0.21	**Rejected**
2	28	22	0.74	0.18	Accepted
3	30	26	0.82	0.12	**Rejected**
4	29	24	0.78	0.15	Accepted
5	31	19	0.74	0.35	Accepted
6	32	23	0.71	0.26	Accepted
7	33	13	0.68	0.59	Accepted
8	22	16	0.56	0.18	Accepted
9	26	21	0.69	0.15	Accepted
10	14	04	0.26	0.29	Accepted
11	24	10	0.50	0.41	Accepted
12	31	15	0.68	0.47	Accepted
13	29	21	0.74	0.24	Accepted
14	29	19	0.71	0.29	Accepted
15	32	20	0.76	0.35	Accepted
16	24	15	0.57	0.26	Accepted
17	25	19	0.65	0.18	Accepted
18	28	13	0.60	0.44	Accepted
19	20	09	0.43	0.32	Accepted
20	25	15	0.59	0.29	Accepted
21	29	13	0.62	0.47	Accepted
22	31	27	0.85	0.12	**Rejected**
23	26	11	0.54	0.44	Accepted
24	32	20	0.76	0.35	Accepted
25	29	09	0.56	0.59	Accepted
26	28	21	0.72	0.21	Accepted
27	27	15	0.62	0.35	Accepted
28	22	14	0.53	0.24	Accepted
29	29	14	0.63	0.44	Accepted
30	27	14	0.60	0.38	Accepted
31	22	08	0.44	0.41	Accepted
32	30	15	0.66	0.44	Accepted
33	22	19	0.60	0.09	Accepted

34	21	07	0.41	0.41	Accepted
35	22	16	0.56	0.18	Accepted
36	07	06	0.19	0.03	**Rejected**
37	21	10	0.46	0.32	Accepted
38	15	13	0.41	0.06	Accepted
39	24	10	0.50	0.41	Accepted
40	14	8	0.32	0.18	Accepted
41	29	10	0.57	0.56	Accepted
42	27	15	0.62	0.35	Accepted
43	07	05	0.18	0.06	**Rejected**
44	17	11	0.41	0.18	Accepted
45	24	09	0.49	0.44	Accepted
46	22	10	0.47	0.35	Accepted
47	16	12	0.41	0.12	Accepted
48	10	08	0.26	0.06	Accepted
49	19	13	0.47	0.18	Accepted
50	15	08	0.34	0.21	Accepted
51	16	14	0.44	0.06	Accepted
52	19	15	0.50	0.12	Accepted
53	09	08	0.25	0.03	Accepted
54	27	24	0.75	0.09	Accepted
55	26	16	0.62	0.29	Accepted

Table No: 3.23 ***DV of Items of the Achievement test***

Sl. No.	DV	Frequency	Item No.	Remarks
1	Above 0.80	3	1, 3, 31	Rejected
2	Between 0.20 and 0.80	50	2, 4, 5, 6, 7, 8, 9, 10 ,11 ,12 ,13 ,14 ,15 ,16 ,17 ,18 ,19 ,20 ,21 ,22 ,23 ,24 ,25 ,26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 37, 38, 39, 40, 41, 42, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55,	Accepted
3	Below 0.20	2	36, 43	Rejected

Table No: 3.24 ***DIof Item of the Achievement***

Sl. No	DI	Frequency	Item No.	Remarks
1	Between 0.40 and 0.90	14	7, 11, 12, 18, 21, 23, 25, 29, 31, 32, 34, 39, 41	Very Good Items
2	Between 0.30 and 0.39	09	5, 15, 19, 24, 27, 30, 37, 42, 46	Good but Subjected to improvement
3	Between 0.20 and 0.29	11	1, 6, 10, 13, 14, 16, 20, 26, 28, 50, 55	Marginal Items Subjected to modification
4	0.19 and Below	21	2, 3, 4, 8, 9, 17, 22, 33, 35, 36, 38, 40, 43, 44, 47, 48, 49, 21, 52, 53, 54	Poor Items

Forth Step: Final draft of Mathematics Achievement Test

For the final layout of the test, material would rearrange the content areas and items according to the markings assigned to them. The final test consisted of 34 items with a maximum score of 80. It took two and a half hours to complete the test. In terms of content and level, the weights are given in Table 3.25 and 3.26 respectively.

Table No: 3.25 ***Weightage of content/ unit***

S.No	Topics	Questions	Marks
1	Square and Square Roots	4	4
2	Cubes and Cube Roots	6	6
3	Rational Number	4	4
4	Ratio and Proportion	1	1
5	Multiplication and Division of Polynomial	6	6
6	Rule of Three	1	1
7	Percentage	4	4
8	Mixture	1	1
9	Time and Work	3	3
10	Algebraic Number	7	7
11	Complementary Angles Supplementary Angles and Adjacent Angles	3	3
12	Area of Square and Area of Rectangle	6	6
13	Formation of an Equation and its Solution	4	4
Total		**50**	**50**

Table No: 3.26 ***Weightage of Objectives (Final draft)***

S.No	Objectives	Marks	% of Marks
1	Remembering	11	22%
2	Understanding	12	24%
3	Applying	27	27%
Total		50	100%

Table No: 3.27 ***Blueprint of Mathematics Achievement Test (Final draft)***

S.No	Topics	Objectives			Total
		Remembering	Understanding	Applying	
1	Square and Square Roots	2	-	2	4
2	Cubes and Cube Roots	1	2	3	6
3	Rational Number	1	1	2	4
4	Ratio and Proportion	-	-	1	1
5	Multiplication and Division of Polynomial	2	2	2	6
6	Rule of Three	-	-	1	1
7	Percentage	-	1	3	4
8	Mixture	-	-	1	1
9	Time and Work	-	1	2	3
10	Algebraic Number	3	1	3	7
11	Complementary Angles Supplementary Angles and Adjacent Angles	-	2	1	3
12	Area of Square and Area of Rectangle	2	1	3	6
13	Formation of an Equation and its Solution	-	1	3	4
Total		**11**	**12**	**27**	**50**

Fifth Step: Validity and Reliability of Test

The researcher has established the validity of the content through the experts in this field of content validity. The researcher used the Cronbech's Alpha Test through reliability in this mathematics achievement test, which has a value of 0.736

3.13.8.4 Mixed Type Group Test of Intelligence (Verbal & Non Verbal)-MGTI

This standard tool is called Dr. P.N. Mehrotra and has developed what is known as the Mixed Type Group Test of Intelligence (Verbal & Non-Verbal) or MGTI for short. The purpose of this test is to determine the mental capability of children aged 11–17 through verbal and non-verbal activity. This tool is based on two types of activity, such as verbal intelligence and non-verbal intelligence. The researcher has included only the verbal intelligence of this tool. This verbal test has five dimensions. They are as follows:

1. Analogy Test
2. Number-Series Test
3. Classification Test
4. Vocabulary Test
5. Reasoning Test

Thus, the tool contains 50 issues over five dimensions. The reliability value of the test varies from 0.89 to 0.91. These tests are in both Hindi and English. Therefore, the researcher translated the test into Urdu. After translating, the researcher was assigned to the experts to establish the face validity. The advice after that, with the help of his research supervisor, the test was modified and finalized as required, and thus the face validity of this tool was established. The researcher used the Cronbech's Alpha Test through reliability in this Test of Intelligence, which has a value of 0.854

3.13.9 Statistical Techniques

The present study uses various statistical techniques to establish the validity and reliability of the research tool and to analyze and interpret the data obtained as follows.

1. Central Tendency
2. t- test
3. Analysis of Variance(ANVOA)
4. Analysis of Covariance

Chapter – IV

Data Analysis and Interpretation

4.0 Introduction

In this chapter results of hypothesis testing are presented in the form of tables and graph followed by their interpretation. The data were collected through experimentation followed by true experimental design under which two group designs were used for giving treatment like approach to deal with the students of the experimental group was ICT mediated constructivist teaching whereas students who participated in the control group received treatment through traditional method of teaching. However, these two groups were formed on the basis of students' scores on the Mixed Type Group Test of Intelligence (Verbal & Non-Verbal) -MGTI. Tests were administered twice, just before the treatment first-time test was administered in both groups whereas after completion of the treatment final test was administered. The same has been presented in the following table and it will also give insight into the testing of the following hypotheses.

Table 4.1: ***Showing research design and planning of the testing hypotheses***

Group	***Test***	***Treatment***	***Test***	***Action***
Control	*MAT – I*	TA	*MAT – II*	***TTC***
Experimental	*MAT – I*	ICTMCA	*MAT – II*	***TTE***
Action	***CEC****	***-----***	***CEC****	

TTC – Control Group pretest and posttest comparison TTE – Experimental group pretest and posttest comparison

MAT – I : Mathematics Achievement Test (Pretest) MAT – II : Mathematics Achievement Test (Posttest)

CEC* - Control and experimental group comparison CEC** - Control and experimental group comparison

ICTMCA- ICT- Mediated Constructivist Approach TA- Traditional Approach

Hypotheses Testing- the following hypotheses were formulated which need to be tested

H_{01}: *There will be no significant difference in the mean of mathematics achievement of the students of experimental and control group before treatment.*

H_{02}: *There will be no significant difference in the mean of mathematics achievement of experimental group students before and after the treatment.*

H_{03}: *There will be no significant difference in the mean of mathematics achievement of control group students before and after the treatment.*

H_{04}: *There will be no significant difference in the mean of mathematics achievement of the students of experimental and control group after treatment.*

4.1 Data Analysis and Interpretation

H_{01}: There will be no significant difference in the mean of mathematics achievement of the students of experimental and control group before treatment.

The first assumption was that the students of both groups have the same level of mathematical knowledge. Deciding the statistical test for testing this hypothesis assumption of t-independence is tested which can be shown here.

Table 4.2: ***Test of Normality – Kolmogrov-Samirnov***

	Statistics	df	p-value
Experimental_Control_Group	0.107	60	0.085

The first assumption of t-test is that data must be normally distributed that is samples are drawn from one distribution. A Kolmogriv-Samirnov test was used for testing the normality through the SPSS, and outcomes are presented in the table 4.2,

which shows that data are normally distributes because p-value of K-S test is 0.085 which is greater than 0.05 (p. value 0.085>0.05).

Apart from this, one more important assumption for using the t-test which states that both the groups are homogeneous in terms of their performance in the achievement test. A Levene's Test was used for testing this assumption and outcomes are represented in the following table 4.3.

Table 4.3: ***Levene's test for equality of variance***

Group	N	F	p-value
Control	30	7.057	0.010
Experimental	30		

The data of above table indicates that student of both the groups have not equal level of mathematical knowledge because p-value is 0.010 which is less than 0.05 level of significance. Since, the data are normally distributed but both the group is not homogeneous. Hence, Mann-Whitney U test is appropriate for testing this hypothesis which states **"**there will be no significant difference in the mean of mathematics achievement of the students of experimental and control group before treatment".

Table 4.4 ***Mean rank difference between students of control and experimental group***

Treatment Groups	N	Mean Rank	Statistics	p-value
Control	30	32.05	4.3.500	0.491
Experimental	30	28.95		

Table 4.4 is indicating that obtained p-value is 0.491 which is far greater than the 0.05 level of significance. Hence the null hypothesis "there will be no significant

difference in the mean of mathematics achievement of the students of experimental and control group before treatment" stands accepted. Therefore, it may be inferred that students who participated in both groups performed equally in the achievement test.

H_{02}: There will be no significant difference in the mean of mathematics achievement of experimental group students before and after the treatment.

The first assumption was that the intervention does not affect the student's mathematical knowledge of the experimental group. A pairwise t-test was performed followed by testing their assumptions. The first assumption is that data must be normally distributed that is samples drawn from one distribution.

Table 4.5: ***Test of Normality – Kolmogrov-Samirnov***

	Statistics	df	p-value
Experimental_Group_Pre-test_Post-test	0.069	60	0.200

Table 4.5 showing that pretests and posttest of experimental group students are normally distributed because p-value is 0.200 which is greater than 0.05.

The second assumption of the paired t-test is the scores of both tests should be correlated. Hence, a correlation test is performed and the results are presented in the following table 4.6.

Table 4.6 ***Showing Paired Sample Correlation between pretest and posttest scores of experimental group students.***

	N	Correlation	p-value
Pretest & Posttest	30	0.346	0.042

The table 4.6 showing correlation between the scores of pre-test and post-test of experimental group students describes how related both each other. It can be seen here

the correlation coefficient is 0.346 and the p-value is 0.042 which indicates that scores of pretest and posttest are significantly correlated ($r=0.346$, $p=0.042<0.05$). Hence, it can be concluded that the scores of both tests are paired.

Since all the assumption of the paired-t-test is tested and met. Therefore, the paired t-test is performed through the SPSS, and the outcomes are presented in the following table 4.7

Table 4.7 ***Mean difference between the scores of pretest and posttest of experimental group students.***

Paired sample statistics				Paired Sample Test: Pretest – Posttest				
Tests	N	Mean	SD	Mean	SD	t-value	df	p-value
Pretest	30	18.00	8.094	-10.233	9.8250	-5.705	29	0.000
Posttest		28.23	9.04					

The above table described the paired t-test which indicates that $t(29)=5.705$ and the p value is 0.000. Here, it can be seen the p is less than 0.05 and therefore, the null hypothesis "*there will be no significant in the mean of mathematics achievement of experimental group students before and after the treatment"* is rejected. Thus, students of experimental group significantly performed better in the posttest as compared to pretest because it indicating means 18.00 and 28.23 in pretest and posttest respectively.

H_{03}: ***There will be no significant difference in the mean of mathematics achievement of control group students before and after the treatment.***

Investigator wanted to see whether pre-test and post-test results have any significant difference among control group. Statistically testing this hypothesis, a paired t-test was used followed by their assumption of normality and correlation of scores of

both tests. The first assumptions of paired t-test have been tested and presented in the following table 4.8.

Table 4.8: ***Test of Normality – Kolmogrov- Samirnov***

	Statistics	df	p-value
Experimental_ group_ Pretest_ Posttest	0.082	60	0.200

Table 4.8 describes that data are normally distributed because the calculated value of the K-S test is 0.082 and the p_ value for df=60 is 0.200 which is greater than 0.05.

The second assumption of the paired t-test is that the scores of both tests should be correlated. Hence, the Pearson correlation test is performed and the results are presented in the following table 4.9.

Table 4.9 ***Showing Paired Sample Correlation between pre-test and post-test scores of control group students***.

	N	Correlation	p-value
Pre-test & Post-test	30	0.462	0.038

The table 4.9 showing correlation between the scores of pretest and post-test of experimental group students describes how related both each other. It can be seen here the correlation coefficient is 0.462 and the p-value is 0.038 which indicates that scores of both tests are significantly paired.

Since all the assumption of the paired-t-test is tested and met. Therefore, the paired t-test is performed through the SPSS, and the outcomes are presented in the following table 4.10.

Table 4.10 Means *the difference between the scores of pre-test and post-test experimental group students.*

Paired sample statistics				Paired Sample Test: Pretest – Posttest				
Tests	N	Mean	SD	Mean	SD	t-value	df	p-value
Pre-test	30	18.367	5.604	-4.2000	8.7035	-2.643	29	0.013
Post-test		22.567	7.015					

The above table described the paired t-test which indicates that t (29)=2.643 and the p-value is 0.013. Here, it can be seen the p is less than 0.05, and therefore, the null hypothesis "there will be no significant difference in the mean of mathematics achievement of control group students before and after the treatment" is rejected. Thus, students among control group significantly performed better in the post-test as compared to the pretest which can be verified from the mean of 18.367 and 22.567 in the pretest and post-test respectively.

H_{04}: There will be no significant difference in the mean of mathematics achievement of the students of experimental and control group after treatment.

Testing the above null hypothesis by using ANCOVA data must be met the following assumptions.

1. Residuals should be normally distributed
2. Both the group should have equal variance
3. The Independent variable should not significantly affect the covariate.
4. Dependent variables and covariates are linearly related.
5. Homogeneity of regression slop that is interaction effect between the dependent variable and covariate must not be significant.

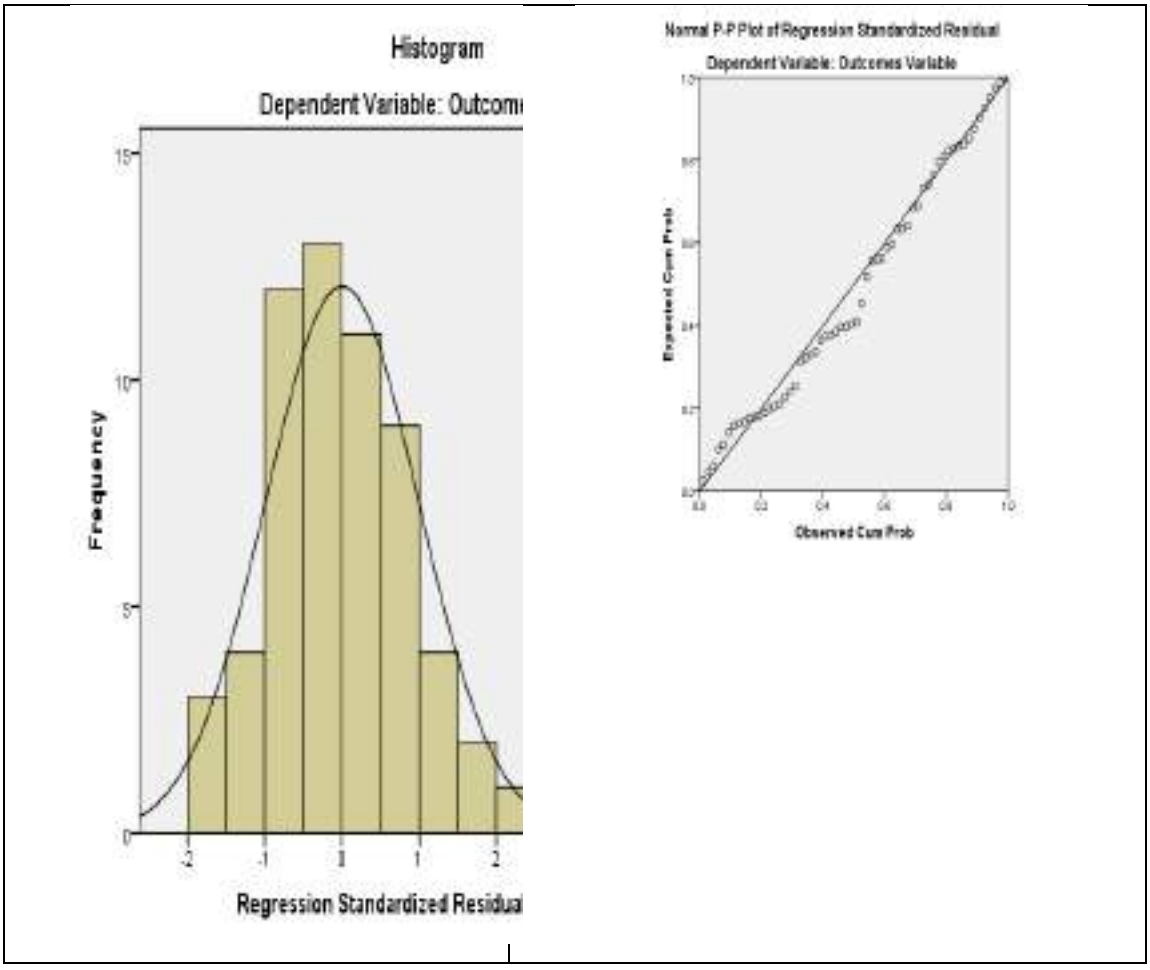
Assumption – 1: Residuals are normally distributed

Table 4.11: *Showing residuals normality data*

Variables	Normality Test: Kolmogorov-Smirnov		
	Statistic	df	Sig.
Dependent Variable	0.113	60	0.053
Covariate	.107	60	0.085

The Kolmogorov-Smirnov test data suggest that the residuals are approximately normally distributed [p. 0.053 & 0.085 > 0.05]. This can also be understood through the graphical representation given in the following graph 4.1. Therefore, the first assumption of analysis of covariance is successfully met.

Graph: 4.1 Residuals Normality data



Assumption 2: Homogeneity of variance that is both the group should have equal variance

Table 4.12 ***Showing homoscedasticity test for testing equality of variance of treatment groups***

Test performing	F	df1	df2	p-value
Leven Test	0.706	1	42	0.406

Levene's test of homoscedasticity test of equal variance is clearly indicates that both the treatment group that is experimental and the control group are equal variance [p. 0.406>0.05].

Assumption – 3: The Independent variable should not significantly effect on the covariate.

Table 4.13: ***Showing equality of the two groups on co-variate***

Source	Type II Sum of Squares	df	Mean Square	F	p-value	Partial Eta Squared
Corrected Model	2.017[a]	1	2.017	.042	.839	.001
Intercept	19838.02	1	19838.02	409.33	.000	.876
Independent Variable	*2.017*	*1*	*2.017*	*.042*	***.839***	*.001*
Error	2810.967	58	48.465			
Total	22651.00	60				
Corrected Total	2812.98	59				

a. R Squared = .001 (Adjusted R Squared = -.017)

Table 4.13 which is showing the data related to the equality of the two groups on the co-variate. In this table, F (1,58) =0.042 and P=0.839 indicate that P-value=0.839>0.05 which clearly shows that the independent variable is not affect

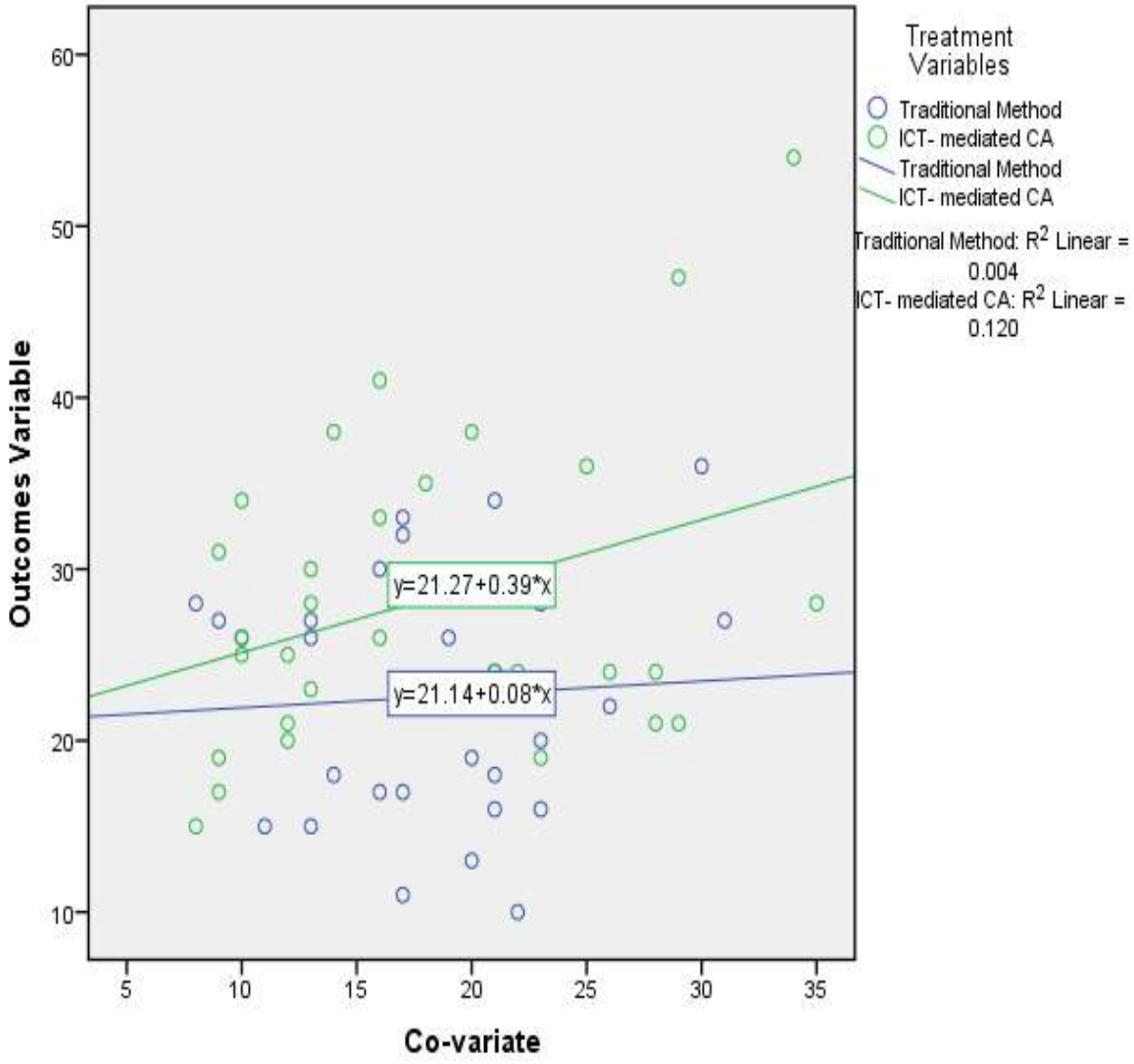
significantly by the co-variate. Thus, the second assumption of ANCOVA that the "independent variable does not significantly affect the covariate" is successfully met.

Assumption – 4: Dependent variable and covariate are linearly related.

Table 4.14: ***Showing dependent variable and covariate are linearly correlated (overall)***

Variables	N	Mean	Standard Deviation	R-value	Decision	Remarks
Covariate	60	18.18	6.90	0.223	0.223 <0.8	linearly correlated
Dependent Variable	60	25.44	8.52			

Table 4.14 Shows the overall relation between a dependent variable and covariate is 0.223 is less than 0.8 which suggests that both the variables (dependent and covariate) are linearly correlated. The same can also be observed in the following graph in such a way that two variables will be correlated if and only if both distribution form a parallel line i.e., do not cross each other. Therefore, the graph: 4.2 also suggest that both treatment groups are linearly correlated.



Graph: 4.2 Dependent variable and covariate

Assumption 5: Homogeneity of Regression Slop: There must be no interaction effect between treatment variable and co-variate.

Table 4.15: *Showing homogeneity of regression slop*

Dependent Variable: Post-Test Scores; Treatment Group: experimental and control group

Source	Type II Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	771.493[a]	3	257.164	4.107	.011	.180
Intercept	3326.416	1	3326.416	53.118	.000	.487
Treatment groups	.028	1	.028	.000	.983	.000
Co-variate	230.974	1	230.974	3.688	.060	.062
*Treatment * co-variate*	*58.852*	*1*	*58.852*	*.940*	***.337***	*.017*
Error	3506.907	56	62.623			
Total	42988.000	60				
Corrected Total	4278.400	59				

a. R Squared = .180 (Adjusted R Squared = .136)

From the above table it can clearly be observed that F(1,56)=0.940, p=0.337 which reflects that there is no significant interaction effect exist between independent variable and covariate. Hence, the covariate is associated with the outcomes in the same way between experimental and control groups.

Table No. 4.16: ***Tests of Between-Subjects Effects – Final Result of ANCOVA***

Dependent Variable/Outcomes Variable: Post-Test Scores

Source	Type II Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	712.641[a]	2	356.320	5.696	.006	.167
Intercept	3098.776	1	3098.776	49.535	.000	.465
Pre-Test	230.974	1	230.974	3.692	.060	.061
Treatment $SS_{Between}$	499.342	1	499.342	7.982	.007	.123
Error SS_{within}	3565.759	57	62.557			
Total	42988.000	60				
Corrected Total	4278.400	59				

a. R Squared = .167 (Adjusted R Squared = .137)

A one-way ANCOVA was conducted to compare the effectiveness of two teaching method (ICT mediated constructivist teaching approach & traditional teaching approach) whilst controlling for pre-Test (Covariate) scores. Levene's test for homogeneity of variance and Kolmogorov-Smirnov for normality along with the homogeneity of regression slop and parallel line assumption and equality of variance on co-variate tests were carried out and the assumptions met. The output of ANOVA suggest that there is a significant difference in mean of mathematics achievement post-test [F(1,57)=62.557, p=0.007] between the experimental and control groups.

Chapter – V

Summary, Findings &Conclusions

5.0 Introduction

In the previous chapter, the analysis and interpretation of the data obtained through the experimental process were described in detail, along with the selection of the statistical model according to the nature of all null hypotheses and the examination of all the necessary conditions for the applicability of this model. Also discussed in detail were data normality, homogeneity, and other conditions. After fulfilling all the necessary conditions, the selected statistical model was used, the details of which have also been presented in Chapter IV. The present chapter presents the summary of the study, findings, conclusions, and discussion, as well as educational implications and suggestions for further research.

5.1 Summary of the research study

In this regard, it is discussed in the first chapter that, under the current research title **"Impact of ICT-Mediated Constructivist Approach on Teaching Mathematics Achievement of Secondary School Students,"** an attempt has been made to investigate the effectiveness of an ICT-mediated constructivist approach to teaching mathematics achievement in students. Knowledge of mathematics helps in understanding and thinking about all kinds of sciences. Since today's world is completely dependent on science and technology, more knowledge of mathematics is needed. Therefore, it is the responsibility of mathematics teachers to try to teach mathematics in the most effective way and in

simple language. Because the student will be able to perform better in mathematics only when the basic concepts of mathematics are clear. On the contrary, if the teacher is not able to explain the basic concepts of mathematics well, then the students' interest in mathematics decreases. And in this way, a negative trend develops for the students. Due to this, the cognitive ability, logical thinking, reflection, the ability to solve problems, and mental ability are not developed in the student. As a result, their mathematics achievement is affected. The recent development of information and communication technology (ICT) has affected every field, including education. Technology-mediated learning is especially important for mathematics students to enhance their logical and reasoning ability, develop conceptual understanding, and engage in activity-based learning. Technology-based learning, especially in mathematics, is considered beneficial for enhancing students' logical and reasoning abilities, promoting active learning, and developing conceptual understanding. In the past, education and learning in general was based on only transfer of education, but the recent development of ICT has changed the approach to learning and teaching. Nowadays, teaching strategies at the school level are being linked to constructivist approaches to teaching and learning. According to constructivism, the development of new ideas, knowledge, or experiences is actively linked to past knowledge or experiences. It emphasizes the construction of knowledge through social interaction as well as the cognitive structure of the self. In this regard, Confrey (1990) said that constructivism is a theory of human knowledge that explains the cognitive acts of humans through which humans construct their knowledge and experiences (p. 108). Therefore, the focus of teaching should be on developing an environment conducive to knowledge construction rather than knowledge transfer.

The National Curriculum Framework (NCF) 2005 has shifted the Indian classroom to a creative learning environment that focuses on knowledge building rather than knowledge transfer. It emphasizes student activity as well as knowledge building, which is based on the already existing concepts and experiences associated with the content and activities (NCF-2005, p.17). In order to achieve better performance in mathematics, Indian classrooms emphasize teaching and learning through the basic principles of a constructivist approach. In this environment, ICT can help foster innovation throughout the teaching and learning process. Can ICT-mediated constructivist approaches to math achievement improve performance through accessible learning? In the light of this basic question, a research question was formulated, which is as follows.

- How effective is the ICT mediated constructivist approach in teaching and learning to improve mathematics achievement in secondary school students?

Major Objectives

- To study the impact of ICT-mediated Constructivist Approach of teaching on mathematics achievement of experimental group students.
- To compare the mathematics achievement of ICT-mediated Constructivist Approach group and Traditional Method group.

Concomitant Objectives

- To develop pre-test and post-test tools for Mathematics achievement tests.
- To prepare lesson plan based on ICT mediated Constructivist Approach of teaching.
- To prepare lesson plan based on Traditional Approach of teaching.

- To develop Mathematics achievement tests for previous knowledge in mathematics

Also, the following hypotheses were formulated to further the study.

H_{01}: There will be no significant difference in the mean of mathematics achievement of the students of experimental and control group before treatment.

H_{02}: There will be no significant difference in the mean of mathematics achievement of experimental group students before and after the treatment.

H_{03}: There will no significant difference in the mean of mathematics achievement of control group students before and after the treatment.

H_{04}: There will be no significant difference in the mean of mathematics achievement of the students of experimental and control group after treatment".

In the light of the nature of the research and its objectives, the following delimitations of the study are stated to avoid unnecessary wastage of time, effort and energy.

1. This study has done only in Co-education secondary school of Darbhanga district of Bihar.
2. This study done only in Urdu medium school of Darbhanga district of Bihar.
3. This study done only in Government Secondary School, Darbhanga District, Bihar.
4. This present study covers only ninth class of Darbhanga district of Bihar.

To complete the present research, the experimental method was adopted, under which the true experimental design was chosen. This design was implemented on the ninth-grade students of Kamran Model School of Maulana Azad National Urdu University, Darbhanga, Bihar, using the purposive sampling technique.

In this reasearch before conducting the experimental process on the students of class IX of the selected school, P.N. Mehrotra's A Mixed-Type Group Test of Intelligence (verbal and nonverbal) test was carried only through verbal intelligence to know the general mental ability. After that, the students of both sections of this group were compared on the basis of T-Scores, as a result of which two groups of 30 and 30 students were selected for the experimental process, then through the randomization technique, students were divided into two groups, one was named as the experimental group and the other as control group. Students of the experimental group were taught mathematics through ICT-mediated constructivist teaching, and the students of the control group were taught mathematics through traditional teaching methods.

A pre-test and post-test were used to collect the data, which was created by the researcher himself. For this, the researcher first prepared a blueprint for the pre-and post-test and determined the objectives, content, types of questions, subjects, and other essential components. After that, face validity was established for its validity by creating the tools. After that, the Difficulty value and discrimination power of the tool were determined by piloting. After that, (and then) in order to establish the reliability of the tool, data were obtained from the Chronbach Alpha Test, with the help of which the reliability of the tool was determined, which was develop by the researcher. To know the previous mathematics knowledge, the researcher first developed the blueprint for this tool, then the tool was developed according to the blueprint, and its face validity was established. After that, the researcher determined the difficulty level and discrimination power of the tool from the data obtained through the pilot study. In order to establish the

reliability of the tool, data was obtained from the Chronbach Alpha Test, with the help of which the reliability of the tool was determined.

Pre-test and previous mathematics knowledge test were conducted in both groups before treatment was administered to all students included in the study. Then mathematics was taught using two different strategies. In which the experimental group was taught through ICT-mediated constructivist teaching and the control group through traditional teaching. A post-test was conducted for both groups after the treatment. The data obtained through both these tests were analyzed and interpreted using t-test and ANCOVA statistical techniques, from which the following results were obtained.

5.2 Findings of the study

H_{01}: There will be no significant difference in the means of mathematics achievement of the students of experimental and control group before treatment.

Finding1: The p-value obtained after testing the hypothesis is 0.491, which is more than the 0.05 level of significance. It shows that there is no significant difference between the means of mathematics achievement of experimental and control group students before treatment, so the null hypothesis is accepted.

The experimental and control group students who participated in the experimental process performed equally in the mathematics test before treatment.

H_{02}: There will be no significant difference in the means of mathematics achievement of experimental group students before and after the treatment.

Finding 2: The means of the pre-and post-tests of the experimental group students obtained after testing the hypothesis are 18.00 and 28.23, respectively, and t (29) = 5.705,

and the p-value is 0.000. Here, it can be seen that p is less than 0.05, and therefore "there is a significant difference in the mathematics achievement of the experimental group students before and after the treatment, so the null hypothesis is rejected."

The experimental group of students who participated in the experimental process had a mean of 18.00 before treatment and a mean of 28.23 after treatment. It showed from the results of pre-test and post-test student performed better after treatment. This result is supported by the results of Nayak (2011), Lata & Sharma (2013), Pattanaik (2010), etc.

H_{03}: There will be no significant difference in the mean of mathematics achievement of control group students before and after the treatment.

Finding 3 : After testing the hypothesis, the control group students' mean pre-test and post-test scores are 18.367 and 22.567 respectively, with t (29) = 2.643 and a p-value of 0.013. Here, it can be seen that p is less than 0.05, and therefore there is a difference in mathematics achievement of control group students before and after treatment. Therefore, the null hypothesis is rejected.

It is concluded that students of control group who participated in the experimental process has a mean of 18.00 before the treatment and a mean of 22.567 after the treatment. It showed from the results of pre-test and post-test that students performed better after treatment.

H_{04}: There will be no significant difference in the mean of mathematics achievement of the students of experimental and control group after treatment".

Finding 4: One-way ANCOVA was used to compare the effects of two intervention methods (ICT-mediated constructivist approach teaching and traditional methods) while controlling the pre-test (covariate) to test the hypothesis. Levene's test of homogeneity of variance and Kolmogorov-Smirnov for normality, as well as homogeneity of regression slope and the parallel line assumption, and equality of variance on co-variate tests were done, and the assumption was fulfilled. The final result of ANCOVA shows that there is a significant difference between the experimental group and the control group in the mean math achievement test. This result is supported by the results of Adak (2017), Aydisheh & Gharibi (2015), Asamoah (2017), Tripathy (2010), Bhimarao (2014), etc.

It is concluded that when the control group students are taught with traditional methods and the experimental group is treated with ICT-mediated constructivist approach teaching, ICT-mediated constructivist approach teaching is more effective than traditional methods of teaching.

5.3 Conclusions of the study

In the present study, after analyzing and interpreting the data obtained, the following conclusions were drawn.

1: There will be no significant difference in the mean of mathematics achievement of the students of experimental and control group before treatment, after the testing, there is no difference in the mathematics achievement of the experimental group and the control group students.

It is concluded that before the treatment, the students of the experimental group and the control group showed the same performance in the mathematics achievement test.

2: There will be no significant difference in the mean of mathematics achievement of experimental group students before and after the treatment" the mean of pre-test and post-test of experimental group students obtained data after testing is 18.00 and 28.23 respectively and t (29)=5.705 and p-value is 0.000. Which is less than p 0.05, and therefore there is a significant difference in the mathematics achievement of the students of the experimental group before and after the treatment.

It is concluded that the experimental group was taught through an ICT-mediated constructivist approach, due to which the students performed better. It showed that the post-test performed better than the pre-test.

3: There will be no significant difference in the mean of mathematics achievement of control group students before and after the treatment" The means of the pre-test and post-test of the control group students' obtained data after testing are 18.367 and 22.567, respectively, and t (29) = 2.643 and the p value is 0.013. Which is less than p 0.05, and therefore there are differences in the mathematics achievement of students in the control group before and after treatment.

The students in the control group who participated in the experimental process had a mean of 18.00 before the treatment and a mean of 22.567 after the treatment, according to the findings. The control group was taught through traditional methods of teaching. It showed that the post-test performed better than the pre-test.

4: There will be no significant difference in the means of the mathematics achievement of the students of experimental and control group after treatment" while controlling for

the pre-test (covariate) during testing. A one-way ANCOVA was used to compare the perceptions of the methods (ICT-mediated constructivist approach to teaching and traditional teaching). Levene's test of homogeneity of variance and Kolmogorov-Smirnov for normality, as well as homogeneity of regression slope and the parallel line assumption, and equality of variance on co-variate tests were done, and the assumption was fulfilled. The final result of ANCOVA shows that there is a significant difference between the experimental group and the control group in the mathematics achievement.

It is concluded that when the control group students are taught traditional methods and the experimental group is treated with ICT-mediated constructivist approach teaching, ICT-mediated constructivist approach teaching is more effective than traditional methods of teaching. The researcher found during teaching that when an ICT-mediated constructivist approach to teaching was being implemented in the experimental group, students learned with engaging activities and cooperation. The fear and anxiety of mathematics were discovered among the students by teaching in this manner, because the atmosphere of the classroom was democratic and educational. On the contrary, the students in the control group had difficulties understanding the basic concepts of mathematics because the control group was taught in the traditional way. During teaching, the researcher found that students in mathematics classrooms do not take interest and remain in passive mode.

5.4 Educational Implications

For students

- Mathematics anxiety can be reduced through ICT-mediated constructivist approach to teaching.
- Mathematical knowledge can be enhanced and improved in the basic concept of mathematics, principle, rules, generalities, and other method by using ICT-mediate Constructivist Approach.
- The students that learned through the ICT-mediated constructivist approach to teaching increased their skills. Because the constructivist approach emphasizes students' own learning by connecting lessons to prior knowledge and experiences.
- Problem solving ability can be promoted in students through an ICT-mediated constructivist approach to teaching.

For teachers

- Mathematics teachers should diagnose or test the student's previous knowledge before teaching them new mathematical concepts.
- Teachers must also give related assignments and frame the motivation, instruction, and guidance to complete these assignments in the group. This creates the habit of learning by doing in the child and the interest.
- Teachers should maximize the use of ICT in mathematics classrooms because students learn through ICT in a dynamic and effective manner.
- Teachers should use ICT as self-confidence develops in students.
- In the constructivist classroom, children learn new information and ideas through activities. Therefore, mathematics teachers should also use activities related to

mathematical concepts in their classrooms as much as possible and ensure the participation of all children.

- One of the principles of the constructivist approach is that children learn about new information and concepts through activities and groups. Therefore, teachers should make the classroom and school environment conducive and happy.
- A constructivist approach supports children's independent thinking and reflection and creativity. Therefore, it becomes the duty of the mathematics teacher to give challenging tasks and assignments to the students and guide the students in solving them. Also, give students opportunities and freedom to ask questions in the classroom.

For school Management

The basic principle of the constructivist approach is that the child constructs new information based on previous knowledge and experience and supports children's in independent thinking. Therefore, the school management should make the internal and external environment of the school suitable for teaching and learning, which will create motivation in the children and encourage them to participate in discussions and learning activities and which will develop scientific attitudes, ideas, experimental processes, discovery, and creativity. In addition, the management should set up a mathematics laboratory and an ICT laboratory in the school and arrange for the use of ICT in teaching and learning.

For curriculum experts

According to constructivism, children construct new information about new things based on their previous knowledge, concepts, and experiences and gain extensive knowledge. In this process, students actively participate through learning activities,

discussions, collaboration, and learning by doing. Curriculum developers are therefore expected to include activities in mathematics textbooks that are based on constructivist principles and ICT.

For teacher training college

It is a fact that the future of education and training of schools is promoted by the education department based in colleges and universities. Therefore, it is important that they should provide such training to the learner that is not only from the theoretical aspects of teaching. Rather, they are well versed in different areas of its practical aspects. Teacher training colleges should acquire skills in the use of ICT and give more priority to the use of ICT.

5.5 Suggestions for further Research

- In the present study, the research work has been carried out by using the 5E model of constructivist approach. 7E Model, ICON Model, and Concept Attainment Model can also be used for further research study.
- In the present study, experimental work has been carried out by mediating ICT with a constructivist approach. For further research, 7E Model, ICON Model, and Concept Attainment Model can study mediating through ICT.
- In the present study, experimental work has been carried out by mediating ICT with a constructivist approach. In which independent variable constructivist approach can be improved children's math achievement by integrating ICT.
- The present study has been done on mathematics subjects, such research can be done on other subjects such as biological sciences, physical sciences, social sciences, etc.

- In the present study, only secondary school students have been included, in such a study the students of primary and upper-primary schools can be included.
- In the present study, only the students of government schools have been included, students of private schools can also be included in the study.
- This study is limited to Darbhanga city; it can be done in schools in other cities.
- This study has been conducted only in Urdu Medium schools. Schools of Hindi, Bangla, English, and other mediums can also be included for further research.
- The present study included only children studying in class IX. For further research, children from other classes can also be included.

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Appendix-I

Formation of Experimental and Control Group on the Basis of T-Scores

Intelligence Classification on the basis of T-Scores

T-Scores Limits	Classification	Frequency
70 and Above	Very Superior	0
63-70	Superior	4
57-63	Bright Average	10
43-57	Average	38
37-43	Dull Average	8
30-37	Inferior	0
30 and Below	Very Inferior	0
Total Students		**60**

Each students Intelligence level

S.No	Gender	Age	Total Score	T_Scores	Interpretation
1	F	14	17	46	Average
2	F	14	28	60	Bright Average
3	F	14	27	58	Bright Average
4	F	15	26	43	Average
5	F	15	20	47	Average
6	F	13	11	40	Dull Average
7	F	14	12	41	Dull Average
8	F	14	35	68	Superior
9	F	15	32	61	Bright Average
10	F	15	18	45	Average
11	F	15	33	61	Bright Average
12	F	15	14	41	Dull Average
13	F	14	15	43	Average
14	F	14	20	51	Average
15	F	15	25	52	Average
16	M	15	19	45	Average

17	M	15	22	50	Average
18	M	15	25	52	Average
19	M	13	36	69	Superior
20	M	15	18	45	Average
21	M	15	23	50	Average
22	M	15	21	47	Average
23	M	14	20	51	Average
24	M	14	20	51	Average
25	M	15	23	50	Average
26	M	15	24	52	Average
27	M	15	24	52	Average
28	M	14	27	58	Bright Average
29	M	14	18	48	Average
30	M	14	32	65	Superior
31	F	15	31	59	Bright Average
32	F	15	22	50	Average
33	F	15	22	50	Average
34	F	15	24	52	Average
35	F	15	27	54	Average
36	F	15	21	47	Average
37	F	14	22	53	Average
38	F	14	27	58	Bright Average
39	F	15	23	50	Average
40	F	14	22	53	Average
41	F	15	19	48	Average
42	F	14	18	48	Average
43	F	15	22	50	Average
44	F	14	20	51	Average
45	F	15	36	59	Bright Average
46	F	15	15	41	Dull Average
47	F	15	13	39	Dull Average
48	M	14	18	48	Average
49	M	14	15	41	Dull Average
50	M	14	33	65	Superior
51	M	14	21	51	Average
52	M	15	17	41	Dull Average
53	M	15	31	59	Bright Average
54	M	15	17	43	Average
55	M	14	22	53	Average

56	M	15	19	45	Average
57	M	14	13	41	Dull Average
58	M	15	19	45	Average
59	M	14	22	53	Average
60	M	14	30	61	Bright Average

Formation of Experimental and Control Groups by using randomization techniques in each category Intelligence

Randomized Group	
Group-1	Group-2
6, 47, 12, 49, 19, 30, 3, 11, 28, 31, 60, 4, 5, 13, 15, 18, 20, 23, 26, 29, 33, 37, 36, 34, 38, 43, 41, 48, 54, 51 Total students =30	7, 46, 52, 57, 8, 50, 2, 9, 38, 45, 53, 1, 10, 14, 16, 17, 21, 22, 24, 25, 27, 32, 35, 39, 44, 42, 56, 58, 59, 40 Total students = 30

Randomized Group	
Group-1	Group-2
Experimental Group	**Control Group**

Appendix-ii
Pre -Test
Mathematics Achievement Test (MAT

Name: ……
Class: ……... Gender: ……
School: ……..
Rural/Urban: …….

وقفہ: 2 گھنٹہ کل نمبرات: 60

ہدایات:

یہ پرچہ سوالات تین حصّوں پر مشتمل ہے حصّہ A، حصّہ B اور حصّہ C

1۔ حصّہ A میں 16 لازمی سوالات ہے جو کہ معروضی سوالات اور خالی جگہ پُر کرنا جو ہر سوال کا جواب لازمی ہے۔ ہر سوال کے لیے 1 نمبر مختص ہے۔ (16 x 1= 16 Marks)

2۔ حصّہ B میں 8 لازمی سوالات ہے جو کہ مختصر سوالات جو ہر سوال کا جواب لازمی ہے۔ ہر سوال کے لیے 3 نمبر مختص ہے۔

(8 x 3= 24 Marks)

3۔ حصّہ C میں 5 لازمی سوالات ہے جو کہ long سوالات ہے جو ہر سوال کا جواب لازمی ہے۔ ہر سوال کے لیے 4 نمبر مختص ہے۔ (5 x 4 = 20 Marks)

Part – A

کل نمبرات = 1 × 16 =16

1۔ لمبائی × چوڑائی کس شکل نما سطح کا رقبہ ہے۔

(a) مثلث (Triangle) (b) مستطیل (Rectangle) (c) مربع (Square) (d) دائرہ (Circle)

2۔ مبدرجہ ذیل میں سے کون سے مساوات میں x کی قدر 5 ہے۔

(a) 5x - 20 = 10

(b) 5x - 10 = 15

(c) 5x - 30 = 30

(d) $4x - 16 = 12$

3۔ دائرہ میں مرکز کا مقام ہوتا ہے۔

(a) دائرہ کے اندر (b) دائرہ کے باہر (c) محیط (Circumference) (d) ان میں سے کوئی نہیں

4۔ مندرجہ ذیل میں سے $3 \times 3 \times 3 \times 3$ کا مختصر شکل ہے۔

(a) 3^5 (b) 3^6 (c) 3^4 (d) 3^0

5۔ مندرجہ ذیل میں 10 کی قوت یا ڈگری (degree) والی دور قمی (Binomial) ہے؟

(a) $10x + 8$ (b) $x^{10} + 8$ (c) $x^2 + 10$ (d) $x^2 - 10$

6۔ 3^5 میں عدد 3 کو کیا کہیں گے؟

(a) Exponent (b) Base (c) Coefficient (d) Variable

7۔ $5x$ میں x کو کہا جاتا ہے۔ ہیں؟

(a) متغیر (Variable) (b) Base (c) معین عدد (Constant) (d) مکمل اعداد (Whole Numbers)

8۔ عددی صفت کو کہا جاتا ہے۔

(a) خام ڈیٹا (Raw Data)

(b) مکمل اعداد (Whole Numbers)

(c) متغیر (Variable)

(d) وسعت (Range)

9۔ اگر ایک $\triangle ABC$ باہمی مثلث (equilateral triangle) ہے تو

(a) $AB = BC = AC$

(b) $AB = BC \neq AC$

(c) $AB \neq BC = AC$

(d) $AB \neq BC \neq AC$

10۔ نقطہ $(0, -4)$ ہو تو گراف پر واقع ہو گا۔

(a) x – axis

(b) Y – axis

(c) x –axis اور y–axis کے درمیان

(d) مبدا (Origin) میں

11۔ دائرہ کے احاطہ یا محیط (circumference) سے لے کر مرکز (Center) کی دوری کو..... کہا جاتا ہے

12۔ کسی بھی دائرہ (circle) کا سب سے بڑا Chord..... کہلاتا ہے۔

13۔ مختص سطح (Coordinate Plane) میں کل ربع (Quadrant)..... ہیں۔

14۔ π کی قیمت ..... ہوتی ہے۔

15۔ مستطیل (Rectangle) کے احاطہ (perimeter) کا ضابطہ.....ہو گا؟

16۔ 2x کو الجبرائی مقدار میں 2 کو x کا ..... کہا جاتا ہے۔

Part – B

کل نمبرات– 3 × 8 =24

17۔ نقطہ (4-, 3) کی دوری معلوم کرو۔

18۔ مندرجہ ذیل نقطوں کو گراف کاغذ پر پلاٹ کرو۔

(5 , 10) , (-7 , 10), (5 , -3) , (2 , 6) , (0 , 3)

19۔ 25xy + 30xyz اجزائے ضربی معلوم کرو۔

20۔ میں نے ایک محلّہ کے 50 خاندانوں کے بچوں کی تعداد کو ذیل میں درج کیا

-

2	3	6	2	0	2	7	8	3	7
2	4	3	3	2	3	5	7	2	4
3	2	4	4	3	4	6	6	4	2
5	5	2	6	4	5	2	1	6	0
4	6	3	1	5	6	3	2	3	1

دیئے گئے دیٹا سے تعددی (Frequency) جدول بناؤ جن کے کلاس وقفہ 0-2، 2-4 ..... وغیرہ ہوں

21۔ کسی دائرہ کا نصف قطر 10cm ہو تو اس کا رقبہ معلوم کریں۔؟

22۔ ایک ہال کی لمبائی 20m اور چوڑائی 10m ہے تو ہال کا رقبہ ہو گا؟

23۔ $(2^2)^2$ اور 2^4 کے درمیان کی قیمت زیادہ ہے؟

24 ۔ مساوات کا حل پزیر ہیں یا نہیں

$$x + y = 2$$
$$5x + 3y = 14$$

Part –ے

کل نمبرات– 4 × 5 =20

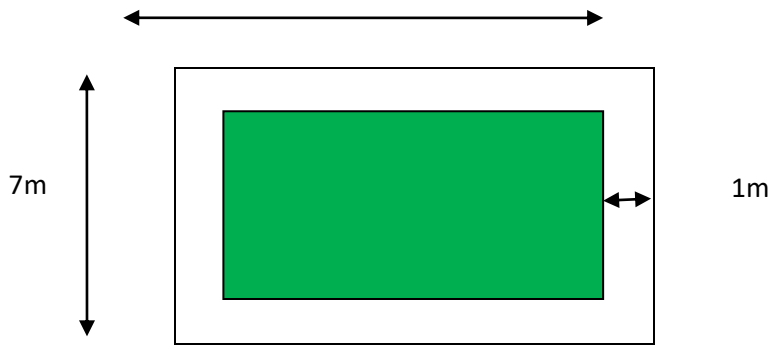
25۔ دائرہ نما کھیل کا میدان کا احاطہ 100m ہے۔اس میدان کا رقبہ کیا ہو گا؟

26۔ $x^2 + 5x + 6$ اجزائے ضربی معلوم کرو۔

27۔ $y = 2x$ مساوات کا گراف تیار کرو۔

28۔ جس دائرہ کا قطر 40cm ہو تو اس دائرہ کا رقبہ کیا ہو گا۔

29۔ تصویر دیکھ کر رنگین حصوں کا رقبہ معلوم کرو۔



Answer Key Answer Key

1	B	7	A	13	4	19	5xy(5 +6z)	25	$795.45m^2$
2	B	8	C	14	3.14 or 22/7	20		26	(x +2)(x +3)
3	A	9	A	15	2(l + b)	21	$314.28cm^2$	27	
4	C	10	10	16	ضریب (Coefficient)	22	$200m^2$	28	$1257.14cm^2$
5	B	11	Radius نصف قطر	17	5unit	23	Equal مساوی	29	$50m^2$
6	A	12	Diameter قطر	18		24	حل پز یر		

Appendix- iii
Post -Test
Mathematics Achievement Test (MAT

Name: ……
Class: …….. Gender: ……
School: ……..
Rural/Urban: …….

وقفہ: 2 گھنٹہ کل نمبرات: 60

ہدایات:

یہ پرچہ سوالات تین حصّوں پر مشتمل ہے حصّہ A، حصّہ Bاور حصّہ C

1۔ حصّہ A میں 16 لازمی سوالات ہے جو کہ معروضی سوالات اور خالی جگہ پُر کرنا جو ہر سوال کا جواب لازمی ہے۔ ہر سوال کے لیے 1 نمبر مختص ہے۔ (16 x 1= 16 Marks)

2۔ حصّہ B میں 8 لازمی سوالات ہے جو کہ مختصر سوالات جو ہر سوال کا جواب لازمی ہے۔ ہر سوال کے لیے 3 نمبر مختص ہے۔

(8 x 3= 24 Marks)

3۔ حصّہ C میں 5 لازمی سوالات ہے جو کہ long سوالات ہے جو ہر سوال کا جواب لازمی ہے۔ ہر سوال کے لیے 4 نمبر مختص ہے۔ (5 x 4 = 20 Marks)

کل نمبرات– 1 × 16 =16

1۔ مستطیل(Rectangle) کے رقبہ کو معلوم کرنے کا فارملا ہے۔

(b) لمبائی+ چوڑائی (b) لمبائی× چوڑائی(c) لمبائی÷ چوڑائی (d) لمبائی× چوڑائی × اونچائی

2۔ مبدرجہ ذیل میں سے کون سی دو متغیرات میں خطی مساوات نہیں ہے۔

(a) $px + qy + c = 0$

$ax^2 + bx + c = 0$ (b)

$3x + 2y = 5$ (c)

$ax^3 + bx + c = 0$ (d)

3۔ کسی بھی دائرہ(circle) کا سب سے بڑا Chord کہلاتا ہے۔

(b) نصف قطر(radius) (b) قطر(diameter) (c) Arch (d) ان میں سے کوئی نہیں (Non of these)

4۔ مندرجہ ذیل میں سے $5 \times 5 \times 5 \times 5 \times 5 \times 5 \times 5 \times 5 \times 5$ کون اس کے برابر ہے۔

$5 \times 5 \times 5 \times 5 \times 5 \times 5 \times 5 \times 5 \times 5 \times 5 \ldots$

5^5 (b) 5^4 (b) 5^9 (c) 9^5 (d)

5۔ کثیر رقمی(polynomial) $x^5 + x^4 + x^3 + 5x^2 + 2x - 3$ کی degree کتنی ہے؟

4 (a) 3 (b) 2 (c) 5 (d)

6۔ 2^6 میں عدد 6 کو کیا کہیں گے؟

Exponent (a) Base (b) Coefficient (c) Variable (d)

7۔ $3x^4 + 5y^3 + 10y^2 - 7$ میں کتنے متغیرات(variables) ہیں؟

4 (b) 3 (b) 2 (c) 5 (d)

8۔ ان میں منفصل متغیر (Discrete Variable) کون سا ہے۔

(e) فیملی میں ممبران کی تعداد

(f) طلباء کا وزن

(g) طلباء کی اونچائی

(h) حرارت

9۔ ان میں سے دوری کا فارمولا کون سا ہے۔

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

(f) $d = \sqrt{(x_2 - x_1)^2 (y_2 - y_1)^2}$

(g) $d = \sqrt{(x_2 - x_1)^2 \div (y_2 - y_1)^2}$

(h) $d = \sqrt{(y-x)^2}$

10۔ مساوات $2x + 3y = 0$ کا گراف

(e) x – axis کے متوازی ہو گا۔

(f) Y – axis کے متوازی ہو گا۔

(g) کسی محور کے متوازی نہیں ہو گا۔

(h) مبدا (Origin) میں ہو گا۔

11۔ دائرہ کے احاطہ یا محیط (circumference) کا ضابطہ..... ہوتا ہے۔

12۔ دائرہ کے رقبہ کا ضابطہ..... ہوتا ہے۔

13۔ مختص سطح (Coordinate Plane) میں کل ربع (Quadrant)..... ہیں۔(Knowledge)

14۔ π کی قیمت (Value)..... ہوتی ہے۔(Knowledge)

15۔ مستطیل (Rectangle) کے احاطہ (perimeter) کا ضابطہ.....ہو گا؟ (Knowledge)

16۔ $x^m \times y^n$ = ...

Part – B

کل نمبرات– $3 \times 8 = 24$

17۔ دوری کے فارمولے کی مدد سے نقطیں (5 , 6) اور (3, 9) کی درمیانی دوری معلوم کرو۔

18۔ مندرجہ ذیل نقطوں کو گراف کاغذ پر پلاٹ کرو۔

(5 ,3) , (−7 , 3), (10 , −3) , (5 , 0) , (−3 , 0)

19۔ $x^2 + 5x + 6$ اجزائے ضربی معلوم کرو۔

20۔ جدولی شکل میں شہروں کے 60 دکانوں کا روزانہ کا منافع لکھا گیا۔

روزانہ کا منافع	0–50	50–100	50–100	150–200	200–250
دکانوں کی تعداد	5	15	12	20	8

مندرجہ بالا کا ایک ہسٹوگرام بناؤ

21۔ دائرہ نما پارک کا نصف قطر 10m ہے۔ اس پارک کا رقبہ کیا ہو گا؟

22۔ ایک کھیت کی لمبائی 12m اور چوڑائی 10m ہے تو ان کا احاطہ ہو گا؟

23۔ $(2^3)^2$ اور 2^{2^3} کے درمیان کو براہے؟

24 ۔ مساوات کا حل پزیر ہیں یا نہیں۔

$$x + y = 20$$

$$10x + 5y = 140$$

Part –C

کل نمبرات– $20 = 5 \times 4$

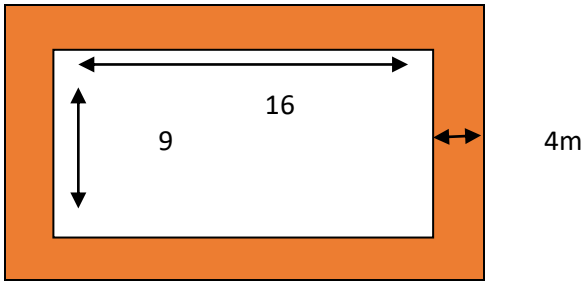
25۔ دائرہ نما پارک کا احاطہ 264m ہے۔ اس پارک کا رقبہ کیا ہو گا؟

26۔ $8a^3 + 8a - 5$ اجزائے ضربی معلوم کرو۔

27۔ $x + y = 20$ مساوات کا گراف تیار کرو۔

28۔ احمد نے 3 میٹر لمبی رسّی سے ایک گھاس کے میدان میں ایک گائے کو باندھ دیا۔ معلوم کرو کہ وہ گائے زیادہ سے زیادہ کتنی زمین کا گھاس کھا سکے گی۔

29۔ تصویر دیکھ کر رنگین حصوں کا رقبہ معلوم کرو۔ .



Answer Key

1	b	7	a	13	4	19	(x+2) (x+3)	25	$5544m^2$
2	d	8	a	14	22/7 or 3.14	20	……	26	(2a-1) $(4a^2+2a+5)$
3	b	9	a	15	2(a+b)	21	$314.28m^2$	27	……
4	c	10	b	16	$x^m y^n$	22	$44m^2$	28	$28m^2$
5	d	11	$2\pi r$	17	5اکائی	23	2^{2^3}	29	$264m^2$
6	a	12	πr^2	18	.....	24	1. x+5 =0 2. 2x-3 =0		

Appendix- iv
Mathematics Achievement Test (MAT)
For previous knowledge

Name: ……
Class: ……... Gender: ……
School: ……..
Rural/Urban: ……

وقفہ: 2 گھنٹہ 30 منٹ　　کل نمبرات: 55

سبھی سوال کے جوات لازمی ہے

1۔ مندرجہ ذیل میں مکمل کعب (Perfect Cube) کون سا ہے؟

(a) 35000　(b) 64000　(c) 18000　(d) 15000

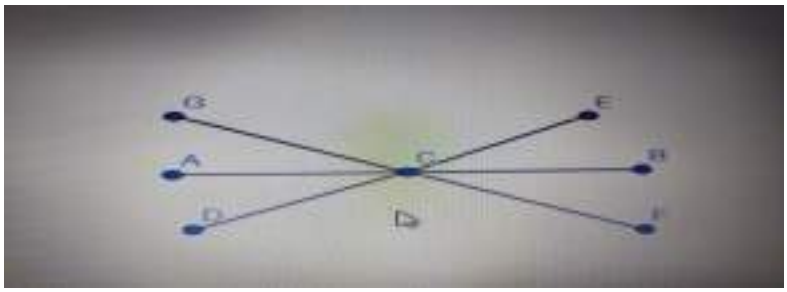
2۔ درج ذیل میں ناطق عدد (Rational Number) کون سا ہے؟

(a) $\frac{17}{2}$　(b) 17　(c) $2a + 1$　(d) -17

3۔ $\frac{3}{4} + \frac{5}{4} + 3\frac{3}{4} + 5\frac{3}{4} = ?$

(a) 26　(b) 25　(c) $\frac{23}{2}$　(d) $\frac{4}{5}$

4۔ درج ذیل تصویر میں زاویہ DCF کی قدر کیا ہوگی اگر زاویہ $ACG = 40^0$ اور $BCE = 30^0$ ہوں۔



(a) 120^0　(b) 110^0　(c) 100^0　(d) 140^0

5۔ احمد کسی کام کو 3 گھنٹے میں کرتا ہے۔ عالم اسی کام کو 6 گھنٹے میں کرتا ہے تو دونوں مل کر اس کام کو کتنے دیر میں پورا کریں گا۔

(a) 2 گھنٹے　(b) 3 گھنٹے　(c) 4 گھنٹے　(d) 5 گھنٹے

6۔ x کے تین گنا میں سے 10 تفریق (گھٹانے) کرنے پر 35 حاصل ہو تو مساوات equation کیا ہو گی؟

(a) $3x - 10 = 35$ (b) $3x - 35 = 10$ (c) $10 - 3x = 35$ (d) $12 - 4x = 20$

7۔ اگر $2x / (7x - 16) = 2$ تو مساوات کا حل کیا ہو گا؟

(a) $x = -16/3$ (b) $x = 16/3$ (c) $x = -16$ (d) $x = 16$

8۔ چار ہندسی پر مشتمل چھوٹی سے چھوٹی عدد بتائیں جو کامل مربع (perfect square) ہے۔

(a) 1024 (b) 1125 (c) 1009 (d) 10000

9۔ $4(x - 3) + 12 = 15 - 5(x + 6)$ ہے تو x کی قیمت کیا ہو گی؟

(a) $X = -3/5$ (b) $x = 5/3$ (c) $x = -5/3$ (d) $x = 10/3$

10۔ کثیر رقمی (polynomial) $x^4 + x^3 + 5x^2 + 2x - 3$ کی degree کتنی ہے؟

(a) 4 (b) 3 (c) 2 (d) 1

11۔ 3^6 میں عدد 6 کو کیا کہیں گے؟

(a) Exponent (b) Base (c) Coefficient (d) Variable

12۔ $(1^3 + 2^3 + 3^3)^2$ کی قدر برابر ہے۔

(a) 1296 (b) 1496 (c) 1396 (d) 1196

13۔ $m(n + p)$ برابر ہے۔

(a) $n \times m + m + p$ (b) $m \times n + m \times p$ (c) $m + n \times p$ (d) $n \times m + p$

14۔ اگر $x^2 + 4x + 2$ کو $(x + 1)$ سے تقسیم کریں تو حاصل تقسیم (quotient) کیا ہو گا؟

(a) $x + 1$ (b) $x + 3$ (c) $x + 2$ (d) $x - 2$

15۔ اگر t کا جذر المکعب (Cube root) s ہو تو اسے ذیل میں سے کس طرح ظاہر کر سکتے ہیں۔

(a) $t = s^3$ (b) $s = t^3$ (c) $t = s/3$ (d) $s = t/3$

16۔ $\square = \frac{5}{2} \times \frac{7}{8} + \frac{5}{2} \times \frac{11}{12}$ میں خالی جگہ میں کیا ہو گا۔

(a) 4.479 (b) 5.255 (c) 4.588 (d) 4.479

17۔ دو ناطق اعداد کا جمع کرنے پر۔۔۔۔۔۔۔۔۔۔۔۔ حاصل شدہ عدد ہوتی ہے۔

(a) جفت عدد (b) ناطق عدد (c) طاق عدد (d) جمع عدد

18۔ کسی کھیت میں 18 لوگ ہل چلاتے ہیں تو 12 ایکڑ زمین جوت پاتے ہے۔ اگر 30 لوگ اسی کھیت میں ہل چلاتے ہیں تو کتنا زمین جوت پائے گا۔

(a) 30 ایکڑ (b) 20 ایکڑ (c) 25 ایکڑ (d) 15 ایکڑ

19۔ کیا مرکب کے لئے صیح تناسب لازمی ہے۔

(a) ہاں ہمیشہ (b) کبھی نہیں (c) کبھی کبھی (d) ان میں سے کوئی نہیں

20۔ فی صد (٪) ہمیشہ ہوتا ہے۔

(a) 100 میں (b) 200 میں (c) 300 میں (d) 500 میں

21۔ آسام چائے اور دار جلنگ چائے کا تناسب 2 : 3 ہو تو 25 گرام چائے میں آسام چائے اور دار جلنگ چائے کتنا ہو گا۔

(a) 15gm اور 10gm (b) 20gm اور 5gm (c) 12gm اور 13gm (d) 16gm اور 9gm

22۔ کسی گاؤں میں 15 دن میں 3 کیلو میٹر کی سڑک تعمیر ہوا ہے تو 8 کیلو میٹر سڑک بنانے میں کتنے دن لگیگا؟

(a) 35 دن (b) 30 دن (c) 20 دن (d) 40 دن

23۔ $5/3 = (y + 7)/(2 - y)$ ہے تو y کی قیمت کیا ہو گی؟

(a) $-11/8$ (b) $-17/8$ (c) $8/11$ (d) $9/11$

24۔ 1225 کا ٪ 35 کتنا ہو گا؟

(a) 428 (b) 428.75 (c) 427.75 (d) 426.75

25۔ 640 روپیے احمد اور پروین کے درمیان میں 3 : 5 کے تناسب میں تقسیم کیا گیا تو دونوں کو کتنا روپیہ ملے گا؟

(a) 400 اور 240 روپیے (b) 300 اور 340 روپیے (c) 500 اور 140 روپیے (d) 200 اور 440 روپیے

26۔ وہ چھوٹی سے چھوٹی عدد بتایں جس کو 90 سے ضرب کرنے پر ایک perfect square بن جاے۔

(a) 12 (b) 10 (c) 6 (d) 11

27۔ مستطیل نما میدان کی لمبائی 80m اور چوڑائی 60m ہے۔ اس میدان کے کنارے سے ایک چکر لگانے میں کتنا راستہ طے ہو گا؟

(a) 290m (b) 300m (c) 280m (d) 250m

28۔ راغب 4000 روپیے لے کر کپڑا اور جوتے خریدنے بازار جاتا ہے، اور جملہ روپے کا ٪ 60 خرچ کرتا ہے تو بتاؤ کہ اس نے کل کتنا روپے خرچ کیے؟

(a) 2500 روپے (b) 2600 روپے (c) 2800 روپے (d) 2400 روپے

29۔ 1، 4، 16 . . . . . ایسے اعداد کو کہا جاتا ہے ہے۔

(a) مربع (Square) (b) مکعب (Cube) (c) Prime Number (d) طاق عداد

30۔ $(64m^2 - 100n^2)$ کا جزو ضربی (factor) درج ذیل میں سے کون سا ہے؟

(a) $(8m - 10n)(8m - 10n)$ (b) $(8m + 10n)(8m - 10n)$

(c) $(8m + 10n)(8m + 10n)$ (d) $(8m + 10n)$

31۔ اگر ایک مربع کی ضلع a cm ہے تو اس کا احاطہ کیا ہو گا ہے؟

(a) 4a cm (b) 2a cm (c) 6a cm (d) 3a cm

32۔ جاپان سے ایک مشین لانے پر ٪ 120 ٹیکس دینا پڑتا ہے اگر مشین کی قیمت 200000 روپیہ ہو تو ٹیکس دینے کے بعد مشین کا اب کل دام کتنا ہو گا؟

(a) 800000 (b) 440000 (c) 500000 (d) 200000

33۔ $x2 + 7x - 18$ کا جزو ضربی (Factor) ہے۔

(a) $(x + 9)(x - 2)$ (b) $(x - 9)(x - 2)$ (c) $(x + 9)(x+2)$ (d) $(x - 9)(x - 2)$

34۔ مستطیل کے احاطے کا فارملا ہوتا ہے؟

(a) $2(l + b)$ (b) $4(l+ b)$ (c) $2lb$ (d) $l + b$

35۔ 1، 8، 20، 16، 64، 125، 120 ان میں سے کون سی اعداد جزر الکعب (Cube Root) ہیں؟

(a) 1، 20، 120 (b) 1، 8، 16، 64، 125 (c) 1، 20، 120 (d) 64، 120، 20

36۔ $x^2 + 5x^3 + 7x + 2 + 5x^4$ کثیر رقمی (polynomial) کا معیاری شکل (standard form) ہے۔

(a) $2 + 7x + 5x^3 + x^2 + 5x^4$ (b) $2 + x^2 + 7x + 5x^4 + 5x^3$

(b) $5x^4 + 5x^3 + x^2 + 7x + 2$ (d) $5x^5 + 4x^3 + 10$

37۔ اگر $4x^2 + 5x + 3$ کو $x + 1$ سے تقسیم کریں تو remainder کیا ہو گا؟

(a) 3 (b) 2 (c) 1 (d) 0

38۔ 1، 8، 27، 64، 81، 125 ..... ایسے عداد کو کہا جاتا ہے۔

(a) مربع (Square) (b) مکعب (Cube) (c) Prime Number (d) طاق عداد

39۔ وہ چھوٹی سے چھوٹی عدد بتائیں جس سے 625000 کو تقسیم کرنے پر perfect cube بن جائے۔

(a) 36 (b) 30 (c) 16 (d) 5

40۔ وہ چھوٹی سے چھوٹی عدد بتائیں جس کو 202 میں جمع کرنے پر perfect cubes حاصل ہوتا ہے۔

(a) 14 (b) 20 (c) 180 (d) 190

41۔ 0.05 کا مکعب cube کتنا ہو گا؟

(a) 0.00000125 (b) 0.00125 (c) 0.0000125 (d) 0.000125

42۔ اگر کسی مربع اور مستطیل کا احاطہ برابر ہو اور ان کا رقبہ بالترتیب P اور R ہو تو درج ذیل میں سے کیا صحیح ہو گا؟

(a) P<R (b) P>R (c) P=R (d) P + R

43۔ ان میں سے کون متمم زاویوں (complementary angle) کا جوڑا ہے؟

(a) $45^0, 90^0$ (b) $30^0, 60^0$ (c) $50^0, 90^0$ (d) $120^0, 60^0$

44۔ $a^2 - b^2$ ذیل میں سے کس کے برابر ہے۔

(a) $(a-b)(a-b)$ (b) $a^2 + ab + b^2$ (c) $a^2 - ab + b^2$ (d) $(a-b)(a+b)$

45۔ $3ab, 9a^2c$ اور $12a^2c^2$ کا L.C.M کتنا ہو گا؟

(a) $30a^3bc^2$ (b) $36a^3bc^3$ (c) $12\ a^3bc^3$ (d) 36abc

46۔ ایسے دو زاویہ جن کا جمع 180^0 یا دو زاویہ قائمہ (right angle) ہونے سے ایک زاویہ کو دوسرے زاویہ کا..... کہتے ہیں۔

(a) متمم زاویہ (complementary angle) (b) ضمنی زاویہ (supplementary angle)

(c) متصل زاویہ (adjacent angle) (d) صفر زاویہ

47۔ $(a+b)^2 - 2ab$ مندرجہ ذیل میں سے کس کے برابر ہے؟

(a) $a^3 + b^3$ (b) $a^2 + b^2$ (c) $(a+b)(a+b)$ (d) $a^2 + 2ab + b^2$

48۔ $2a^2b, 4ab^2$ اور $6a^2b^2$ کا H.C.F دریافت کرو۔

48ab (d)　　8ab (c)　　3ab (b)　　2ab　　(a)

49۔ ایک مربع نما میدان کی لمبائی 80 m ہے۔ اس میدان کے چاروں طرف تار کا احاطہ لگانے کے لیے کتنے لمبے تار کی ضرورت ہو گی؟

340m (d)　　320m (c)　　300m　(b)　　330m　(a)

50۔ ایک مربع نما دیوار کا رقبہ $1600cm^2$ ہے اگر دیوار کو رنگنے میں فی مربع سینٹی میٹر 1 روپیہ خرچ ہوتا ہے تو پوری دیوار کو رنگ کرنے میں کل کتنا خرچ ہو گا؟

(a) 1800 روپے　　(b) 1600 روپے　　(c) 1700 روپے　　(d) 1500 روپے

Answer Sheets

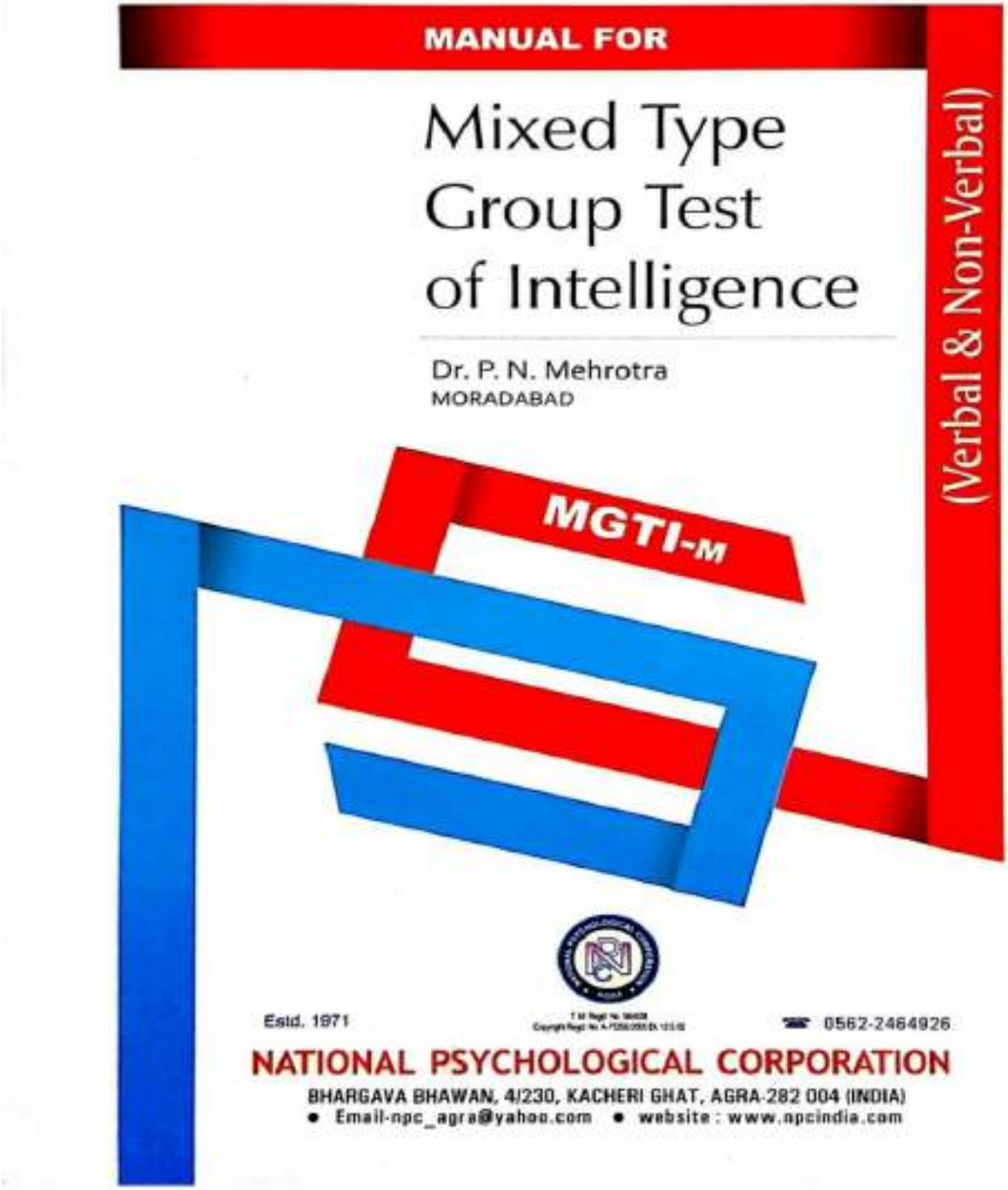
Name: ……
Class: ……... Gender: ……
School: ……..
Rural/Urban: …….

1		16		31		46	
2		17		32		47	
3		18		33		48	
4		19		34		49	
5		20		35		50	
6		21		36			
7		22		37			
8		23		38			
9		24		39			
10		25		40			
11		26		41			
12		27		42			
13		28		43			
14		29		44			
15		30		45			

Answer key

1	B	16	A	31	A	46	B
2	B	17	B	32	B	47	B
3	C	18	B	33	A	48	A
4	B	19	B	34	A	49	C
5	A	20	A	35	B	50	B
6	A	21	A	36	C		
7	B	22	D	37	B		
8	A	23	A	38	B		
9	B	24	B	39	D		
10	C	25		40	A		
11	A	26	B	41	D		
12	A	27	C	42	B		
13	B	28	D	43	D		
14	B	29	A	44	D		
15	A	30	B	45	C		

Appendix- v


MANUAL FOR
Mixed Type Group Test of Intelligence
(Verbal & Non-Verbal)
Dr. P. N. Mehrotra
MORADABAD
MGTI-M
Estd. 1971
0562-2464926
NATIONAL PSYCHOLOGICAL CORPORATION
BHARGAVA BHAWAN, 4/230, KACHERI GHAT, AGRA-282 004 (INDIA)
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VERBAL TEST
शाब्दिक परीक्षा

Please do not turn the page untill you are told to do.
जब तक कहा न जाये पन्ना मत पलटिये

Answer Sheets

Name: ……

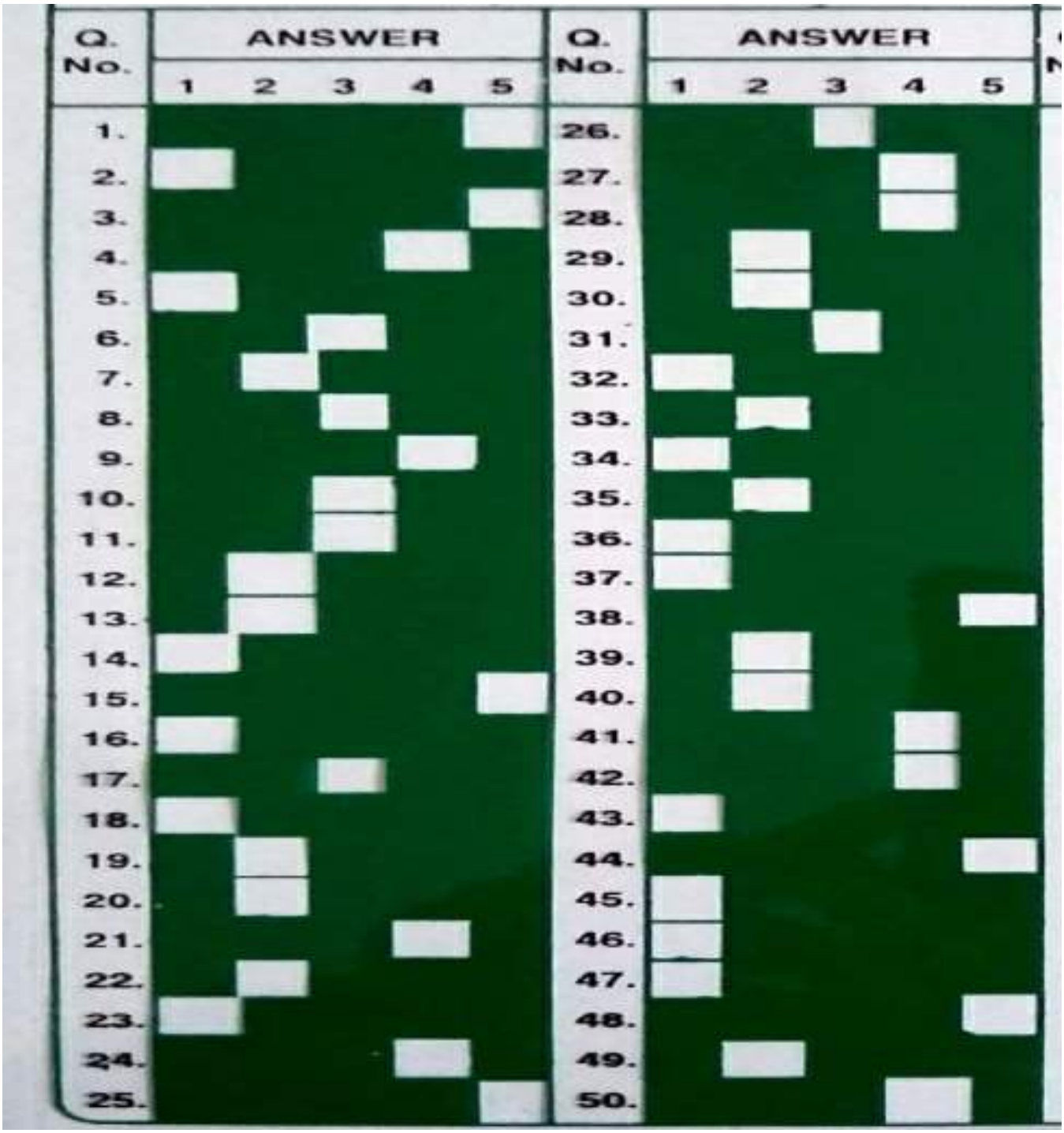
Class: ……. Gender: …… Age: ……

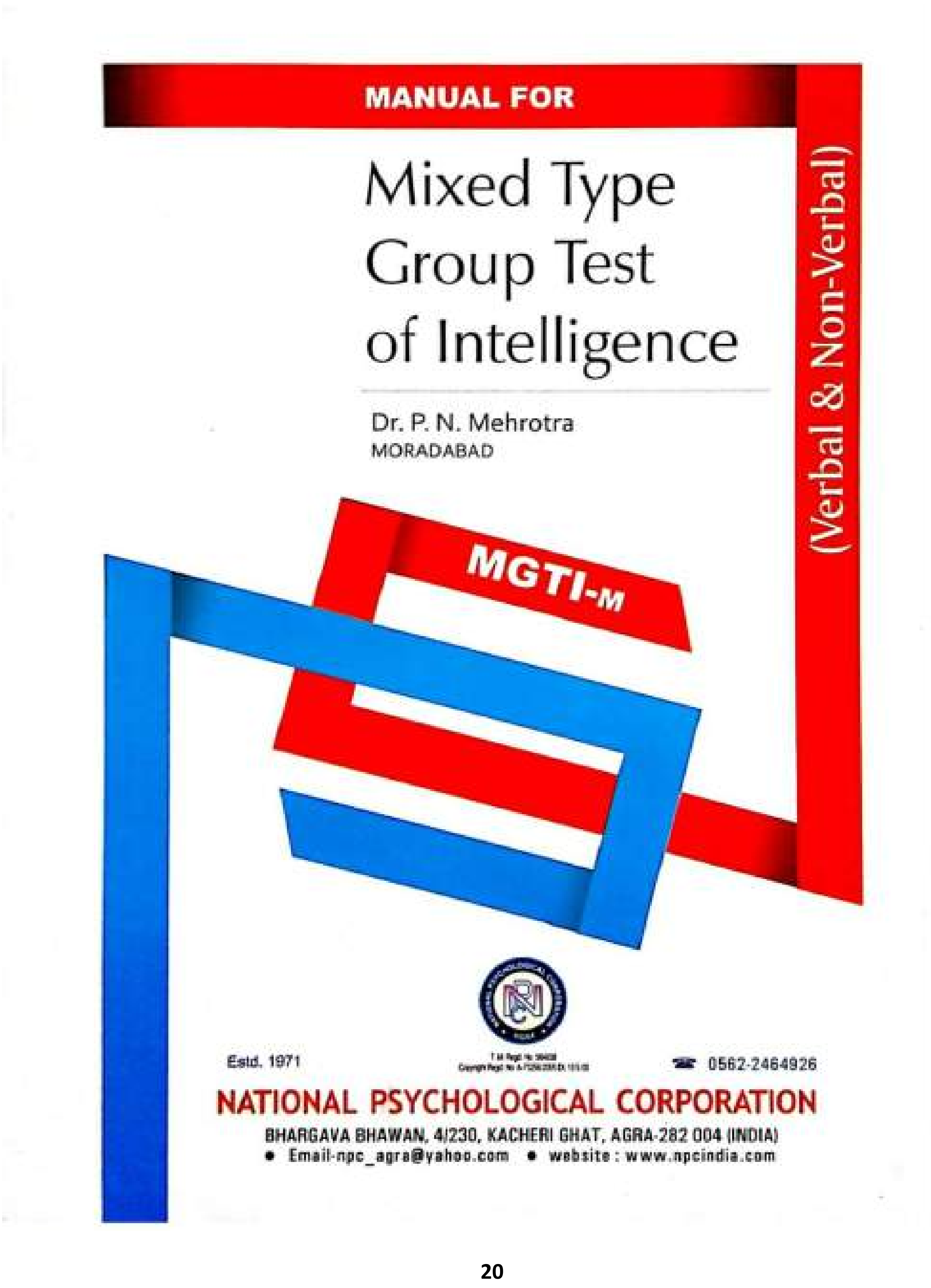
School: ……..

Rural/Urban: ……Parents Qualifications: ……

Parents Occupation: ……..

Q.No	1	2	3	4	5	Q. No	1	2	3	4	5
1						26					
2						27					
3						28					
4						29					
5						30					
6						31					
7						32					
8						33					
9						34					
10						35					
11						36					
12						37					
13						38					
14						39					
15						40					
16						41					
17						42					
18						43					
19						44					
20						45					
21						46					
22						47					
23						48					
24						49					
25						50					

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VERBAL TEST
शाब्दिक परीक्षा

32/57

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जब तक कहा न जाये पन्ना मत पलटिये

حرفی ذہانت جانچ

1

پانچ پیسے	دس پیسے	پچیس پیسے	پچاس پیسے	روپیہ
1	2	3	4	5

2

اگر کرکٹ کا کھیل فٹ بال سے مہنگاں ہے اور فٹ بال کھیل ہاکی کے کھیل سے مہنگاں ہے تو بتاؤ کہ سب سے مہنگاں کھیل کون سا ہے؟

کرکٹ	فٹ بال	ہاکی
1	2	3

3

کانپور	الہ آباد	وارانسی	آگرا	پنجاب
1	2	3	4	5

4

صحت مند:	ذہانت	لمبا	وزنی	بیمار	دولت مند
	1	2	3	4	5

5

شری رام اپنے بیٹے کمار سے زیادہ چالاک ہے۔ بیٹی رما اپنی ماں ریکھا کی بہ نسبت کند ذہن ہے۔ شری رام شری متی ریکھا کی بہ نسبت زیادہ چالاک ہے تو بتاؤ کہ ان سب سے زیادہ چالاک کون ہے؟

شری رام	کمار	رما	ریکھا
1	2	3	4

6

گیہوں	مکئی یا مکا	چینی	بازرا	چنا
1	2	3	4	5

7

پیاش: پانی:: بھوک:	چائے	کھانا	انڈا	دودھ	مکھن
	1	2	3	4	5

8

آم	سیب	ٹماٹر	انار	سنترا
1	2	3	4	5

9

گیس لائیٹ موم بتی کے روشنی سے تیز ہوتا ہے اور برقی (electric light) کے روشنی سے دھیما ہے۔ برقی روشنی سورج کے روشنی سے کم ہوتا ہے اور سورج کا روشنی چاند کے روشنی سے زیادہ ہوتا ہے تو بتاؤ کہ سب سے تیز روشنی کس کا ہوتا ہے؟

گیس کی روشنی	موم بتی کی روشنی	برقی کی روشنی	سورج کی روشنی	چاند کی روشنی
1	2	3	4	5

10

رام گنگا	گوداوری	سمندر	یمونا	برہم پترا
1	2	3	4	5

11

سشیل سے پہلے سنیل پیدا ہوا، سنیل سے پہلے سوبھاس پیدا ہوا تو بتاؤ کہ عمر میں کون سب سے بڑا ہے۔

سشیل	سنیل	سوبھاش
1	2	3

12

بھتیجا: چاچا:: بھانجا	سالا	ماما	چاچا	پھوپھا	بھائی
	1	2	3	4	5

13

کتّا	کبوتر	شیر	گھوڑا ہیرن	
1	2	3	4	5

14

تامبا چاندی سے بھاڑی ہے۔ چاندی سونے سے ہلکی ہے۔ لوہا سونے سے بھاڑی ہے۔ بتاؤ سب سے ہلکا کیا ہے؟

چاندی	سونا	تامبا	لوہا
1	2	3	4

15	کامراج	نہرو	گاندھی	نندا	کلجلنا .
	1	2	3	4	5

16	کمزور:	طاقت	غریب	بیوقوف	کام چور	ناکارہ
		1	2	3	4	5

17	رونا: دکھ: : ہنسنا	کامیاب	شادی	خوشی	پیشہ	بچّہ
		1	2	3	4	5

18	گانا	ہارمونیم	بانسوری	ستار	سارنگی
	1	2	3	4	5

19	بہادر:	عقل مند	ڈرپوک	غریب	شرارتی	بیوقوف
		1	2	3	4	5

20	بھارت	اترپردیش	پاکستان	روس	امریکہ
	1	2	3	4	5

21	روشنی:	رات	دن	آسمان	اندھیرا	چاند
		1	2	3	4	5

22	2، 4،	6،	8،	10 :	11	12	14 ،	16، 15،
					1	2	3	4 5

23

رمہ پدمہ سے تیز دوڑتی ہے اور پدمہ نیر ملہ سے تیز دوڑتی ہے تو بتاؤ کی کون سب سے تیز دوڑتی ہے؟

رمہ	پدمہ	نیر ملہ
1	2	3

24

پنکج:	گلاب	پون	پشپ	نیر مل	کمل
	1	2	3	4	5

25

13،	3،	14،	4 ،	15 :	4،	3،	10،	6،	5
					1	2	3	4	5

26

رام، موہن، سوہن، گنیش، کیلاش پانچ طلباء ہے۔ رام سائنس، ریاضی اور کلا پڑھتا ہے، موہن اور گنیش سائنس، ریاضی اور جغرافی پڑھتے ہیں۔ سوہن تاریخ، کلا اور جغرافی پڑھتا ہے اور کیلاش تاریخ، ریاضی اور جغرافی پڑھتا ہے تو بتاؤ کہ ایسا کون لڑکا ہے جو کلا تو پڑھتا ہے لیکن سائنس نہیں پڑھتا؟

رام	موہن	سوہن	گنیش	کیلاش
1	2	3	4	5

27

تکرار:	جھگڑا	مارنا	لڑنا	بحث	رونا
	1	2	3	4	5

28

بے توف: غفلت:: عقل مند:	تنقید	کھوج	فلسفہ	تعریف	دکھ
	1	2	3	4	5

29

-10,	-20,	-40,	-80,	-160 :	-2,	-5,	-4,	-1,	-9,
					1	2	3	4	5

30	جدید:	آزاد	قدیم	نیا	فیشن	امریکن
		1	2	3	4	5

31	دن : رات:: صبح:	دوپہر	چلنا	شام	سورج	پڑھنا
		1	2	3	4	5

32	خوشی:	مسرّت	مہربانی	عزّت	غصّہ	محبّت
		1	2	3	4	5

33	مچھلی: تیرنا: : جہاز:	پانی	اڑنا	لڑنا	مہنگا	سفر
		1	2	3	4	5

34	فرمان:	حکم	تبلیغ	درخواست	پیغام	صلاح
		1	2	3	4	5

35	15،20،25،30،35 :	5،	10 ،	15 ،	20،	25
		1	2	3	4	5

36	دن: ہفتہ: : مہینہ:	سال	جنوری	منگل	مستقبل	بارہ
		1	2	3	4	5

37	90، 45،	42 ،	21،	18 :	9،	7،	11،	13 ،	10
					1	2	3	4	5

38

تصویر: پنسل: : پینٹینگ: رنگ وارنش حسرتیہ ٹ کاری نقاشی برش

1 2 3 4 5

39

3، 9، 15، 21 ، 27: 30، 33 ، 36 ، 39، 42

1 2 3 4 5

40

ھری کا نام ہریش کے نام سے پہلے آتا ہے، ھری کا نام گوپال کے بعد آتا ہے، تو بتاؤ کہ سب سے بعد میں کس کا نام آتا ہے؟

ھری ھریش گوپال

1 2 3

41

غصّہ: دشمن: : پیار: ماں دشمن لڑکا دوست استاد

1 2 3 4 5

42

0 ، 10، 19، 27 ، 34: 41، 45 ، 43 ، 40، 46

1 2 3 4 5

43

غریب امیر دولت مند کسمپرسی کروڑپتی

1 2 3 4 5

44

25، 24، 23، 24، 23 : 21 ، 20، 25 ، 26، 22

1 2 3 4 5

45

ھری، موہن، سوہن، کرشنا اور وینوڈ پانچ لڑکے ہیں۔ ھری، موہن سے لمبا ہے۔ سوہن کرشنا سے چھوٹا ہے۔ ھری وینوڈ سے چوٹا ہے۔ موہن کرشنا سے لمبا ہے تو بتاؤ کہ سب سے لمبے کو چھوڑ کر باقی میں سب سے لمبا کون ہے؟

ھری	کرشنا	وینوڈ	موہن	سوہن
1	2	3	4	5

46

تعلیم یافتہ: غیر تعلیم یافتہ: : عقل مند:	بے قوف	ہوشیار	دانش	پاگل	امیر
	1	2	3	4	5

47

رمیش اپنے گھر سے ایکٹ کی طرف تین میل گیا۔ پھر پورب کی طرف تین میل چلا اور ا اپنے دفتر پہونچ گیا۔ سوریش اپنے گھر سے تین میل مغرب کی طرف چلا اور پھر تین میل ایکٹ کی طرف چلنے پر اسی دفتر میں پہونچ گیا تو بتاؤ کہ سوریش کا مکان رمیش کے مکان سے کس سمت میں ہے۔

پورب	مغرب	ایکٹ	دکھن
1	2	3	4

48

30،	24،	19،	15،	12 :	13	14،	،	15	11،	10،
					1	2		3	4	5

49

تیر شنا:	لالچ	پیاس	چاہ	تجسس	غصّہ
	1	2	3	4	5

50

3،	6 ،	30	15،	30، :	120	100،	90،	150	180،
					1	2	3	4	5

Answer Sheets

Name: ……

Class: ……. Gender: …… Age: ……

School: ……..

Rural/Urban: ……Parents Qualifications: ……

Parents Occupation: ……..

Q.No	1	2	3	4	5	Q. No	1	2	3	4	5
1						26					
2						27					
3						28					
4						29					
5						30					
6						31					
7						32					
8						33					
9						34					
10						35					
11						36					
12						37					
13						38					
14						39					
15						40					
16						41					
17						42					
18						43					
19						44					
20						45					
21						46					
22						47					
23						48					
24						49					
25						50					

Appendix-vi

ICT Mediated Constructivist Teaching Approach – 5 E Based Lesson Plan

آئی سی ٹی ثالثی تعمیراتی اکتسابی طرز رسائی- 5E پر مبنی منصوبہ سبق

منصوبہ سبق (Lesson Plan)- 1		
درجہ / گریڈ / سکشن	:	IX
موضوع	:	ریاضی
عنوان	:	گراف
ذیلی عنوان	:	ربع دائرہ کا تصور
وقفہ	:	40منٹ
ہدایتی مقاصد(Instructional Objectives)		
1. طلبا کو کارٹیسی نظام سے متعلق معلومات فراہم کرنا۔ 2. طلبا کو کارٹیسی سطح یا مختص سطح کے بارے میں معلومات فراہم کرنا۔ 3. طولی مختص اور ارضی مختص سے متعلق تفہیم پیدا کرنا۔ 4. کارٹیسی سطح کے ربع اور مرکز سے واقفیت کرانا۔ 5. گراف کاغذ میں کسی بھی نقطہ کو پلاٹ کرنے کے طریقہ سے واقفیت کرانا۔		
آموزشی ماحصل (Learning Outcomes)		

اس سبق کی آموزش کے بعد طلباٗ اس لائق ہو جایئں گے کہ وہ۔۔۔۔

1. مختص سطح کو اپنے الفاظ میں بیان کر سکیں۔
2. طولی مختص اور ارضی مختص کے تصور کو بیان کر سکیں۔
3. کسی بھی مختص سطح کے ربع اور مرکز کی سناخت تشکیل کر سکیں۔
4. کسی بھی نقطہ کو گراف کاغذ پر پلاٹنگ کر سکیں۔

ماقبل مطالبات (Prerequisite)

تصوراتی علم (Previous Learning Experience)

طلباء کو نقطہ، خط، عمودی خطوط کی معلومات ہونی چاہیے۔

زبان کی معلومات (Language Background)

طلباء کو اردو زبان بولنے، پڑھنے اور لکھنے کی مہارت ہونی چاہیے۔

ٹکنالوجی کی معلومات (Technological Knowledge Background)

طلباء کو بنیادی کمپیوٹر کی مہارت ہونی چاہیے۔ کی بورڈ اور ماؤس (Mouse) کا استعمال کرنا آنا چاہیے۔ کٹ، کوپی، اور پیسٹ کمانڈ، انٹرنیٹ براوزنگ آنی چاہیے۔

دستیاب وسائل اور تدریسی اشیاء s Available Resources and Teaching Aid

ٹکنالوجی–ہاڈویئر

■	لیپ ٹاپ	■	پروجیکشن سکرین	☐	موبائل
☐	پرنٹر	☐	کیمرا	☐	ویڈیو کیمرہ
☐	اسکینر	☐	ڈی وی دی پلیئر	☐	لیزر ڈسک
■	پروجیکٹر	☐	کمپیوٹر	☐	USB & Pen Drive
■	پین ٹیبلیٹ	■	اسپیکر		

ٹکنالوجی– سافٹ ویئر

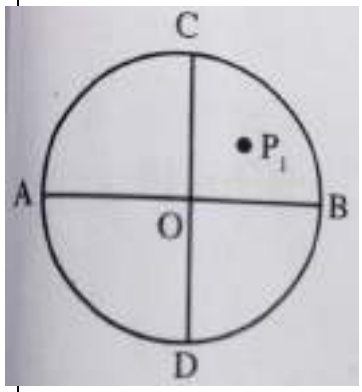
☐	پاور پوائنٹ	☐	WhatsApp	☐	Cabri 3D
■	یوٹیوب	☐	Geometry Pad	☐	Scientific Workplace 5.5
■	متحرک ویڈیو	☐	Microsoft Mathematics	☐	Robocompass
☐	Goegebra	☐	Math Blaster	☐	Mindmaster

Printed Materials

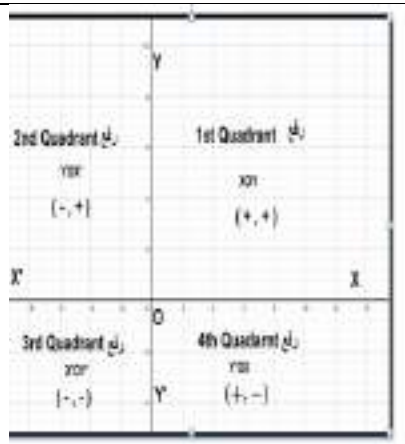
گراف کاغذ، درسی کتاب

OERs

https://www.youtube.com/watch?v=0orIA1FX2U0
https://www.youtube.com/watch?v=hAJxMawR-Do
https://www.youtube.com/watch?v=09d0JFeeamE&feature=youtu.be

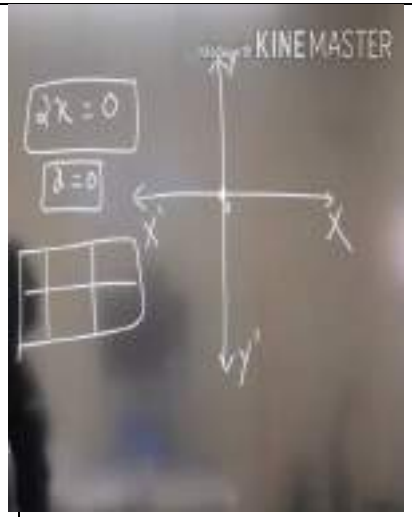
ہدایتی مراحل Instructional Procedure					
Topic عنوان	Engagement مشغولیت	Exploration تفتیش	Explanation تشریح	Elaboration تفصیل	Evaluation تعین قدر
Set Induction	کھیل کے میدان میں کھیل رہے تمام طلبا میں سے کسی ایک طالب علم مثلا حامد کا صحیح مقام کس طرح معلوم کریں گے؟ معلم اس سوال کے ذریعے تمام طلبا کو سبق کے طرف راغب کریگا۔ جسے ذیل کے شکل سے بھی مشاہدہ کیا جاسکتا ہے۔	طلبا شکل کو بغور مشاہدہ کریں گے اور کھیل کے میدان میں حامد کا صحیح مقام کو معلوم کرنے کی کوشش کریں گے۔	معلم طلبا کے کاموں کا مشاہدہ کرنے کے بعد ان کو عمودی خطوط اور مرکز کے بارے میں بتائیں گے۔ 	طلبا اپنی کاپی میں کھیل کے میدان کی شکل بنائیں گے اور دو عمودی خطوط اور مرکز کی نشاندہی کریں گے۔	معلم طلبا کو ان کی سابقہ معلومات اور دی گئی ہدایات کے مطابق سمجھنے کی کوشش کریں گے۔

					
ربع دائرہ کا تصور Concept of	معلم طلبا کے سامنے ربع دائرہ یعنی quadrant کا تصّور کوواضح کرنے کے لئے پروجیکٹر کے ذریعے تصویر اور Video دکھائے گا۔	طلبا پیش کی گی شکل کو غور سے مشاہدہ کریں گے اور اس ربع کی خصوصیات کو سمجھنے کی کوشش کریں گے۔	دیے گیے شکل میں OX اور OY کا سمت مثبت ہوتا ہے اور 'OX اور 'OY کا سمت منفی کہلاتا ہے۔جبکہ زاویہ XOY کے احاطہ کے درمیانی حصہ پہلا رفع (1st Quadrant) کہلاتا ہے۔ X'OY زاویہ کے درمیانی حصہ	طلبا ویڈیو یا تصویر کو دیکھنے کے بعد مندرجہ ذیل قسم کے سوالات کو تفصیل سے بیان کرنے کے قابل ہوجائے ینگے۔ 1. کسی بھی سطح میں کتنے ربع ہوسکتا ہے؟	ایک مختص سطح (coordinate plane) quadrant ہوتے ہیں؟ Abscissa اور Ordinate سے کیا مراد ہے۔؟

	2. کسی بھی سطح کا مرکز سے کیا مراد ہے؟ 3. X-axis اور Y-axis کے سمت کیسے تعین کیا جاتا ہے؟	دوسرا رفع (2nd quadrant) کہلاتا ہے۔ زاویہ X'OY' کے درمیانی حصہ تیسرا ربع (3rd quadrant) کہلاتا ہے۔ جبکہ زاویہ XOY' کے درمیانی حصہ چھوتھا ربع (4th quadrant) کہلاتا ہے۔ ہم اس سطح کو کارٹیسی سطح (Cartesion Plane) یا مختص سطح (Coordinate plane) کہتے ہیں۔ O کو مبدا (Origin) کہا جاتا			Quadrant

		ہے۔ x- axis کے ہمراہ کے y- axis سے کسی نقطہ کی عمودی دوری اس نقطہ کا x– مختص (x- coordinate) یا طولی مختص (Abscissa) کہلاتی ہے۔ x-axis کے ہمراہ y-axis سے کسی نقطہ کی عمودی اس نقطہ کا y– مختص (y-coodinate) یا ارضی مختص (ordinate) کہلاتی ہے۔			

			پہلا ربع (+ , +)ہوتا ہے۔ دوسرا ربع (+ , -)ہوتا ہے۔ تیسرا ربع (- , -)ہوتا ہے۔ چوتھا ربع (- ,+)ہوتا ہے۔		
گراف کاغذ پر نقطوں کو پلاٹ کرنے کا طریقہ Plotting of Points on graph paper	معلم گراف کاغذ میں کسی بھی نقطہ کو پلاٹ کرنے کا طریقہ سے منسلک ایک ویڈیو کلپ دیکھائیگا۔	طلبا وڈیو کلپ غور سے سنے گا اور اہم نکات کو اپنے کاپی میں اتارے گا۔	سب سے پہلے گراف کاغذ میں دو عمودی خطوط XX' اور YY' کھینچا جائیگا جو O مرکز پر قطع کرتا ہے۔ اس کے بعد گراف کے ایک چھوٹے مربع کے ایک ضلع کی لمبائی ایک اکائی فرض کر لیا جاتا ہے۔ پھر دیے گیے نقطہ کی	طلبا گراف کاغذ میں کسی بھی نقطہ مثلا A(0, -9) , B(4,5), C(7, -7) کو بھی پلاٹ کرنے کے قابل ہو جائیگا۔	ذیل کے دیے گیے نقطہ Y-axis سے کس طرف واقع ہے؟ A (-4, 5), B (-5, -2) , C (2, -7)

		طولی مختص وار ضی مختص اور اس کا سمت کو دیکھتے ہوئے گراف کے مربع کو گنتے ہوئے نقطع کو پلاٹ کر دیا جاتا ہے۔		

Assessment Plan

Formative Assessment

1. ایک مختص سطح (coordinate plane) کتنے رابع (quadrant) ہوتے ہیں؟
2. Abscissa اور Ordinate سے کیا مراد ہے۔؟
3. ذیل کے دیے گیے نقطہ Y-axis سے کس طرف واقع ہے؟

$A(-4, 6), B(-4, -2), C(3, -5)$

Home Assignment

1. مندرجہ ذیل نقطوں کو گراف کاغذ پر پلاٹ کر کے بتاؤ کہ یہ نقطہ y-axis کے کس جانب واقع ہے؟

$(5, -7)\ (-10, 10)\ (-8, -4)\ (4, 3)\ (-6, 2)\ (11, -3)$

Appendix-vii

Traditional method base lesson plan

روائتی طریقہ کار پر مبنی منصوبہ سبق

منصوبہ سبق (Lesson Plan)- 1		
درجہ / گریڈ / سکشن	:	IX
موضوع	:	ریاضی
عنوان	:	گراف
ذیلی عنوان	:	ربع دائرہ کا تصور
وقفہ	:	40منٹ

عمومی مقاصد (General Objective)

1. ریاضی کے ایسے بنیادی اصول اور تصورات کی معلومات فراہم کرنا جو طلباو طلبات کی روز مرّہ زندگی میں کار آمد ثابت ہو۔
2. طلباو طلبات میں کسی مسئلے کے ادراک کی اہلیت پیدا کرنا۔
3. طلباو طلبات میں حقیقی اور تخلیقی سوچ کو فروغ دینا۔
4. طلباو طلبات میں سائنٹفیک روئے، خود عتمادی، حصول علم دلچسپی اور محرکہ پیدا کرنا۔
5. ہر طالب علم کو ریاضی کی معلومات کو اپنے روز مرہ زندگی میں استعمال کرنے اور وسیع مسائل کو حل کرنے کے قابل بنانا۔
6. طلباء کے اندر جمالیاتی، ذہانتی شوق وزوق، اطمینان بخش طریقوں کے ذریعوں سے واقف کروانا۔
7. طلباء کو معاشرہ میں مطابقت اور کامیاب زندگی گزارنے کے لئے سماجی اور اخلاقی اقدار کو حاصل کرنے میں مدد کرنا۔
8. طلباء میں منظّم اور مثبت عادتوں کے ذریعے کردار کی نشوونما کرنا۔
9. طلباء کو ریاضی کی مہارتوں کو فروغ دینا تاکہ وہ روزمرہ زندگی کی مانگ کو پورا کر سکیں۔
10. طلباء کو ذہنی نظم وضبط کی مشق کروانے کے مواقع فراہم کرنا

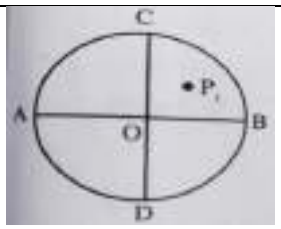
خصوصی مقاصد (Specific Objectives)

اس سبق کی آموزش کے بعد طلباٗ اس لائق ہو جائیں گے کہ وہ۔۔۔۔

1. مختص سطح کو اپنے الفاظ میں بیان کر سکیں۔

2. طولی مختص اور ارضی مختص کے تصور کو بیان کر سکیں۔ 3. کسی بھی مختص سطح کے ربع اور مرکز کی سناخت تشکیل کر سکیں۔ 4. کسی بھی نقطہ کو گراف کاغذ پر پلاٹنگ کر سکیں
تدریسی اشیاء (Teaching Aid)
گراف کاغذ، چارٹ،
تدریسی طریقہ کار اور تکنیک (Teaching Method and Technique)
تشکیلی و تحلیلی طریقے کار اور لیکچر طریقے کار
سابقہ معلومات (Previous Knowledge)
طلباو طلبات سے یہ امید کی جاتی ہے کہ وہ خطوط (Line)، نقطہ (Point) وغیرہ معلوم ہو گا۔

تمہید (Introduction)		
نمبر شمار S.No	معلم کا طرز عمل (Teacher Behaviour)	طلباء کا طرز عمل (Student's Behaviour)
1	بچّوں کچھ کھیل کا نام بتاؤ؟	فٹ بال، کرکٹ، ہاکی، بیڈمینٹن وغیرہ
2	تم لوگ کون سا کھیل کھلتے ہو؟	کرکٹ

3	 تختہ سیاہ کا استعمال کرتے ہوئے مانا کہ P_1 کھیلاڑی کرکٹ کے میدان میں فلڈنگ کر رہا ہے تو اس کھیلاڑی کا مقام کیا ہے۔	غیر تسلّی بخش جواب

موضوع کا اعلان (Statement of the Topic)
تو طلباء آج ہم لوگ ربع دائرہ کا تصور مطالعہ کریں گے

پیش کش (Presentation)				
نمبر شمار S.No	نکات تدریسی Teaching Point	معلم کا طرز عمل Teacher Behaviour	طلباء کا طرز عمل Student's Behaviour	تختہ سیاہ کا کام Black Board Work
1	ربع دائرہ کا تصور Concept of Quadrant	دیے گیے شکل (کون سی شکل) میں OX اور OY کا سمت مثبت ہوتا ہے اور 'OX اور 'OY کا سمت منفی کہلاتا ہے۔ جبکہ زاویہ XOY کے احاطہ کے درمیانی حصہ پہلا رفع (1^{st} Quadrant) کہلاتا ہے۔		

		X'OY زاویہ کے درمیانی حصہ دوسرا رفع (2nd quadrant) کہلاتا ہے۔ زاویہ X'OY' کے درمیانی حصہ تیسرا ربع (3rd quadrant) کہلاتا ہے۔ جبکہ XOY' زاویہ کے درمیانی حصہ چھوتھا ربع (4th quadrant) کہلاتا ہے۔ ہم اس سطح کو کارٹیسی سطح (Cartesion Plane) یا مختص سطح (Coordinate plane) کہتے ہیں۔ O کو مبدا (Origin) کہا جاتا ہے۔ سوال - ایک مختص سطح (Coordinate Plane) میں کتنے ربع ہوتے ہیں؟ شاباش..... چارٹ کو دیکھاتے ہوئے x-axis کے ہمراہ y-axis سے کسی نقطہ کی عمودی دوری اس نقطہ کا x– مختص (x- coordinate) یا طولی مختص (Abscissa) کہلاتی ہے۔ y-axis کے ہمراہ x-axis سے کسی نقطہ کی عمودی اس نقطہ کا y– مختص	ایک مختص سطح میں چار ربع ہوتے ہیں۔ طولی مختص (Abscissa) کہا جاتا ہے۔	XOX' کو طولی مختص (Abscissa) کہا جاتا ہے اور YOY' کو ارضی مختص (ordinate) کہا جاتا ہے۔

		(y-coodinate) یا ارضی مختص (ordinate) کہلاتی ہے۔ سوال۔'XOX کو کہا جاتا ہے؟ بہت اچھا چارٹ کو دیکھاتے ہوئے پہلا ربع (+ , +)ہوتا ہے۔ دوسرا ربع (+ , -)ہوتا ہے۔ تیسرا ربع (- , -)ہوتا ہے۔ چوتھا ربع (- ,+)ہوتا ہے۔ سوال-پہلا ربع میں ہوتا ہے؟ Very good	پہلا ربع میں (+ , +) ہوتا ہے۔	پہلا ربع (+ , +) ہوتا ہے۔ دوسرا ربع (+ , -) ہوتا ہے۔ تیسرا ربع (- , -) ہوتا ہے۔ چوتھا ربع (- ,+) ہوتا ہے۔
2	کاغذ پر نقطوں کو پلاٹ کرنے کا طریقہ Plotting of Points on graph paper	سب سے پہلے گراف کاغذ میں دو عمودی خطوط 'XX اور 'YY کھینچا جائیگا جو O مرکز پر قطع کرتا ہے۔ اس کے بعد گراف کے ایک چھوٹے مربع کے ایک ضلع کی لمبائی ایک اکائی فرض کر لیا جاتا ہے۔ پھر دیے گیے نقطہ کی طولی مختص و ارضی مختص اور اس کا سمت کو دیکھتے ہوئے گراف کے مربع کو گنتے ہوئے نقطع کو پلاٹ کر دیا جاتا ہے۔ مثال کے طور پر (-7, -6) کو گراف کاغذ پر پلاٹ کیا جاتا ہے۔		

		نقطہ (-6, -7) میں طولی مختص مثبت اور ارضی مختص منفی ہے ۔ اس لیے مبدا O(0,0) سے 'OX کی طرف 6 اکائی جا کر پھر وہاں سے 'OY کے متوازی 7 اکائی نیچے جا کر نقطہ (-6, -7) حاصل ہو گا۔		

اعادہ سبق (Recapitulation)

1. ایک مختص سطح (coordinate plane) کتنے رابع (quadrant) ہوتے ہیں؟
2. Abscissa اور Ordinate سے کیا مراد ہے۔؟
3. ذیل کے دیے گیے نقطے Y-axis سے کس طرف واقع ہیں؟

A (-4, 6), B (-4, -2) , C (3, -5)

تفویض / گھر کا کام (Home Assignment)

1. مندرجہ ذیل نقطوں کو گراف کاغذ پر پلاٹ کر کے بتاؤ کہ یہ نقطے y-axis کے کس جانب واقع ہیں؟

(11, -3) (-6 , 2) (4 , 3) (-8 , -4) (-10 , 10) (5, -7)