

**DEVELOPMENT AND EFFECTIVENESS OF AN
INSTRUCTIONAL MODEL IN LIFE SCIENCES
BASED ON MIND, BRAIN, AND EDUCATION
SCIENCE APPROACH IN CONGRUENCE
TO THINKING PATTERN AND
PARENTAL COGNITIVE
STIMULATION**

A
Thesis Submitted to



for the award of
DOCTOR OF PHILOSOPHY(Ph.D.)
in
EDUCATION

By
AMANDEEP KAUR
(40900121)

Supervised by
DR. NIMISHA BERI

**LOVELY FACULTY OF BUSINESS AND ARTS
LOVELY PROFESSIONAL UNIVERSITY
PUNJAB
2019**

DECLARATION

It is certified that present study “Development and effectiveness of an Instructional model in life sciences based on Mind, Brain and Education Science approach in congruence to thinking pattern and parental cognitive stimulation” is an original piece of research, being submitted to Lovely Professional University for the award of Ph.D. degree in Education. It has not been submitted to any other University or Institute for the said purpose.

AMANDEEP KAUR

CERTIFICATE

*This is certified that certified that present study “**Development and effectiveness of an Instructional model in life sciences based on Mind, Brain, and Education Science approach in congruence to thinking pattern and parental cognitive stimulation**” was carried under my supervision by Amandeep Kaur. It is an original piece of research, being submitted to Lovely Professional University for the award of Ph.D. degree in Education. It has not been submitted to any other University or Institute for the said purpose.*

DR.NIMISHA BERI
Professor
School of Education
Lovely Professional University

ABSTRACT

The Education is a process of teaching and learning that go hand in hand. Instructions play an important role in it. Instructional process is multidimensional, which mainly involves learning theories based on which, instructional delivery is designed. Educational system of every country support certain learning theories to meet learning objectives based on the needs of that particular country. There are many different learning theories that have been followed till date like behaviorist, cognitivist and constructivist. All the theories are focused on the change in behavior of the learners through information retention in different memory systems of the brain. Hence, focus of instructions is on memory and thinking i.e. how that information stored in memory, is transferred to thinking, to further elicit the desired behavior to solve the problems or take decisions in real life. So, the behavior of an individual is the reflection of thinking involved to act in particular way because the focus of the instruction is to develop thinking skills. Bloom et al.'s taxonomy of cognitive domain has clearly outlined different thinking levels in cognitive domain i.e. knowledge to evaluation. Since the new technologies have emerged and now learning in brain is being studied from different perspective, so with the birth of science of learning, it has put forward a new theory of learning based on the principles of brain and learning interaction through the lens of behavior underpinnings. The researchers around the world have put forward different aspects of brain and learning. Mind, brain, and education (MBE) has started gaining momentum as new science of teaching and learning since last few years when researchers in this area, from Harvard to John Hopkins and Cambridge along with many more in different countries, started exploring the links of human learning with different human sciences from neurosciences to developmental biology and psychology. The main idea is to make learning more effective. Till now, only major feeding science for educational theories is psychology, but now other science fields related to brain also have their role to play in various learning problems from dyslexia, dyscalculia and attention deficient hyperactivity syndrome. The research data of all the subfields like neuroscience genetics and psychology, are filtered through the lenses of education being gathered, which is exploring new challenges and finding ways to solve various educational problems, may it be learning disabilities, motivational problems, memory, development of thinking or similar sort of teaching-learning problems. The objective of

7C's instructional model, designed based on the principles of MBE, is to focus on development of thinking skills among learners, to make the process of learning more meaningful and interesting to the learners, using positive emotions in teacher-student interactions and creating good learning environment. The role of teacher is very important in any teaching activity. He acts as a catalyst for learning to take place in the teaching-learning process. It is expected that the 7C's instructional model is useful in alignment of teaching-learning activities to bring the desired changes in learner's thinking. The main objective of the study was to develop an instructional model based on mind, brain, and education guidelines and to measure its effectiveness in terms of thinking pattern of learners in congruence to parental cognitive stimulation. For the Development of instructional model, ADDIE (Analysis, Design, Development, Implement and Evaluation) model was used as framework to outline different phases of developmental process. The evaluation of Instructional model is done in terms of its effectiveness in congruence to thinking pattern and parental cognitive stimulation. The t-test and ANCOVA were used along with measures of central tendency i.e. mean and standard deviation. The data was analyzed using SPSS 22 and testing of hypotheses was done at level of significance $p=.05$ (two-tailed). It has been found that instructional model based interventions has significant impact in achievement of thinking levels in life science. The Parental Cognitive Stimulation (PCS), data was analyzed, where it has been found that PCS alone does not impact Thinking variables in post-test when data of both the experimental and control groups was analyzed. Low PCS experimental group performed better ($M\ dif=16.346, t=3.472, p=.005$) over Low PCS control group ($M\ dif=-0.638, t=0.202; p=0.842$) where no statistical significant difference in pre-test and post-test performance was reported. Similarly, in average PCS experimental group in pre-test and post-test, statistically significant difference was found ($M\ dif.=13.95, t=6.077; p=0.001$). It has been concluded that PCS has no independent effect in influencing the thinking pattern. But, It is in congruence with 7C's instructional model. Thinking Pattern data were analyzed by calculating mean average percentage of each group at five variables i.e. Knowledge, Understanding, Application, Analysis and Evaluation. The data was analyzed using independent and paired sample t-test, bar diagrams and line charts of mean values were prepared to show pattern, the reporting of results suggested that experimental group performed better over control group. The percentage gain in mean is higher in experimental group over control group in post-test performance in

thinking pattern. It has been observed that in thinking pattern control group has not shown any significant impact with low and average PCS, while in experimental group with high PCS and Average PCS, students performed better than Low PCS in post test, while in control group, high PCS student's performance declined in post-test and average and low PCS group performance is also less as compared to experimental group.

In the end, it is concluded that thinking pattern and parental cognitive stimulation are congruent with the instructional model. Thinking pattern has significantly improved in instructional model based teaching in a classroom of life sciences. Parental cognitive stimulation, coupled with the instructional model, has significant improvement in results of students' performance in average PCS group while low PCS group performed better due to instructional model based intervention.

This instructional model is based on mind, brain and education science approach, which primarily focus on emotional regulation and strengthening neural pathways related to memory, attention, and perception further study to measure the effectiveness of it can be done. The brain learning principles highlighted in MBE are not any subject specific, hence not only life science but also other areas like languages, social sciences and mathematics can be taught through this instructional model. It is suggested that more time in the timetable could be allotted to the activities for cognitive stimulation and comprehensive evaluation should be done.

Keywords: mind, brain, and education science, instructional model, parental cognitive stimulation, thinking pattern, life science.

ACKNOWLEDGMENTS

My words are short to express my gratitude to all the persons, who were my support to complete his research. I would like to start with Dr.S.K. Das, who was the first among all, to introduce me to the field of neuroscience in education. It's his initiative that I further explored this field of research to reach Mind, Brain, and Education Science. My words are not enough to thank Dr. S.K. Bawa, who was there all the time when I needed her guidance to proceed further. She never let me down and encouraged to complete this work efficiently. Her belief in my ability to undertake this research was a big intrinsic motivation.

During this research process, I get to work with Dr. Sneh Lata Verma and Dr. Mihir Kumar Mallick. I would thank both of them for their valuable suggestions and motivation. But I have no words to express my gratitude towards my supervisor Dr. Nimisha Beri, who supported me when I was in dire need for it. I shall always be indebted to her.

I feel sense of thankfulness towards Dr. Parminder Kaur Tulsi, who despite her busy schedule helped me a lot in finalizing my research tools. Dr. Harpreet Kaur Chhabra discussed the role of cognition in educational context. It helped me in conceptual understanding of my area of study. I am thankful to Dr. R. K. Bansal, Dr.Samar Singh and Dr. Jubilee for their valuable inputs.

I am deeply thankful to Dr. Tracey Tokuhama, who gave me her consent, to use MBE principles and instructional guidelines, as a base for my research. I am also thankful to Dr. Mary Helen for sparing her valuable time for communication through email and providing valuable suggestions on various aspects while proceeding in this area of research. This list is endless as I wish to thank all the brilliant minds, who contributed to evolving my thinking process in this field of research.

I also thank my family for their perseverance and consistent help during all these years, as without their support I would not have been able to complete this research. I am particularly thankful to my life partner Dr. Kamaljit for his loving support in my life and I can't express myself if I talk about my children Tarannumjeet and Shubhkarmanjit, it is too much that they have sacrificed to enable me to complete this research work. I am thankful to my parents and parents' in-law for their moral support.

I am thankful to all my friends and particularly Mr. Prem Kumar Mittal to help me out when I needed it the most, I shall treasure his contribution to this work. Last, but not the least, I am thankful to all my colleagues for their supportive role in making my work accomplished.

Amandeep Kaur

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CHAPTER I

INTRODUCTION

1.1 THEORETICAL ORIENTATION

The education system of every country has its own aims and objectives. It is broadly based on the sole objective of changing the behavior of learners and to develop certain skills among them. The behavior modified through learning would be helpful for the growth and development of that country on the global scenario. In India, education has grown tremendously since the National Policy on Education 1986; Programme of Action (PoA) 1992 has laid down some aim and objectives for imparting school education. School education has three important components or aspects i.e. curriculum, instructions and assessment of learning outcomes. The educational system has its backbone in the form of a curriculum that is designed on the basis of certain objectives, which are supposed to be achieved through instructional delivery by teachers. The assessment of these objectives is done through certain evaluation tools. Teachers are supposed to focus on instructional objectives, so that it could be attained by using different instructional strategies.

Education is a comprehensive term used for both formal and non-formal system of education. The formal system of education depends mainly on the process of teaching and learning which is based on certain educational objectives. In formal system of education, we deal with the learning and teaching directly. The aims and objectives are framed according to the need of the society of that particular place of living. According to those aims and objectives of education, the curriculum is developed and to achieve these objectives, instructions are provided and evaluation is done (**Figure 1**).

The modern concept of education invites the best practices to make the process of teaching and learning in the classroom more effective. There is no dearth of technology being incorporated in classrooms. The main focus is on the learning of students. Learning is defined in many ways, which involves cognitive mechanisms of the brain. The brain is the organ where learning takes place. Learning in brain is a complex process of wiring of neurons with the help of neurotransmitters. It is a

process which helps in making new nerve connections in the brain, which are strengthened with experiences and result in behavior manifestations. Brain has a complex structure and it is the function of associated cells that are dependent on the genetic constitution and environmental influences. Hence, learning is not just a mechanical rather a neuropsychological process, which is dependent on genetic constituents and environmental interactions of the learner with surrounding environment as well as teachers.

Teachers have a significant impact on their students. The instructional strategies selected by the teachers influence student learning outcomes. Therefore, teachers need to be selective in the choices they make. The theory based on research in teaching suggests that the teachers serve as a guide to enhance student learning. The teacher is responsible for ensuring the appropriate teaching approach to use in helping students learn in an effective manner and in helping them to achieve the intended learning outcomes. It is possible if a planned and systematic model of instructions is provided to the teachers to follow, which fulfills all the needs of teachers and students. It is based on a research-based theory of learning to ensure intended learning outcomes in terms of set instructional objectives.

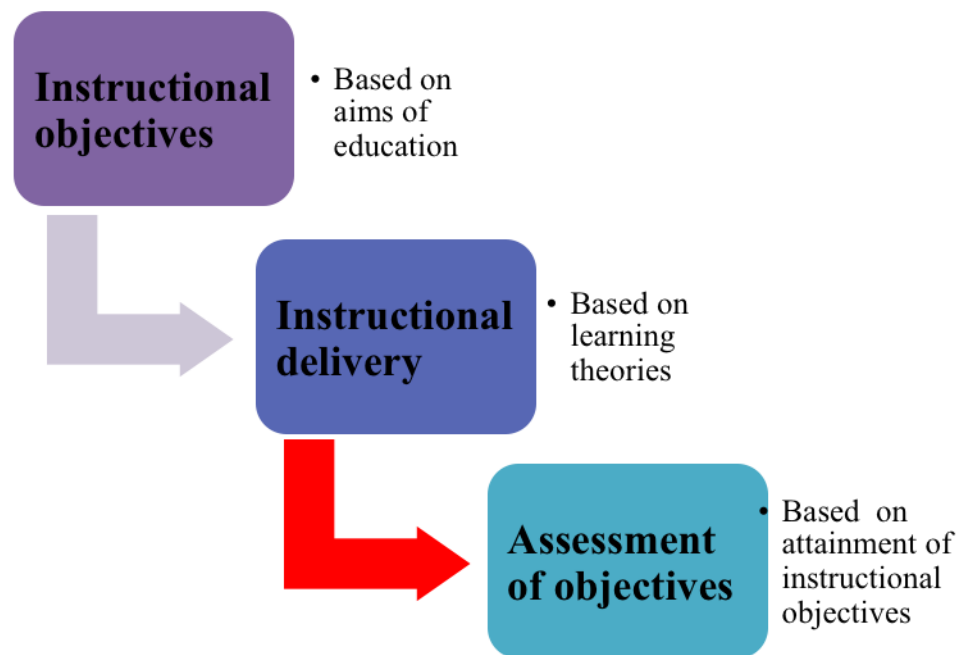


Figure 1: Representation of the Educational Process

1.1.1 Instructional System Design

Instructions are the backbone of the educational teaching-learning process. Through these instructions, desired objectives of teaching and learning are sought to be fulfilled. The connection between learning theory and educational practice is through instructional science. The foundation of instructional science through instructional system design is from the 1950s, when during World War II, educational psychologists got involved to design instructional model for training of military personnel. Later on, other commercial industries also adopted it. Models are visual representations of the instructional design process. They represent a direct link between learning theory and educational practice. Learning theories provide the foundation for the selection of instructional strategies that provide reliable prediction of their effectiveness. To achieve effective learning outcomes, the science of instruction and instructional design models are used to guide the development of instructional design strategies that elicit appropriate cognitive processes (Khalil, 2016). Several instructional system design (ISD) models have been developed for systematic planning and the development of instruction.

In teaching, the usage of this model is not new. Socrates, the Greek Philosopher, deployed his own model of question-answer (dialect). Ancient Indian teachers developed their own model of teaching to bring about the desired changes in the behavior of the learners/students. Numerous models of teaching have been established during the previous two decades in some western countries. These models recommend different approaches to the instructional process to carry out variations in the behavior of the learners. The mutual implication of these facts is that teacher should use different strategies of teaching related to the students' learning styles and personality dimensions. The instructions should be planned by making use of predominant theories and theoretical knowledge into different models of teaching that may be willingly used by teachers in schools as well as school settings.

Instructional design is a system of procedures for developing an instructional activity in education and training programmes in a consistent and reliable way (Gustafson & Branch, 2002). It is a systematic presentation of activities involved with instructions to make it more effective. Instructional designers are formally trained to use several instructional design models that have been developed for systematic

planning and the development of instruction. The systematic process of designing instruction is aimed at increasing instructional efficiency and facilitating student learning. In that respect, design models translate the general principles of learning and instruction to provide a procedural framework for developing instructional materials and creating an environment for successful learning outcomes.

Although there are many different ISD models available, but all of them include the following essential phases of instructional design: Analysis, Design, Development, Implementation, and Evaluation (ADDIE). These are the core elements of instructional design development process i.e. analyze needs, design instructions based on learning objectives, develop training materials, implement the training and evaluation of an assessment of instructions. Thus, the ISD model and ADDIE act as a conceptual framework for the designing of instructional design models.

Initially, instructional system design was taking insights from behaviorism alone. Skinner (1954) later incorporated individual differences into the instructional design process. In the late 1960s and throughout 1970s, there was a shift in paradigm from behaviorism to cognitivism. It had been theorized by Gagne (1962) that attainment of knowledge is more effective by hierarchical sequencing of the content. The nine events of instructions prominently depict the prominence of the instructional model in the learning process. Instructional design researchers in 1970 developed the complete picture of the situations of learning, the theories of instructional design and incorporated individual differences into their instructional design process. The theory of structured learning by Joseph Scandura focused on rule acquisition and knowledge base and contributed to the ISD with automated systems of instructional design (Scandura, 2001). Researchers began to move away from Stimulus-Response Model to cognitive processing of information. The instructional system design, at this point, started inculcating learning theories into the design of instructions. Initially, the focus of ISD was behaviorism, which later shifted to cognitivist and then to constructivism, depending on the contemporary theories of learning.

The reforms in science education worldwide are now derived from the constructivist views of teaching and learning. The promotion of students' thinking has become the focus of educational studies and programs (Boddy, Watson & Aubusson, 2003; Kuhn, 1999). These reforms explicitly ask teachers to change their teaching

strategies by shifting the emphasis from the traditional textbook-based rote learning to exploration inquiry-based learning situated in real-world phenomena (National Research Council, 1996). The constructivist theory recognizes that students need to be exposed to learning experiences that enables them to construct their own knowledge and promote their thinking skills.

A model of teaching is designing curriculum, instructional materials and more specifically a learning environment. These models prescribe different approaches to instructional process to bring changes in the behavior of the learners. Joyce and Weil (2009) outlined models of teaching in four families i.e. the information processing, the social, the personal and the behavior system family. It depends on the objective of teaching to choose the appropriate model of teaching. Every model of teaching is based on the theory of learning e.g. behavior system supports mastery learning by Bloom. Direct teaching and stimulus response is the theory of behaviorism. Similarly information processing family of models supports cognitivist approach and principles of cognitive psychology and concept attainment and advance organizer model is an example of the information processing family. Social family of teaching models facilitates social interaction and group activities as learning tool. Personal family of teaching model has the concept of self-directed learning as it supports non-directive teaching and self-autonomy for self-growth. All the four types of model families are based on some psychological theory of learning. Hence, it is clear that every teaching model has theoretical base of principles of learning provided by a theory of learning.

1.1.2 Learning Theories and Instructional System Design

Cognitive theory is the dominant theory in instructional design and cognitivists also use many of the instructional strategies advocated and utilized by behaviorists. The basics of behaviorism, as a learning theory, can be traced back to Aristotle. The theory of behaviorism concentrates on the study of observed behaviors that can be measured. It views the mind as a "black box" in the sense that response to stimulus can be observed quantitatively; it totally ignores the possibility of thought processes that occur in the mind. Major researchers in the development of the behaviorist theory were Pavlov, Watson, Thorndike and Skinner. Behaviorism focuses the behavior; changes in behavior can be observed and can be used as indicators to understand the learner's mind. Cognitivism supports the process of mind, it highlights the mental

processes involved in learning. Constructivism, on the other hand, is based on the premise that we all construct our own perspective of the world, through individual experiences and schema. Constructivists believe that "What someone knows is grounded in perception of the physical and social experiences by the mind" (Jonasson, 1991).

Behaviorists assess learners to determine a starting point for instruction, while cognitivists look at the learner to determine their predisposition to learning (Ertmer & Newby, 1993). When designing from a behaviorist/cognitivist stance, the designer analyzes the situation and sets a goal. Individual tasks are broken down and learning objectives are developed. Evaluation determines whether the criteria for the objectives have been met or not. In this approach, the designer decides what is important for the learner to know and attempts to transfer that knowledge to the learner. To design from a constructivist approach requires the designer to produce a product that is much more facilitative in nature than prescriptive. The standard pencil-and-paper tests of mastery learning are not used in constructive design. The instructional design techniques are different for different instructional objectives (Mergel, 1998)

Although cognitive psychology emerged in the late 1950s and began to take over as the dominant theory of learning, it wasn't until the late 1970s that cognitive science began to influence instructional design. Cognitive science began a shift from behavioristic practices that emphasized external behavior, to a concern with the internal mental processes of the mind and how they could be utilized in promoting effective learning. The design models that had been developed in the behaviorist tradition were not timed out, but instead, the "task analysis" and "learner analysis" parts of the models were reframed. The new models addressed the components of process of learning such as knowledge encoding and representation, information storage and retrieval as well as incorporation and integration of new knowledge with previous information. The goal of instruction in behaviorism and cognitivism remained the communication or transfer of knowledge to learners in the most efficient and effective manner possible. For example, for a behaviorist who is trying to find the most efficient method of shaping a learner's behavior, the breaking down of a task into smaller steps will work but the cognitivist would analyze a task, break it down

into smaller steps or chunks and use that information to develop instruction that moves from simple to complex building on prior schema.

The shift of instructional design from behaviorism to cognitivism was not sudden. Behaviorism and cognitivism both are objective in nature. Behaviorism and cognitivism both support the practice of analyzing a task and breaking it down into manageable chunks, establishing objectives and measuring performance based on those objectives. Constructivism, on the other hand, promotes a more open-ended learning experience, where the methods and results of learning are not easily measured and may not be the same for each learner.

While behaviorism and constructivism are very different theoretical perspectives, cognitivism shares some similarities with constructivism. After having compared and contrasted behaviorism, cognitivism and constructivism, Ertmer and Newby (1993) feel that the instructional approach used for novice learners may not be efficiently stimulating a learner who is familiar with the content. They do not advocate one single learning theory, but stress that instructional strategy and content should depend on the level of the learners.

Since the 1990s were considered as the decade of the brain, a lot of evidence-based practices were highlighted and educators around the world have adopted evidence-based practices in this decade. Now in the present era, with the advent of evidence-based technologies, it is clear that brain science is the driving force behind improving education practices. The entire world is looking forward to interdisciplinary nature of work in every sphere of science. Neuroscience Research in Education Summit (2009) was organized by the Society for Neuroscience in the University of California, Irvine, with the following objectives:

- How can results in neuroscience laboratories translate to classrooms, curricula and educational policy?
- What do we already know about learning and the brain?
- What do we need to better understand?
- How can we communicate this knowledge effectively to multiple constituencies including educators, parents, researchers and other critical stakeholders?

The study of functions of brain, particularly research relating neuroscience in education, brings the learning system of brain forward (Christoff, 2008). The brain is the major organ, which is related to learning. So, it is necessary to understand the basic structure and function of the brain, specifically the areas of the brain, which are related to learning. Learning is the formation of new nerve connections in the brain and the nerve connections are stored in different regions of the brain. Whenever information is recalled, these areas are lighted up by neurotransmitters to retrieve the memories stored there. Basically, our educational aim is to build and strengthen these nerve connections.

Nevertheless, it is well known that educational theories are not always implemented properly in the classroom (Boddy, Watson et al., 2003). To change the theory to practice, there is a need to develop a framework based on applications of major implications of that theory to the process of teaching and learning. Evidence-based and neuroscience-based findings of human learning would be helpful in improving educational practices (Stern, 2005). It is well established that education is our principal means of preparing students – our future citizens – for active and responsible life within our modern society. Therefore, schools at all levels should work for fostering the higher order thinking skills. Accordingly, a major purpose of education should be the development of such skills in the context of the specific content of science and related disciplines.

Teaching is considered as a social phenomenon, which involves the interaction of students with the teacher as well as with their surrounding environment (Yano, 2013). Hence, the role of the environment as well as interaction of teacher and student is important. The role of the brain in learning is well established since long. The stimulation, which affects the learner's receptors, produces patterns of neural activity that are briefly "registered" by sensory registers. This information is then changed into a form that is recorded in the short-term memory. The short-term memory has a limited capacity in terms of the number of items that can be retained in mind. The items that are so held, however, may be internally rehearsed and thus, maintained. In the subsequent stage, a significant transformation called semantic encoding takes place when the information enters the long-term memory for storage. As its name implies, in this kind of transformation, information is stored according to its meaning.

When learner performance is called for, the stored information or skill is searched for and recovered, by way of a response.

It is a very clear matter now that brain-science is the driving force behind improving education practices. The era of brain-based pedagogy needs to be supplemented by a better-off, interdisciplinary dialogue aimed at understanding and reshaping the study of learning. It is necessary to forge strong alliances amongst the brain sciences and education to impart the best practices at school, at home and in the community (Hinton & Fischer, 2008). Although different cognitive scientists have contributed to the theoretical part of education, no such theory is there, which could throw light on the problems of teaching and learning so closely, that it suggests solutions of educational problems directly. Fischer et al., (2008) has suggested concept of research schools to link the science of human learning to educational theory and practice. The idea of research school is to bridge the gap between laboratories and classrooms. Teachers often lack the background knowledge needed to interpret scientific results, whereas scientists often lack an understanding of pedagogical goals (Fischer et al., 2010). We need to build an infrastructure that supports sustainable collaboration between researchers and teachers and create a strong research foundation for education.

To build a common vocabulary of neuroscience, psychology and education, an interdisciplinary field should be created, which fulfills all the basic requirements of translating brain research into education through theoretical filters related to design of learning environments based on emotions and social nature of cognition (Immordino, 2011). Brain-based learning is gaining much attention in education sector as it involves accepting the rules of how the brain processes, and then organizing instructions, bearing these rules in mind, to achieve meaningful learning (Caine & Caine, 1994). It is a set of principles and a base of knowledge and skills, through which we can make better decisions about the learning process (Jensen, 2000).

Every psychological theory of learning and philosophy from behaviorism to constructivism has taken inputs from brain science. Cognitive psychology is already a well-established field of study. The common implication of these facts is that the teacher should use different strategies of teaching, which match the objectives of teaching. The instructions should be designed by making use of prevalent theories and

their theoretical knowledge into different models of teaching, which can be readily used by teachers in school settings because, still there are contradictions among various researchers over the direct application of brain research in education.

Similarly, various ethical and other methodological problems are put forward by different researchers, but there is one argument in favor of the use of neuroscience in education that is, if natural sciences can inform applied sciences, for example, a civil engineer uses fundamentals of physics when designing a bridge, and an urban planner might use chemistry, meteorology, and physics in a project to develop an urban city, neuroscience can also be used in planning better educational practices.

An educator designing a pedagogical strategy would be well advised to use knowledge about how humans learn, attend, understand language, resolve conflicting cognitive processes, regulate emotion and get motivated. It would seem that neuroscience would be well positioned to provide some of this information to affect educational practices. To apply neuroscience research in education, common vocabulary should be built, which involves experts from all related field such as cognitive neuroscience, psychology, human genetics and human development along with education, which will discuss the problems of teaching and learning at a common platform and suggest best research-based practices for application in the classrooms.

It is clear that brain science can act as a driving force in improving educational practices. A richer, interdisciplinary dialogue aimed at understanding and reshaping the study of learning should supplement the era of brain-based pedagogy. Hence, it is right time now to make strong alliances between the brain sciences and education to work to inform best practices at school, home and in the community. The interdisciplinary and inter-institutional nature of this work is both, exciting and essential for developing real solutions to educational issues. The theoretical base of this interdisciplinary science is now developing as Mind, Brain and Education (MBE) Science, which is also termed as Educational Neuroscience or Neuro-education by some researchers around the world, but the consensus is more on the term Mind Brain and Education Science.

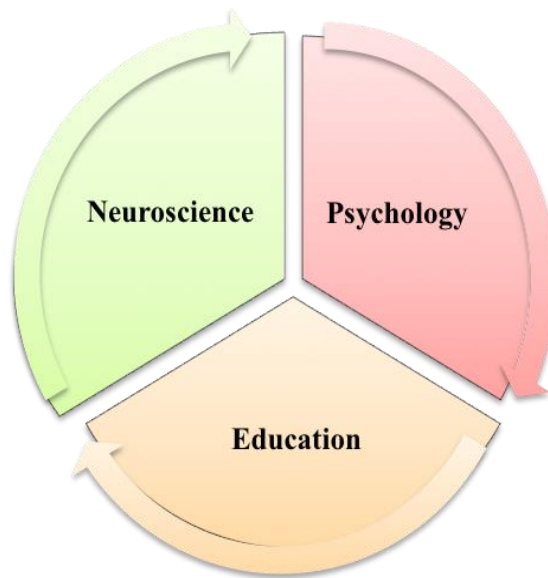


Figure 2: The flow of information in MBE as an interdisciplinary science

1.1.3 Mind, Brain, and Education Science (MBE)

The MBE has emerged as a common pool for education, psychology and neuroscience. The research in the new field of science i.e. Mind, Brain and Education science, is emerging with fast velocity, which is targeted towards improving both teaching and learning. The interdisciplinary collaboration of different streams like neuroscience, psychology and genetics gives an insight to improve and solve the problems relating to education. A lot of new research studies are coming up in this area, which is taking learning as a mechanism of the brain and studying the teaching-learning process through brain research perspective. With the increase in studies related to this field now, the mind, brain and education is almost finalized as a world leader in the field and are determined to give its meaning. At Harvard Graduate School of Education ,Professor Kurt Fischer is doing the pioneering work in this area. Mind, Brain and Education journal is being published under his lead by IMBRO (International mind, brain and research organization). EARLI (European Association for Research on Learning and Instruction) has created a Special Interest Group in neuroscience and education.

Mind-brain in education have started gathering its momentum in the early 21st century only, although the 1990s have been declared a decade of the brain when lots

of research on the brain has started. Various researchers in this area of MBE are working on different systems of human learning and teaching. Major among them is Kurt Fischer of Harvard University, who has pioneered the area of connecting brain research to education. International Mind, Brain and Education Science Society (IMBES) has been formed (www.imbes.org). Other universities around the world are exploring MBE. Major among them are, John Hopkins University, Cambridge University, University of Southern California, OECD (Organization of Economic Corporation Development), etc. The main idea behind MBE movement is to make learning more effective. The brain, being an important organ in learning, should be explored. Till now, only major feeding science for educational theories is psychology, but now other sciences have their role to play, where various educational problems like learning disabilities such as dyslexia, dyscalculia, and attention deficit hyperactivity syndrome are explored and interventions are suggested. International Mind, Brain and Education Society is publishing a journal namely Mind, Brain and Education, in which related interdisciplinary research studies are published from around the world.

The use of cognitive science in educational theory and practice is not new. Almost every learning theory is getting insights from brain science. Then what is new about Mind, Brain, and Education (MBE)? This is the question commonly asked by many. Actually, this is the process of development, verification and validation of our old and new theories of teaching and learning in the light of an interdisciplinary, rather we can say, a transdisciplinary approach involving mainly neuroscience, psychology and education. The whole thing is aimed towards improving the learning and teaching (Immordino, 2011).

The past two decades have provided extraordinary progress in our understanding of the nature of learning (Willis, 2007). Brain sciences are discovering many things that educators have always intuitively known about learning. However, the important point is actively using this new information to improve both, students' learning as well as current teaching practices. Various studies on the application of neuro-scientific data in classroom instruction have been done or are still in progress. Now, educators can find evidence-based neuro-imaging and brain-mapping studies to

determine the most effective ways to teach, as advances in technology have enabled people to view the working brain as it learns.

Neuroscience in education brings forward the learning system of brain often called brain-based learning. It takes into consideration how the brain takes, processes, interprets information; makes the connection, stores (like making the connection, coding and constructing matrix) and remembers the messages (Greenleaf, 2003). It is student-centered learning that utilizes the whole brain and recognizes that not all students learn in the same way. It is also an active process, where students are actively engaged in constructing their own knowledge in a variety of learning situations and contexts (Caine & Caine, 1994, 1997; Caine & Caine and Crowell, 1999).

A theory of teaching and learning is being developed for Mind, Brain and Education, which deal with both the teaching and learning problems because both these forms are inseparable from each other. Research on brain sciences has great scope for education, as every learning activity is brain-based; hence brain is directly related to learning. Every field from pharmaceutical medicine has its research and development unit to constantly update and evaluate the needs and assessment of interventions, although there are different views by different educational researchers on the application of neuroscience research directly into classrooms. Bruer (1997) has his views, as it's a bridge too far. The reason is the application of translation of neuroscience findings in classrooms requires to be evaluated through psychology, for better understanding and translation of education. On the other hand, there are too many researchers, who have accepted neuroscience and education as a bridge to solve educational problems related to learning and teaching.

Although neuroscience does not directly deal with teaching, successful learning is the result of success in teaching (Goswami, 2006). Successful learning is the clear indicator of successful teaching which would definitely result in successful learning. The theoretical base of MBE is developed by using the latest technology with the use of neuro-imaging and by taking feedback directly from the functional brain. So, we can say that our views about learning and teaching have changed. Now, brain is no more a black box, rather we can see inside it as how learning happens in brain, so, we can redefine the definition of learning as, "Learning is forming new nerve connections and strengthening these nerve connections through the process of myelination, so that

they could not be eliminated and become stable in the brain, which could be used later on as and when required.’’

There are many research studies which show the effectiveness of brain-based pedagogical interventions. Brain sciences are discovering many things that educators have always intuitively known about learning. However, the important point is actively using this new information to improve both students learning and current teaching practices. Now, educators can find evidence-based neuroimaging and brain-mapping studies to determine the most effective ways to teach, as advances in technology enable people to view the working brain as it learns. Several studies on brain-based teaching strategies to improve students’ learning are discussed below:

Geake and Cooper (2003) proposed a study of adaptive plasticity, which relies on stimulus-reinforcement and examines possible implications for pedagogy and curriculum in relationship to school learning with more recent advancements in cognitive neuroscience. Cognitive neuroscience may be able to open the lid just a little, to have a glimpse inside the mind. Such insights may, in turn, be helpful in either supporting long-regarded best educational practice, or in deciding between competing cognitive models and their use in educational settings. Cognitive neuroscience advances our understanding of the basics of learning. So, the educationists need to appropriate this research with regard to its implication and application for teaching informal educational settings, especially school classrooms.

Caine and Caine (2005) defined brain-based learning as recognition of the brains code for meaningful learning and adjusting the teaching process in relation to those codes. Studies in the field of neurobiology have improved understanding of how brain functions and how learning is formed. Educators, who work in collaboration with neurobiologists, integrate knowledge of the function of the brain and adapt it to the learning principles. Brain-based learning aims to enhance the learning potential, and in contrast to the traditional approaches and models, provides a teaching and learning framework for educators. Research into the functioning of the human brain, particularly during the past decade, has greatly enhanced our understanding of cognitive behaviors i.e. learning, memory, intelligence and emotion. Cognitive neuroscience in education might provide a means for teachers to reclaim eroded professional autonomy (William & Eric C, 2003; Johnson & Hallgarten, 2002).

Cognitive neuroscience literature has provided several informed suggestions about the areas of educational practice, where the interface between what we know about neuroscience and the brain, might be incorporated into effective classroom learning techniques.

Kennedy and Teresa (2006) highlighted the implications of neuroscience for educational reform regarding the second language (L2) learning. These implications of neuroscience can clearly be seen in the various categories of content such as science, social science and technology, etc. The study was designed to address relationships between the corpus callosum and bilingual capacity and provides recommendations to language teachers regarding integrating brain-based activities framed around content-related topics into their classroom teaching and to promote programs that start language learning as early as possible in a sequentially organized framework for next generation of students to enable them to successfully communicate in their chosen area of study.

In a 10-week longitudinal evaluation study Griffee, D. T. (2007) tested a brain-based learning curriculum proposed by Smilkstein (2003) by comparing it with a traditional basic curriculum. This study included two classes each of experimental and traditional methods. Results of the data indicated that the experimental classes exhibited more positive comments than the traditional classes and final scores were significantly higher for experimental students.

Bonnema (2009) proposed that learning is enhanced with brain-based research. This study discusses brain-based learning principles and its relation to classroom instructions. A rapidly growing quantity of research currently exists regarding how the brain perceives processes and ultimately learns new information. In order to maximize their teaching efficacy, educators should have a basic understanding of key memory functions in the brain and how these functions relate to student's learning (Sousa, 2006).

Similarly, Laughbaum (2008) conducted a study about the implications of neuroscientific research on teaching algebra. This study makes an argument that algebra should be taught through functional approach implemented with a graphic calculator so that one can seamlessly capitalize on the brain's normal functioning. In teaching algebra, one should strongly consider a functional approach with tools such

as cognition, the neural process of association, pattern recognition, attention, visualization and enriched classroom environment.

Schiller et al. (2008) examined a study using brain-based teaching strategies to create supportive early childhood environments that address learning standards. The researcher reminds teachers that standards are not intended to fence in creative teachers or become obstacles for learners with special needs. To help teachers optimize learning for all children, they review brain-based research findings such as the importance of safe environments, the effect of emotions on learning, the use of multisensory practices and differentiated teaching practice, the process of sense-making and the importance of planning for meeting special needs.

Duman (2010) conducted a similar study that looked at the effects of brain-based learning on the academic achievement of students with different learning styles. In this study, 68 university students were grouped into one control group and four experimental groups based on their personality types. The control group was taught using traditional teaching methods i.e. lecture method and question/answer sessions. The experimental groups were taught using a brain-based learning method based on the brain learning principles of Caine and Caine (1990). Students were given a pre-test and post-test to measure the effectiveness of this strategy. In this study, the researcher found that brain-based learning significantly increased the students' academic achievement as compared to traditional teaching methods. The experimental group showed a 47.25% increase from the pre-test to post-test, whereas the control group showed an increase of 21.75%. There was no connection found between the learning style of the student and the increased achievement. Therefore, the method was successful for all students in the experimental group.

Gokhan (2010) studied the effect of BBL method on student achievement level and attitude towards English lesson in 6th grade students. The findings of the study at 0.05 level of significance using t-test showed significant difference in attitude and positive development in achievement in experimental group. It was suggested that BBL method was more successful and have high motivation as compared to traditional instructional method.

Bokhari (2011) studied the effectiveness of brain-based learning theory at secondary Level. This study compared conventional teaching methods with brain-

based learning methods based on the twelve brain/mind principles of natural learning. Sixty ninth-grade math students were selected for this study. Thirty students were placed in the control group, who used the textbook to memorize information. The teacher was delivering the information via lecture and students were expected to learn by listening and note-taking. The other thirty students were placed in the experimental group. This group was placed in an enriched, non-threatening environment. The learning in this group was based on student activity, patterning, varied learning activities and novelty. The researchers gave a pre-test and post-test to the sixty students involved in the study and they claimed that an improvement in student achievement occurred among the students in the experimental group.

Saleh(2012) found that by using the Brain-Based Teaching Approach (BBTA), improvement could be made in the student's understanding of Newton's Laws through a research study called 'the effectiveness of the brain-based teaching approach in enhancing scientific understanding of Newtonian physics'. The study aimed to improve student understanding of physics and chose brain-based approach as a method of instruction because it was more learner-friendly. Out of total one hundred students, which were divided into two groups of 50 each, one group was taught using the Brain-Based Teaching Approach and the other group was taught using Conventional Teaching Methods (CTM). It was not defined by the author, but it was implied that lecture method and textbook work is CTM. As suggested by Caine and Caine (1995), the instructional strategies, which included relaxed alertness, orchestrated immersion and active processing, were used in BBTA approach. The researcher reported that the BBTA group showed improvement in their understanding of Newton's Laws over the students in the CTM group.

In an experimental study Haighighi (2013) measured the impact of brain based interventions in teaching to civil aviation students in Iran, on academic achievement and retention .The study consisted of total 50 students in two intact groups. The study lasted 16 weeks. During the research process, the experimental group was administered a brain-based learning approach, while the control group was administered a traditional teaching approach. Analysis of post-test achievement and retention tests revealed a significant difference between the groups favoring brain-

based learning. The findings suggested that there is significant difference in academic achievement and retention of students with BBL approach over traditional approach.

In a study instructing teachers how to use neuroscience in middle schools using BRAIN U program at the STEM Education Center at the University of Minnesota, the researchers wanted the teachers to gain inquiry-based strategies and neuroscience information that they would pass on to their students and create an excitement for science (MacNabb et al., 2006). This study involved 170 fifth to eighth-grade teachers and nearly 9,000 students. As a large number of teachers and students were involved, they were asked to evaluate the effectiveness of the program. A large number of the participants rated the program as effective. Teachers stated that they knew more about neuroscience and changed their teaching style to inquiry-based strategies (35%) and the students stated they grew in their knowledge of the brain and learned how to design and conduct an experiment (36%).

Serep & Damriel (2009) conducted a research study to determine the effect of organized instructions based on brain based learning on achievement, retention, attitude and learning process. Control group pre-test post-test experimental design was applied. It revealed that brain based learning environment has a positive impact on same level of learning, retention and attitude towards a course of university students.

Roehrig et al. (2012) reported a similar study with a science teacher in which 41 science teachers completed 160 hours of professional development on neuroscience. The experimental group included these 41 science teachers and 12 additional classroom teachers, who were used as a comparison group. The comparison group continued teaching in their normal routine while the experimental group introduced neuroscience to their students and used inquiry-based lessons. Pre-test and post-tests were given to each group to assess their knowledge of neuroscience. The teachers involved in the BRAIN U program's knowledge of neuroscience went from 53.6% to 78.7%. Observations were conducted in both types of classrooms to determine time spent in activities designed for inquiry. The percentage of time for inquiry in the comparison classrooms was 21% whereas in the experimental classrooms it was 39%. These results mark changes in neuroscience knowledge and teaching and learning methods for both teachers and students as a result of the education that BRAIN U provided (Roehrig et al., 2012).

Akyurek & Afacan (2013) conducted a study to examine the effect of brain-based learning approach on attitudes and motivation levels in 8th-grade students' of science classes. The pre-test/post-test control group research model was used in this study. The research was conducted with one experimental group and two control groups. Out of total 57 students, 19 of the experimental group and 19 each in both control groups participated in this research. In the experimental group, students were taught using brain-based learning approach. The experimental group using brain-based learning performed better in achievement test scores. The achievement was determined to be statistically significant differences in favor of the experimental group.

Remadevi (2014), in a research project using brain based learning approach for 9th grade chemistry, took sample of 60 students in experimental and control group that participated in this experimental study. The findings of the study suggested that BBI is effective in bringing positive change in achievement level of students taught through BBI approach as compared to traditional approach.

In another similar study, Shabatat and Mohammed (2016), the impact of teaching-learning program based on a brain-based learning on the achievement of female students of 9th grade in chemistry. The researchers designed instructional plans, pre achievement and past achievement test. The study consisted of a sample of 64 female students in the 9th grade secondary school students. The results indicated statistically significant differences in instructional achievement of the experimental group which used instructional method based on brain-based learning in chemistry.

Ozdemir and Sadik (2016) in a study on 6th grade students on the topic of fractions with the help of brain based learning. They observed that experimental group get benefit from brain based learning approach. The pre-test and post-test data was analyzed using t test.

The studies discussed above has given a clear indication that brain based learning principles have been proved to be significant in making classroom learning effective. It is now important to learn about the basic structure and important functions of brain, which are helpful in the understanding of brain based learning in more specific way.

The human brain consists of millions of nerve cells packed in the skull to perform different functions of human body, one of which is learning. It could be of any type, may it be life skills related to routine life or specific skills to perform specific tasks.

The brain is divided into a left and a right hemisphere by a deep groove, which runs from the front of the head (at left) to the back (at right). In each hemisphere, the cerebral cortex falls into four main divisions or lobes, each is best known for one or two specialized functions. The frontal lobes house the motor area (responsible for instructions of movement) and Broca's area, which handles the production of speech. The faculties of planning and mental representation of the outside world are also attributed to the frontal lobes. In the parietal lobes, the cerebral cortex processes the signals that come from the sensation. The temporal lobes are concerned with memory and hearing, and in Wernicke's area, with the ability to understand language. The occipital lobes are specialized to manage the processing of vision.

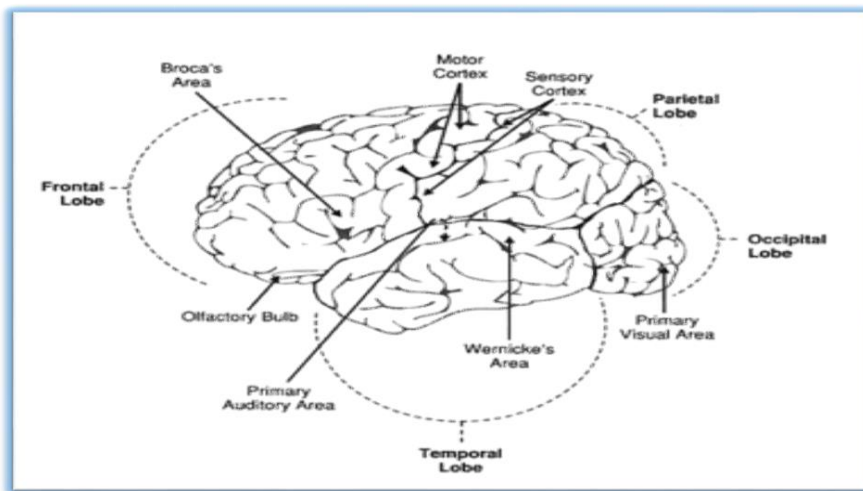


Figure 3: Different Brain Regions for Specific Brain Functions

1.1.4 Learning Changes Structure of Brain

Learning is a physical change that happens in the brain in terms of nerve connections. The size of the brain increases with the growth of body till it reaches adult level. In addition to changes in connectivity at the cellular level, learning has also been linked to gross structural changes in the brain. For example, a well-known study demonstrated on London taxi drivers, who are well learned about the street plans and routes and rapidly recall them, it was reported that the posterior part of the hippocampus in a sample of taxi drivers was larger than those of non-taxi drivers. Moreover, this growth was proportional to the number of years they had been driving a taxi (Maguire et al., 2006).

In another study on the brain to observe the learning patterns of the activity on a computer screen, Abbot and Ryan (2001) have found that the brain reshapes itself according to its usage or non-usage. They ascertain that “Humans are predisposed to learn from and adapt to their environment”. Changes in the brain generally occur as a function of the use of the brain. In other words, the brain continuously adapts to its environment.

Diamond (1988) stated that experience has been found to affect the physical structure of the brain, a phenomenon known as plasticity. The brain grows new connections with environmental stimulation and modifies itself structurally depending on the amount and type of usage (Healy, 1990). Each new stimulation and experience rewires the brain. Enriched environments enable the brain to grow more neural connections, thickening the cortex of the brain, while less stimulating environments actually have a thinning effect on the cortex (Diamond & Hopson, 1998).

Enriched environments provide a challenge by including reading and language, motor stimulation, a focus on the arts, stimulating surroundings, and a wide variety of approaches to thinking and problem-solving. Exposing children to a variety of problem-solving approaches acknowledges the complexity of the brain. Children should be encouraged to explore alternative thinking, multiple answers and creative insights. More we learn, more unique our brains become because experience structurally changes the brain. Neural pathways that help us to excel at thinking skills are very specific and while a student may succeed at one type of thinking, he or she may have difficulty with another.

1.1.5 The Plasticity of the Human Brain

Changes in the brain generally occur as a function of the use of the brain. In other words, the brain continuously adapts to its environment. Research on plasticity is another significant finding of brain sciences. Brain plasticity, the ability of brain structure and organization to change based on demands and experience, is retained throughout our lives (Maguire et al, 2006). Studies on recovery from brain damage are relevant to quote for plasticity of the brain. Research on plasticity in the adult brain has benefited from brain imaging techniques such as MRI and PET. Immordino (2008) presents findings from 2 boys, Nico and Brooke, each of whom lost half of his brain. The remarkable recovery of functions in these two boys highlight the degree, to

which emotional and social experiences shape brain development, as well as the importance of plasticity. The brain is plastic - it means that learning is possible at any age, but it is not equally plastic for all brain tissues. Cortex shows the most plasticity. Similarly, in another study, Geake and Cooper (2003) proposed a study of adaptive plasticity that relies on stimulus-reinforcement and examine possible implications for pedagogy and curriculum depth.

1.1.6 Sensitive periods of learning

When the child is born, he is able to see and the signals are received on the visual cortex, where synaptic density (nerve connections) increases, which is at peak at 10 months of age. After that, the pruning process (shunting of extra connections) starts and there is a decline in synaptic density until it stabilizes at the age of 10 years and remains at this level throughout adult life. Different parts of the human brain mature at different times (Bruer, 1997; Hall, 2005). This has been established by neuroscience that human brain is adaptable and shows plasticity but it is also said that some sensitive periods to learning also exist which means that learning is more efficient during that period of life.

The language and its components like sounds, vocabulary and grammar are mastered in early childhood using innate learning mechanisms that help children to learn a vast amount by listening to and interacting with adults and siblings. Because children acquire language without any explicit instruction well before they enter formal education, it has been suggested that humans have a predisposition to learn and generalize the rules of language (Pinker, 1994). Second language learning in early childhood also produces a positive effect on the brain. It was reported that bilingual children are better in concepts and general rules of grammar than their monolingual counterparts (Petitto & Dunbar, 2004).

1.1.7 Pre-existing knowledge and Learning

New learning is constructed on the basis of pre-existing knowledge. The results of a study suggest that when students are presented with information that they do not believe, they inhibit the information and this will make acquisition of new concepts extremely difficult. Most importantly, we find that presenting students with information inconsistent with their theory results in inhibition rather than a

restructuring of knowledge (Petitto & Dunbar, 2004). Hence, teachers should be aware of the understanding of the particular concept that their students already have, otherwise every effort to make them learn will not be successful.

There is widespread agreement that prior knowledge influences learning, and that learners construct concepts from prior knowledge (Resnick, 1983). More recent research findings have shown that the ability to relate new information to prior knowledge is critical for learning. It is not possible for someone to understand, remember or learn something that is completely unfamiliar. Some prior knowledge is necessary to understand the task at hand. But having the pre-requisite prior knowledge is still not sufficient to ensure adequate results. People must activate their prior knowledge in order to be able to use it for understanding and for learning. Research shows that students do not consistently see the relationship between new material that they read and one they already know.

There are major developmental differences in learning. Research shows that learning is enhanced when teacher pays close attention to the prior knowledge of the learner and use this knowledge as the starting point for instruction (Bransford, Brown & Cocking, 2000; Coward, 1990).

1.1.8 Patterning in the brain

The brain innately seeks meaning through seeking patterns. The patterns give context to information that may otherwise be discarded as meaningless. Freeman (1995) suggests that the making of familiar connection and the locating of conforming neural networks or pattern making are critical to the formation of meaning. For younger children, hands-on, experiential and relevant learning enables the patterns to develop. Relevance helps children to make personal connections between what they already know and the work they do in class. Relevance can be created through linking with prior learning and experience and context and pattern making may result from the use of universal concepts and core organizing principles (Jensen,1998,2005).

1.1.9.Imitation

Neuro-imaging techniques have shown that, when human subjects observe someone making a movement, without making any movements themselves, a component of their brain's motor system is activated which are named as mirror

neurons (Iacoboni et al.,1999). Human beings naturally imitate other people's gestures, facial expressions and actions. Imitation seems to play an important role in learning about other people (Meltzoff, 1999).

Social psychology studies suggest that there are massive effects of peer groups in learning. A deeper understanding of imitation, its role in learning and its brain basis might enable us to understand how it can be exploited for beneficial learning or controlled in the case, where it might be harmful (Blakemore & Uta Frith, 2007).

1.1.10 Emotions and memory

Emotions have a powerful influence on learning and memory. Studies on declarative emotional memories show how front temporal regions work conjointly to retain emotionally arousing events even from long-term stores (LaBar & Cabeza, 2006). People were scanned while viewing and remembering emotionally arousing films (Cahill et al., 1996). Activity in the amygdala, while viewing the emotional films, was highly correlated with the number of emotional films (but not the number of neutral films) recalled. This suggests that the amygdala is crucial for the memory of emotionally salient events, which are better recalled than neutral events.

Retention is better for emotionally arousing words over neutral words when memory is tested after long (1 hour to 1 day) than after short (immediate) delay intervals (Labar et al., 1998; Sharot et al., 2004). Such observations evidence that emotional arousal benefit memory consolidation.

LeDoux (1994) stated that emotions drive attention, create meaning and have their own memory pathways. They cannot be separated from learning, and in fact, may drive to learning. Emotions help us make better value-based decisions, as all values are emotional states. Emotions generate and drive the execution of our goals and plans (Freeman, 1995). Chemicals activated by emotions help us recall things better, thereby, affecting long-term memory. When emotions are engaged, the brain learns fastest and easiest. During the early school years, as children develop, they form new ways of representing the world and they also change the processes and strategies, they use to manipulate these representations. One of the qualities of a good learning environment is emotional safety. Having time to learn, the pursuit of a learning goal, novelty and repetition, problem-solving, visuals, and creativity are all parts of the focus for online instructors .The brain pays the most attention to what is personally

meaningful or that has a link or association to previous learning. If brain perceives a threat, either physically or psychologically, the cerebral logical thinking process becomes inhibited or shuts down as the hypothalamus and pituitary gland release adrenaline in the fight or flight response. While this response is a physiological response, it is not conducive to learning. The thalamus acts as a relay station to direct information to the amygdala and the hippocampus. The amygdala is at the center of the limbic system (emotional brain) and, if the brain perceives a threat, then it closes the connections to the prefrontal cortex of the brain and logical thinking becomes impaired.

1.1.11 Sleep and memory

Neuroscientists believe that sleep after learning helps to recall later. Sleep plays an important role in the consolidation of memory. Its effects are clear in adults for procedural and declarative memory (e.g. recall of facts). Declarative memory is important in school performance (Potkin, 2012).

In an experiment on high school students' ability to remember vocabulary, it has been found that declarative memory is enhanced when sleep follows within a few hours of learning, independent of time of day and with equal amounts of interference during retention intervals (Gias et al. ,2006).

Memory consolidation refers to the transformation over time of experience-dependent internal representations and their neurobiological underpinnings. The process is assumed to be embodied in synaptic and cellular modifications at brain circuits in which the memory is initially encoded. To proceed by recurrent reactivations, both during wakefulness and during sleep, there is culmination in the distribution of information to additional locations and integration of new information into existing knowledge (Dudai, 2015). Rapid eye movement (REM) sleep is helpful in strengthening learning. Brain imaging study showed that when children were given a task to press the keys of the computer by watching visual signals on a computer screen, their brain area showed great activity during sleep (Maquet ., 2006).

1.1.12 Exercise on learning

On studying the effects of exercise on the brain (studied on the brain of rats) by neuroscientists, it was found that with exercise, new nerve cells are formed in a

hippocampal region of the brain. This finding leads us to conclude that exercise has a positive effect on learning. In some other studies, exercise has a positive impact on cognitive behavior and academic performance with increased brain activity (Tomporowski et al., 2008).

1.1.13 Individual differences in learning

Developmental psychologist Howard Gardner (1993) has argued that there are many dimensions of human intelligence other than the logical and linguistic skills that are usually valued in most school environments. There are individual differences in learning. Some children are gifted in music; others have exceptional spatial skills (architects and artists), bodily/kinesthetic abilities (athletes), abilities to relate to other people, etc. Schools must create the best environment for the development of children taking into consideration such individual differences (Case, 1978; Gardner, 1993).

There has been a major paradigm shift in a whole educational setup with these new evidence-based researches and findings. MBE science, which is projected as an interdisciplinary or rather trans-disciplinary science of human learning, involves science, which is related to learning in humans in any form. Major among these are psychology, neuroscience, developmental biology, genetics and education. The research data of all the subfields filtered through the lens of education is being gathered which is exploring new challenges and finding ways to solve various educational problems, may it be learning disabilities, motivational problems, development of thinking skills, memory retention or similar sort of teaching-learning problems.

1.1.14 Relationship of Memory with Learning

To better understand the brain, we need to know the basic memory systems. Memory and attention both are important aspects of learning. Hence, it is important to transfer working memory to the long-term memory store. Memory is a vital function of the brain. It is important for learning, both formal and informal, as without long-term memory student would fail in the examination and would be non-functional in society, too. Memory is stored in neurons in physiological form (Kandel, 2007). It is stored in the temporary storage as working memory from where it could be transferred to long-term memory (Baddley, 2001). The teacher should plan activities

that enhance memory by creating authenticated learning experiences relating new information to real life experiences (Sylwester, 1985).

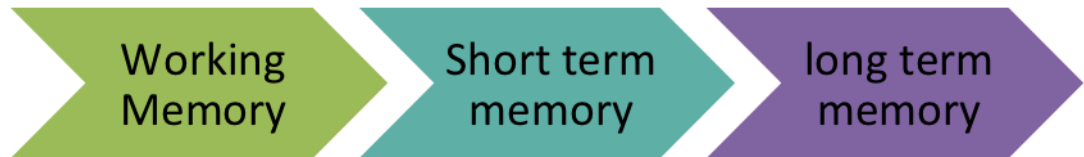


Figure 4: Conceptual representation of different types of memories

Memory is the information stored for its future consolidation in the brain. There are different areas, which store different memories. From research on brain-damaged patients and functional imaging, we know that there are multiple memory systems in the brain. (Figure 5). Any stimulus provided and received by the brain is processed and stored in neuron networks (Kandel, 2007). This information is filtered through different memories of past experiences. Episodic memories (memories of episodes) are stored in different brain areas from semantic memories (memories of facts). Thus, people with profound amnesia cannot remember episodes (what has happened to them a few minutes ago) but can retain their semantic knowledge and can still talk. Short-term memory and long-term memory both are important for us. It has been proved by researchers that emotional memory is more liable to be stored for long term.

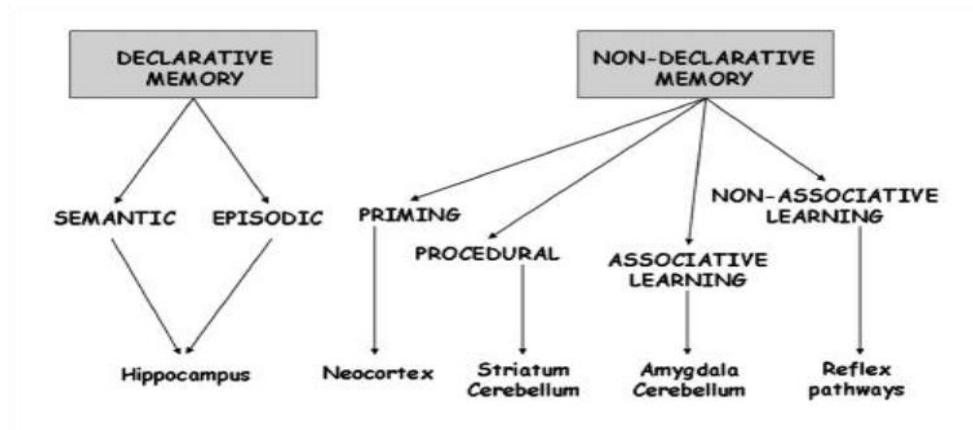


Figure 5: Memory systems (Brandford et.al.2000)

The instructional process focuses on the development of memory and then making that memory transferred to long term, which further gets integrated into thinking to find the solutions to the real-life problems (**Figure 6**). The main medium of delivery of instructions to the students is teachers; hence, teachers should be trained to lead the process of instructional delivery in such an effective way, that it gets transferred to thinking.

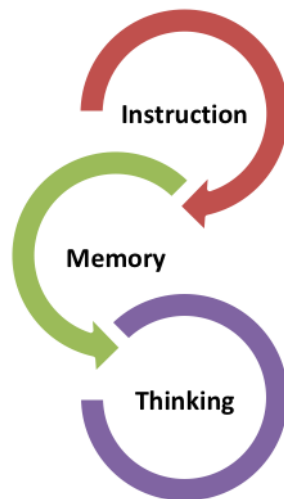


Figure 6: Integration of learning to thinking through instruction.

Education is a developmental process, which kept on changing its philosophical views with the need of society and creation of new knowledge i.e. from naturalism to realism to pragmatism. Since the concept of learning and teaching came into existence education has its own system. There is always a theory, which came to light and was the guiding force behind the philosophy and practice of teaching and learning. Similarly, psychology too, developed its roots from behaviorism to cognitivism, now constructivism. All these have absorbed the current needs and requirements of society in their theory to provide guidelines for the implementation to take benefit out of them to solve the problems of society. Learning theory does not provide a simple technique for designing effective learning environments, just as physics provides only theoretical knowledge but does not dictate how to build a bridge (Simon, 1969).

Teaching and learning are interrelated as the success of teaching depend on how much learning it has caused. Success in teaching occurs when the whole class is in

synchronization with each other, where the teacher has its role to play to create such learning environment (Kent, 2013). Teaching is a complex system of human interaction to make a desired change in the behavior of learners. It requires cognitive ability to make human interaction more synchronized (Rodriguez, 2013). Teaching brain along with learning brain is another term used in MBE, which highlights the effect of teachers’ personal beliefs, motivation and attitude on the learning of their students.

Today, information flow is very fast. Hence, the future generations have a lot of information to deal with but our methods of teaching are not adapting to the flow of information. So, we need to move with the current theory of learning, which should be adapted to current information. It should not be limited to any specific philosophy or theory of learning rather it should integrate all philosophies to derive best possible solutions for the common cause of better educational system.

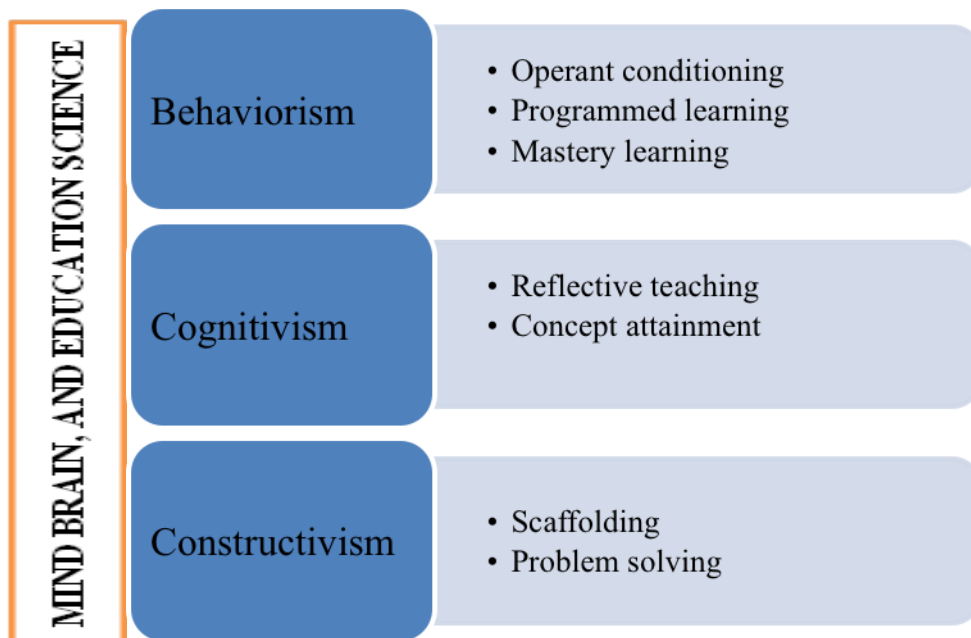


Figure 7: Relationship of philosophies of education with mind, brain and education

The new developments in the science of learning raise important concerns about the design of learning environments that suggest the value of rethinking, what is taught and how it is being taught. The main objective of MBE is to make teaching and

learning more effective by exploring the methods and problems of teaching and learning, to put light on theories of learning through evidence-based research (Immordino, 2011) and guiding educational philosophy. Tokuhama-Espinosa (2008) has developed a course structure for this new field of MBE. The major principles of MBE are designed through ground theory analysis of approximately 4400 studies related to neuroscience psychology and education dealing with the teaching-learning process.

The present study is designed to develop an Instructional model based on Mind, Brain, and Education science approach. Hence, the basic principles, tenets and instructional guidelines of MBE as proposed by Tokuhama-Espinoza (2010) were referred to as building block to design an instructional model.

1.2 PRINCIPLES OF MIND, BRAIN, AND EDUCATION

Mind, Brain and Education Science suggests the best practices based on evidence to inform the educational process i.e. how people learn, different processes of learning and how memories are formed and retrieval is done in the brain, what are different factors that impact learning, how teachers' motivation and personal beliefs affect the teaching-learning process. It is also called the new brain-based teaching by Tokuhama-Espinoza (2011), who, in a study in the development of standards in the new academic field of mind, brain and education science through ground theory, supported by meta-analysis of the entire literature available in the field under study, proposed 10 instructional guidelines after defining 21 different principles and 12 tenets in the field of Mind, Brain, and Education Science as discussed below.

Principle 1: Each brain is unique and uniquely organized

Human brains are as unique as faces, although the structure is same, genetic and individual differences make it unique in each of its own way e.g. monolinguals process languages in a different way than the multi-lingual. It is important to know the past experiences before starting new learning. Teachers should have the ability to differentiate instructional and assessment practices that value each individual's uniqueness. People prefer different learning styles-kinesthetic, auditory or visual,

which can be used depending upon the preference for new information. The teacher should maximize the use of all the styles during the presentation of material to cover individual differences.

Principle 2: All brains are not equally good at everything

Context and ability influence learning, the context here is the environment, the level of motivation and prior knowledge about it, all these influence person's ability to learn. The teacher, being a behavioral modifier, should diagnose the potential of each student and design the individualized instructional learning program to help the student in understanding his strengths and weakness.

Principle 3: The brain is a complex, dynamic system and is changed daily by experiences

Brain changes daily with experiences. 'Use it or lose it' is a famous quote to define that active synapses are strengthened with experiences and less active synapses are weakened. This indicates that if knowledge/information is not used, it is liable to be lost in memory. Hence, every method will work if rehearsal and repetition are done. It would result in observable learned behavior.

Principle 4: The search for meaning is innate in human nature

Humans are born to learn. To search for meaning, it is an inborn human need. Learning is due to the evolutionary process of human survival. If the brain is engaged, it continues to explore, hence new methodologies that excite and stimulate to learn are important.

Principle 5: Brains have a high degree of plasticity and develop throughout the lifespan

Plasticity is the brain's ability to adapt to new learning and the flexibility to learn. Plasticity works well with brain-damaged persons, who recruit different brain regions to perform certain tasks. The brain is susceptible to challenges. As physical exercise keeps the body fit, challenges stimulate brain for better performance. To keep brain active to learn is to challenge it. Learning can happen at any stage, provided, the brain is actively involved and proper stimulus is provided.

Principle 6: Learning is based in part on the brain's ability to self-correct

Brain corrects the information received by self-reflection. The brain adjusts behavior when well-being is challenged. Self-correction is based on actions, which

are undesirable, sometime to protect self-esteem, humiliation or other bad feelings. Self-reflection means it takes time to ponder over new ideas in relation to existing schemas, where integration of new information to mental schemas is done. It has a strong implication for teaching. Students should be given time to reflect and make better choices. Well-designed feedback is important for better teaching.

Principle 7: The search for meaning occurs through pattern recognition

Brain learns through patterns. It relates to the information already there and it compares new information with past information. Teacher helps students to identify their own relationship to learning to that they learn better.

Analogies, reason, metaphors are useful in making connections between concepts. Once they comprehend the gist and then they have a better idea of concept with further experience and knowledge. The teacher should help students relate the unfamiliar conceptual ideas in a way that make a pattern, it helps for the learning to be successful.

Principle 8: Emotions are critical to detecting patterns, to decision-making and to learning

Emotions play vital role in learning particularly indecision making and choice making; it has enormous value in creating emotional link to learning contexts. It is strengthened with various evidence-based studies. Goleman's work on emotional intelligence (1996) reflected the role of affect in learning, the idea of what a student feels about what is being taught, by whom, how, when and where, all impact the quality and efficiency of learning.

Principle 9: Learning is enhanced by challenge and inhibited by threat

Learning is enhanced by challenge and is typically inhibited by threat, although it is a personal context that what is challenging and threat, sometimes, what is threatening for the one, is challenging for others. The good learning environment should be non-threatening and filled with personal challenges and low threat levels. The teacher should be aware of this concept and should classify the challenging learning environment with low threat levels.

Principle 10: Brains seek novelty

Human brain seeks novelty. It quickly detects fluctuation and changes, while searching for a pattern. It is altered to its thirst for novelty. The teacher can use the

varying classroom routines and create significant learning experiences, which stimulate meta-cognitive understanding and stimulate new learning by linking past knowledge to new ideas.

Principle 11: Human learning involves both focused attention and peripheral perception

Attention can be defined as the appropriate allocation of processing resources or being able to concentrate on one aspect of incoming stimulus while effectively ignoring others such as distractions of other external stimuli.

Principle 12: The brain conceptually processes parts and wholes simultaneously

The mind processes the whole information simultaneously, so it is better to reveal the whole concept before explaining its parts so that students can relate the information as a whole set.

Principle 13: The brain depends on interactions from other people to make sense of social situations

Humans are social creatures. Learning cannot be isolated from social contexts. Support from others is critical for academic performance. Learning occurs better by sharing the experiences, it strengthens the concepts and hence, the teacher should maximize the use of group activities.

Principle 14: Feedback is important to learning

In order to improve learning students should know their errors. When guided, they can overcome those errors and improve their performance next time. Feedback is important to know, where they went wrong so that they can improve, but it should be done tactfully to encourage and not discourage the students.

Principle 15: Learning is a constructivist process and the ability to learn goes through developmental stages as an individual matures

The learners always construct learning on past experiences or knowledge. It is important to know the past experiences of learners, before giving them new information, as it becomes building blocks of new information in later stages of life.

Principle 16: Learning involves conscious and unconscious processes

Learning is, both, conscious and unconscious. Conscious learning occurs in the classroom. The mechanism of unconscious learning is not so clear. There are two

ways in which learning occurs unconsciously. First there is the unconscious perception of voices and faces, how we feel about the information, which is being delivered, therefore, facial expressions and voice tone is important in making good learning environment.

Second, sleep is important for declarative memory. Sleep deprivation has a negative impact on memory. Hence, students should be made aware of the effect of sleep deprivations and be encouraged to have good night sleep; otherwise, rote memorization is not always integrated to long-term memory. Importance of Random Eye Moment sleep (REM) is for memory consolidation is also highlighted.

Principle 17: Learning engages the entire physiology

The mind-body connection in learning means that nutrition, sleep, exercise, all influence brain's potential to learn. Parents and students should be made to understand the impact of these on learning potential. The efforts should be made to spread awareness through the guidance of parents and students, to take care of these factors, intervention programs for the needy can be designed.

Principle 18: Different memory systems of the brain.

The brain has different memories i.e. Short term, working, long-term, emotional, spatial, rote memories. It receives and processes information in different ways and it can be retrieved through different neural pathways.

The brain uses different memory systems to give input and get the output of the information. It is mainly sensory input, which is stored in working memory, but recall requires different system i.e. long-term memory. When the transfer of learning to long term does not occur from working memory, learning diminishes. The teacher should take care of this, by incorporating problem-solving teaching techniques where students need to relate the information in working memory to solve those problems. The rehearsal and practice are helpful in the transfer of learning.

Principle 19: The brain remembers best when facts and skills are embedded in natural contexts

The human brain learns well when facts and skills are embedded in natural contexts, which might be helpful in solving their real-life problems. Memory improves when facts are related to real-life contexts. But some facts are concepts that

cannot be directly related to real life contexts. Maximum use of videos, visuals and field trips can be done than merely rote memorization of the facts.

Principle 20: Learning relies on memory and attention.

Memory + attention = learning. This clearly shows that no learning without memory and attention exists. The teacher should be aware of different memory systems and attention systems so that learning experiences could be engaging and memorable to the students. Student-centered activities should be promoted.

Principle 21: MBE principles apply to all ages

The human brain has a high degree of plasticity and it develops throughout its lifespan, although there are sensitive periods for learners, but no critical periods, which limit opportunities to learn. The order, in which skills are learned, is more important than the age at which it is learned.

1.3 TENETS IN MIND, BRAIN AND EDUCATION

Similar to the principles, the twelve tenets of the new model also come from the beliefs and neuro-myths table and/or the meta-analysis. Twelve tenets appeared with frequency in the literature. Whereas the 21 principles discussed above, are true for all learners, each of the twelve tenets relates to a highly individualized aspect of learning as explained in the meta-analysis above. The core tenets of mind, brain, and education: the new science of teaching and learning are discussed below.

Tenet 1: Motivation Impacts How Teachers Teach and How Students Learn

“All brains are not equal in their ability to solve all problems. Context as well as ability influences learning. Context includes the learning environment, motivation for the topic of new learning, and prior knowledge and self-esteem impacts learning and academic achievement.

Tenet 2: Stress

Stress impacts learning. ‘Good’ stress (eustress) heightens attention and helps to learn, while ‘bad’ stress detracts from learning potential.

Tenet 3: Anxiety

Anxiety blocks learning opportunities. Emotions are critical to decision making.

Tenet 4: Depression

Depressive states can impede learning.

Tenet 5: Voices

Other people's tones of voices are quickly judged in the brain as either threatening or non-threatening. The human brain judges others' faces and tones of voices for threat levels in a rapid and often unconscious way, influencing the way information from these sources is perceived (i.e. valid, invalid, trustworthy, untrustworthy, etc.).

Tenet 6: Faces

People's faces are judged nearly instantaneously (i.e., good or bad intentions). Human brain judges others' faces and tones of voices for threat levels in a rapid and often unconscious way, influencing the way information from these sources is perceived (i.e., valid, invalid, trustworthy, untrustworthy, etc.).

Tenet 7: Movement

Movement can enhance the learning of academic subjects.

Tenet 8: Humor

Humor can enhance learning opportunities.

Tenet 9: Nutrition

Nutrition impacts learning (good eating habits contribute to learning and poor eating habits deprive the brain's ability to maximize its learning potential).

Tenet 10: Sleep

Sleep is important for declarative memory consolidation. Sleep deprivation also has a negative impact on memory.

Tenet 11: Learning Styles

Learning styles (cognitive preferences) are due to the unique structure of individual brains. All people use kinesthetic, visual and auditory pathways to take in new information, and there is strong evidence that different people use different processing strategies at different times depending on the context of the learning. Human brains are as unique as faces; while the basic structure is the same, there are no two, which are identical. While there are general patterns of organization of how different people learn and which brain areas are involved, each brain is unique and uniquely organized.

Tenet 12: Differentiation

Differentiation (allowing students to learn at different paces) in classroom practice can be justified by the fact that students have different bits of intelligence and cognitive preferences.

1.4 INSTRUCTIONAL GUIDELINES IN MIND, BRAIN, AND EDUCATION

Each of the instructional guidelines given below is built upon the principles and tenets mentioned above. Ten instructional guidelines were prominent in the literature and are detailed exactly which tenets and which principles support each in the meta-Analysis above. Each of these guidelines is described briefly below.

1: Good Learning Environments are Made, Not Found

Teachers know that they are responsible for structuring the learning environment of their classrooms. This begins with showing and requiring respectful exchanges, a class assessment of what students already know and a clear vision of what they need to know to learn the material well and the design of learning activities that are student-centered and dynamic.

2: Sense and Meaning

Try to link what is taught in class with applications in the students' lives. This requires not only thoroughly knowing the subject matter but also knowing the students' needs. The understanding of students' needs can only be achieved through a clear assessment of prior knowledge and appreciation of the cultural baggage they bring with them to class.

3: Memory

Teachers appreciate the complex nature of memory and understand the vital link between memory and learning. They should also vary their classroom activities to take advantage of different memory systems.

4: Attention Spans

Linked closely with memory is the importance of attention spans. Students have limited attention spans, which vary by individual, subject matter and activity. The teacher should avoid passive activities, which can easily bore students. Mind, Brain, and Education science professionals opt for the delivery of information using proven

methods and strategies that engage learners and maximize opportunities to gain new knowledge.

5: The Social Nature of Learning

Learning often occurs in social contexts, such as classrooms and it can often be enhanced through social interaction, as in student group work, discussions or debates.

6: The Mind-Body Connection

The teacher should understand the ways that the body impacts the mind and the mind impacts the body. He should have known about the ways nutrition, sleep and exercise impact learning.

7: Orchestrated Immersion

Classrooms are filled with different types of students, with a different brain and different preferences for how to receive new information. Successful teachers will consider these differences to be an opportunity, rather than a problem. Mind, Brain and Education science professionals will create interactions that integrate the strengths and weaknesses of the learners in such a way as to maximize the experiences of all.

8: Active Processes

To engage the learner, the teacher should be involved. Such involvement is often active (though reflective processes are also important). Good Mind, Brain and Education science professionals know when and how to integrate active learning activities into classroom activities in order to enhance learning potential.

9: Metacognition

Incorporate activities that stimulate metacognition, as the time for reflection and to “think about thinking” elevates the overall conceptual grasp of new concepts.

10: Learning Throughout the Lifespan

Human brains have a high degree of plasticity and continue to develop throughout the lifespan. They also know that while “Human learning is achieved through developmental processes which follow a universal pattern for most skills, including academic skills shared across literate cultures, such as reading, writing, mathematics.” These two points mean “There are ‘sensitive periods’ (not critical periods) in human brain development, in which certain skills are learned with greater ease than at other

times”. Good Mind, Brain and Education science professionals take advantage of this fact to teach skills at an appropriate time based on the characteristics of the learner.

The above-mentioned principles, tenets and instructional guidelines are filtered through the psychology and neuroscience experts to apply in education. In present educational scenario with the growth spurt of knowledge, our aims of education have also changed from knowledge acquisition to problem-solving, and to decision-making ability. Earlier, the aim of teaching was only information processing, but now we want our children to be able to solve the real world’s problems, to make the right decisions, be creative and bring positive changes in the world around them. So, our teaching methodologies need to be revised for the better. The teacher should know how their learners take learning in their brains and what are the basic mechanisms in the learning process. Although a lot of teaching methods are there, which could individually deal with these aims, but we need to build a common method, which would be able to deal with all the teaching aims single-handedly. This could be done to get the benefit from all the constituent fields of learning sciences put together in a single discipline, and Mind, Brain, and Education (MBE) as a discipline caters to all these needs. MBE is naturally at its best to fulfill these requirements. As said earlier, MBE is not a totally indifferent theory; rather it is built on the base of all the prevalent theories from behaviorism to constructivism and it involves all the findings which are established in these theories (**Figure 7 & 8**). It has emerged as a science of teaching and learning and has added the best knowledge from all the related fields to enhance the knowledge about teaching and learning as a process.

The information of MBE is checked on the standards of its constituting fields. Nevertheless, it is well known that educational theories are not always implemented properly in the classroom (Boddy, Watson et al., 2003). To change the theory to practice there is a need to develop a framework based on applications of major implications of that theory to the process of teaching and learning, the development of an instructional model using MBE principles to use in the classroom teaching practices could be used to bridge the gap of theory to practice.

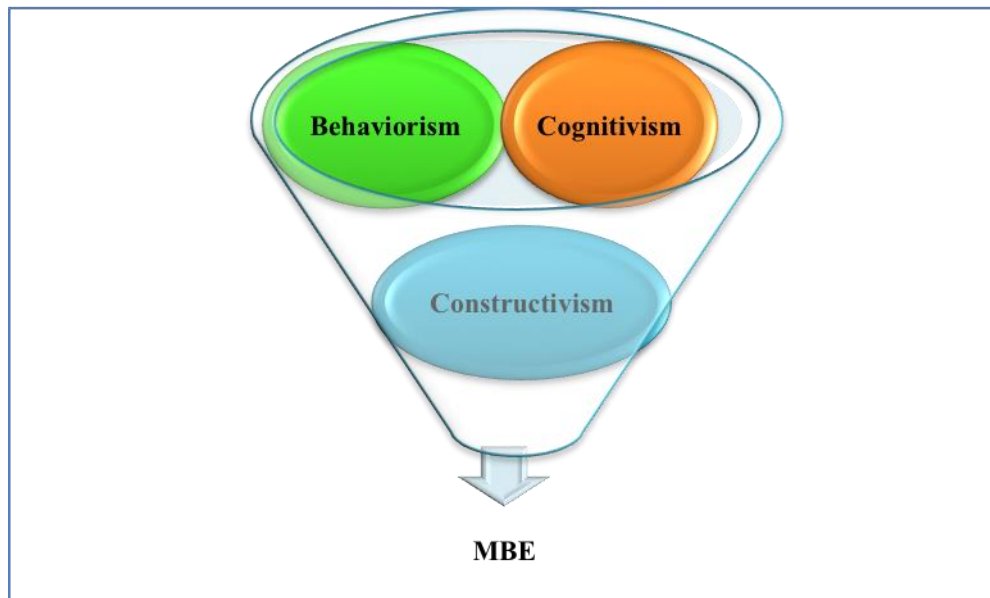


Figure 8: Integration of three philosophies of education in MBE

1.5 RATIONALE OF THE STUDY

“All animals learn very few teach.”- Blackmore & Uta Firth (2007)

Learning is an intrinsic; all animals learn but teaching is a specific trait exhibited specifically by humans. There are many theories of learning which are guiding the process of teaching. Among those, there is behaviorism, cognitivism and neo constructivism. Behavior is the manifestation of thinking. The person’s thinking is dependent on neuro-chemical and electrical impulses generated in the brain, that processes the information stored in the brain and suggest an active thought to be produced and reflected in behavior. Genetics also has an impact on thinking as the genetic makeup of an individual has variations. Hence, the behavior is an individualized thing, but it can be changed through training and learning. This is the ultimate aim of education. Learning is defined as the change in behavior. It has also been proved through research that environmental effect is more significant on human behavior than genetics. So, it can be concluded that with effective training desired changes in thinking are possible.

Teaching is designed on the basis of objectives to be attained through different methods. The instructional objectives to be attained at the end of a secondary stage of education have been developed by the NCERT keeping in view the needs of the

society, in particular, and the country, in general. The NCERT model of classification of objectives is based primarily on Bloom's Taxonomy, development of high order thinking from the central concern of education in our society. It comprises of four objectives i.e. knowledge, understanding, application and skill to be attained in the core subjects of science, mathematics and social science, at the end of the secondary stage of education, which can be evaluated through the written examinations (NCERT, 2004).

According to Bloom's classification, knowledge, understanding and application are lower order thinking skills and analysis, evaluation and synthesis are higher order thinking skills. Higher order thinking basically involves the application of multiple criteria, reflection and self-regulation. Similarly, recall of information is an example of a lower order cognitive pattern or thinking skills.

In 21st century, school education has undergone major radical changes due to Sarv Shiksha Abhiyan and Right to Education, 2009. Sarv Shiksha Abhiyan and Rashtriya Madhyamik Shiksha Abhiyan are continuously working for the quality education for both elementary and secondary school children in the country as specified by National Curriculum Framework, 2005, which emphasizes that quality of education is to be ensured for the achievement of objectives. Mid-Day Meal (MDM) Scheme and School Health Programme are ensuring good health and nutritional status of school children in the government-run schools of the country. Various grants in aids are provided for maintaining a good learning environment in schools. School buildings are transforming into learning resources under the Building as A Learning Aid (BALA) scheme. Teachers are provided with information technology equipped computer labs and teaching-learning materials to aid their teaching. Computer Aided Learning (CAL) project to use ICT in teaching and learning, where teachers provide electronic content prepared in the regional languages for the use. Schools are well connected with broadband Internet connections to keep pace with the flow of knowledge. Although, every facility for quality improvement of the government schools is being provided, but there is no such instructional model, which could guide the teachers to properly sequence the teaching activities with the vast expansion of resources and knowledge. Teachers use different teaching methods according to their choice.

Instruction model is basically a plan of teaching and learning activities to organize learning. The application of knowledge of MBE in our educational setup is to guide the process of teaching, so that maximum benefit could be acquired. MBE science puts effort to engage the entire physiology of the learners, considering different psychological processes in mind, to create the best learning environment to make the learning successful and to make the whole process uniform. To guide the teacher, one such instructional model is required, which should be followed without interfering with the freedom to choose the pedagogical method of their choice. There are different models in educational practice like information processing model, advance organizer model, cognitive attainment model, etc., but these are the teaching models, which a teacher should use, to teach in the classrooms. These models serve the purpose of teaching a single concept and are effective on that part, too. There is a basic difference in teaching and instruction; an instruction is a vast term which includes teaching in it. So, when we are talking about instructions, whole teaching learning process is involved (teaching is the method of giving information but instructions are set for the whole developmental process with set objectives to achieve). MBE, being interdisciplinary in nature, is an advantage to any other theory, as it has inputs from all the fields of science, which are directly related to teaching and learning process. It does not guide on methods of teaching only, but also on the part of teachers, too, it provides guidelines as to what qualities an ideal teacher should have and what should be the mindset of the teacher because motivation on the part of the teacher is very important to ignite motivation in learners.

MBE has developed as a new science of teaching and learning to make a teaching and learning process effective. The theoretical base of MBE has projected some principles of learning that are relevant to teaching and learning process in the classrooms, it highlight the importance of emotions, psychological processes of processing the information and motivation. Brain is a complex structure of neuron and associated cells. It is dependent on the genetic constitution, environmental influences and health of individuals. Learning in the brain is not only a mechanical process of making new nerve connections, rather it is a psychological process, which is filtered through psychological filters of emotions and physiological processes. Psychological behavior of learners as well as teachers in the classroom is important. Although

teaching is mainly centered on learners only, somewhere it is dependent on the teacher's attitude, motivation and psychological behavior, which are reflected in their teaching. There are many studies on teaching effectiveness but in terms of MBE, teaching and learning occur in synchronization with each other. Hence, it is equally important to focus on the process of teaching as well as learning. To guide the teachers in the process of teaching several models have been put forth based on different contemporary theories of learning, the present study is to develop an instructional model, which could best analyze a learner's needs and help teacher to perform better in their teaching work, based on the theory of MBE Science.

Instructional model designed on the principles of MBE to sequence teaching process so that it would be effective in terms of methods to make learning effective and to make a teacher effective in using neuropsychological, physiological processes, and the role of emotions in their practice. The whole teaching process is based on inquiry and exploratory systems, where the brain plays a prominent role. MBE science explains meaningful links between concepts that are learned and their application in real life situation. Such links will strengthen their neural connections and integrate incoming information and experiences into their existing network. Educators and scientists have long known that teaching-learning and brain functions are intricately connected. But until recently, the fields of education and neuroscience have remained isolated in the classroom and laboratories respectively, with only sporadic attempts to find opportunities for strategic cooperation. Many areas of neuroscience are already producing research findings that could provide ideas to improve teaching methods and curricula. Studies of memory consolidation and retrieval suggest important aspects for learning. Keeping the neuro-scientific research findings in full view, an attempt is proposed through this study to design and develop an Instructional model for teachers to make teaching-learning process more effective. Effective design of instructional materials would elicit appropriate cognitive processes in the learner and mediates more successful learning outcomes.

Home environment and stimulus provided in the form of parental involvement and emotional security to the children play important role in the overall development of the children. Instructional model-based pedagogy along with parental cognitive stimulation could improve the educational effectiveness through improvement in

thinking pattern (**Figure 9**). The principles of MBE can be implemented using different teaching methods to create effective learning environments. Hence, Instructional model based on MBE can improve the educational effectiveness in terms of academic achievement and thinking skills of the learners. Teaching activities based on the model's guidelines could guide the existing time table and curriculum for the better teaching and learning experiences. It would further guide the teachers, stating how learning happens and how it can be made effective through the use of different methods of teaching and learning.

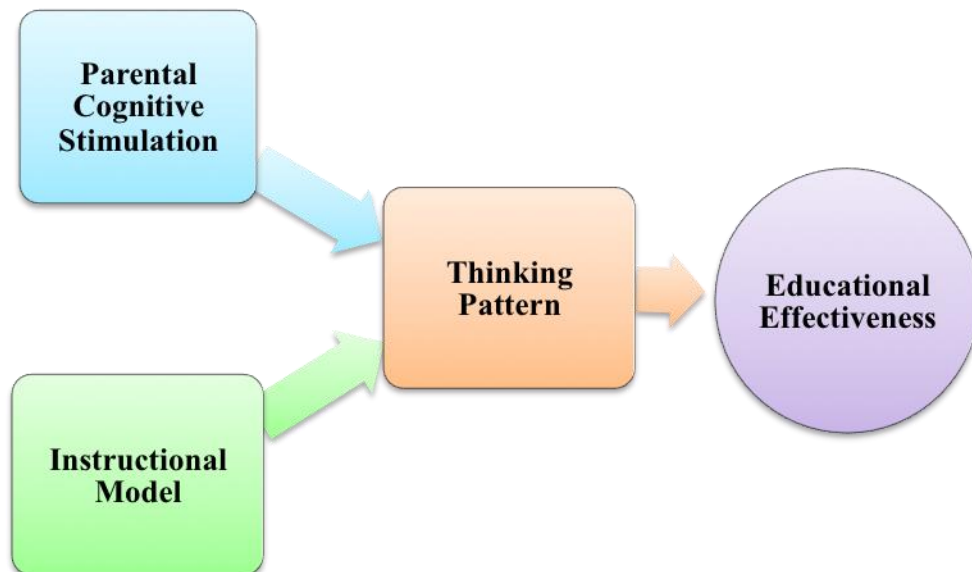


Figure 9: Conceptual framework showing the effect of different variables of study on the educational effectiveness

1.6 STATEMENT OF THE PROBLEM

The present study is entitled as:

DEVELOPMENT AND EFFECTIVENESS OF AN INSTRUCTIONAL MODEL IN LIFE SCIENCES BASED ON MIND BRAIN AND EDUCATION SCIENCE APPROACH IN CONGRUENCE TO THINKING PATTERN AND PARENTAL COGNITIVE STIMULATION

The attempt would be made to develop an instructional model on MBE principles, tenets and guidelines (Tokuhama-Espinoza, 2010) and effectiveness of this model would be measured on secondary level students.

1.7 OBJECTIVES OF THE STUDY

The main objectives of this study were:

1. To develop an Instructional model for life sciences based on Mind, Brain, and Education Science approach.
2. To find out the effectiveness of an Instructional model for life sciences based on Mind, Brain, and Education Science approach.
3. To explore the impact of an Instructional model for life sciences based on Mind, Brain, and Education Science approach to Thinking pattern of secondary school students.
4. To reveal the influence of Instructional model for life sciences based on Mind, Brain, and Education Science approach in congruence to Parental Cognitive Stimulation of secondary school students.

1.8 HYPOTHESES OF THE STUDY

On the basis of objectives, following hypotheses were proposed to be tested:

- H₁. Academic achievement of Secondary school students significantly improves with an Instructional model in life sciences based on Mind, Brain, and Education Science approach.
- H₂. There is no significant change in Thinking Pattern of Secondary School students with an Instructional model in life sciences based on Mind, Brain, and Education Science approach.
- H₃. Academic Achievement of Secondary School Students does not vary with Parental Cognitive Stimulation.

1.9 OPERATIONAL DEFINITIONS OF THE TERMS

The different terms used in the present study have been defined below:

1.9.1 Instructional Model (IM)

It is the sequence of steps and activities done in the process of teaching by the teacher. Instructional model provides guidance to the teachers in designing their teaching practices. It does not focus on any single method of teaching. Instructional

process and its sequence of activities undertaken by the teachers would be based on the research findings and principles, tenets and guidelines of brain research. The Mind, Brain and Education Science discipline would be providing insights and theoretical base for the development of the instructional model.

1.9.2 Mind, Brain, and Education Science (MBE)

It is the new discipline of study and the interdisciplinary field of Education, Educational Psychology and Cognitive Neuroscience. The MBE science is the new science of teaching and learning. It is an innovative way to consider old problems of education with best possible evidence-based solutions for the classroom (Tokuhama-Espinoza, 2011). It is not limited to any single philosophy of education rather it involve all major philosophies of teaching and learning to arrive at consensus with best possible methodologies to make teaching learning process effective. MBE science provides the best information that can inform new science of teaching and learning. It suggests new and innovative ways to deal with old problems of education. MBE science include history , philosophy and epistemology of its parent discipline i.e. neuroscience, psychology and education. In the present study principle ,tenets and instructional guidelines of MBE as suggested by Tokuhama-Espinoza (2010) are referred to as a guide to develop understanding of MBE.

1.9.3 Thinking Pattern

Thinking is the highest mental activity present in man. It is the process of mind, which reflects the individual's thought process. All human achievements and progress are simply the products of thought. The evolution of culture, art, literature, science and technology are all the results of thinking. Thought and action are inseparable - they are actually the two sides of the same coin. All our deliberate actions start from our deliberate thinking. To do something, a man should first see it in his *mind's eye* -- he should imagine it, think about it first, before he can do it. Thinking pattern of the individual reflects its thinking level. To make the thinking visible is to test the thinking dispositions over a standard test. In the present study, thinking levels suggested by Bloom's taxonomy in cognitive domain i.e. knowledge,

understanding, application, analysis and evaluation were taken into consideration for assessment of thinking dispositions. The scores at each level are further plotted as thinking pattern in life sciences based on the achievement scores at five levels i.e. Knowledge, Understanding, Application, Analysis and Evaluation.

1.9.4 Parental Cognitive Stimulation (PCS)

The term parental cognitive stimulation, here, implies the conditions and environmental stimulus provided to a child by his parents that may include the home environment, emotional support and motivation, the behavior towards physiological well-being and their general behavior towards their ward. In the present study parental cognitive stimulation as perceived stimulation is taken into account.

1.9.5 Life Sciences

Life sciences is sub-discipline of science, which is related to the life-related processes and functions of the living organisms and it includes many fields of science like botany, zoology, microbiology, biochemistry, human genetics, etc. In the present study life processes are taken into consideration; it includes human circulatory system, respiration, excretion, nutrition etc.

1.10 DELIMITATIONS OF THE STUDY

The model based on MBE would be applied in the secondary classrooms in designing the teaching and learning process. This model would work for the development of thinking skills as outlined by Bloom in the taxonomy of educational objectives. Five thinking skills of cognitive domain i.e. knowledge, understanding, application, analysis and evaluation are taken into consideration in this study. The model could be applied to all the classrooms irrespective of the age group. But, the present study is delimited to 10th standard life science subject and students of Government schools of Punjab are taken in consideration. Some other de-limitations are listed below:

1. The curriculum prescribed by the PSEB (Punjab School Education board) was followed by the school.

2. The Government schools run by Government of Punjab, Department of School Education.
3. The Government school with projector and Internet facility available.
4. The school had classes up to the 10+2 standard.
5. The students were from rural area.
6. All the teachers who taught had a professional degree in Education.
7. Students were from almost the same socio-economic background though they belong to different religious communities such as Hindu, Muslim or Sikh community.
8. Teachers were regularly given in-service training programs and were, thereby, updated in all current developments in education.
9. The school had facilities such as laboratories, classroom, space, etc.
10. Punjabi language as the medium of instruction in the school.

CHAPTER II

METHOD AND PROCEDURE

This chapter explains the methods of descriptive qualitative inquiry used to conduct this study. The overall zest of this study was to use the analytical literature review to develop a theoretical instructional design model that will be pedagogically sound and potentially applicable to the classrooms. Current literature demonstrates a gap in theory and practice of mind, brain, and education science. Therefore, the present study was designed to collect, review and analyze information on brain-based learning theory and instructional system design, in an attempt to develop a theoretically based instructional design model for classroom teaching. Both qualitative and quantitative information was researched, analyzed, synthesized and reported research articles were selected and reviewed accordingly. The principles, tenets and instructional guidelines of mind, brain, and education were analyzed to create and develop instructional design model for classroom teaching.

This chapter deals with all the methodological and procedural aspects of the problem. The procedure and design followed in the selection of the sample, hypotheses, etc. gives a description of tools employed and procedure adopted in data collection, besides the statistical operations carried out for the treatment of the data.

2.1 RESEARCH DESIGN

The research design is the plan or proposal to conduct research. It involves strategies of inquiry philosophical underpinnings and specific methods (Creswall, 2009). There are three main types of research designs i.e. quantitative, qualitative and mixed method research.

The present study is to develop an Instructional Model and to measure its effectiveness. So, two different approaches are used. Hence, it's more pertinent to call it a mixed method research. Qualitative methods were applied for the development of Instructional Model, the scale of Parental Cognitive Stimulation (PCS) and Thinking Pattern (TP) scale, whereas Quantitative research method was used to measure the effectiveness of the Instructional Model (IM) (**Figure 10**). The whole study is divided

into two phases i.e. development of instructional model and the effectiveness of instructional model. The effectiveness is measured through quasi-experimental research method that involves the use of single intact group in an experiment rather than randomly assigning subjects to the experimental groups.

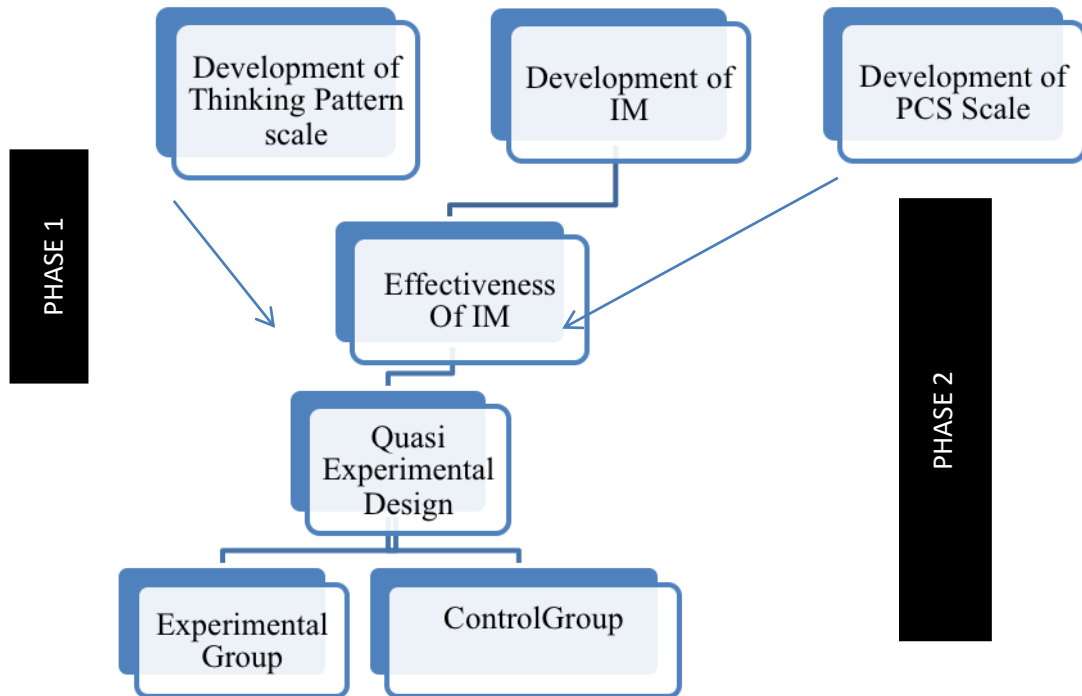


Figure 10: Diagrammatic representation of research design

PHASE 1:

DEVELOPMENTAL PHASE: The Instructional Model based on MBE guidelines and principles was developed along with Parental Cognitive Stimulation Scale and Thinking Pattern Scale. So, this phase includes three steps:-

- Development of an Instructional Model
- Development of Parental Cognitive Stimulation Scale (PCSS)
- Development of Thinking Pattern Scale

2.2 DEVELOPMENT OF THE INSTRUCTIONAL MODEL

The main objective of the study is to develop an instructional model based on mind, brain and education guidelines and to measure its effectiveness in terms of thinking pattern of learners in congruence to parental cognitive stimulation.

Development of an instructional model is a design process which was done with the help of theory of instructional science and MBE put together.

Several models of teaching have been developed in the last two decades in the western countries. BCSE's 5E is a very popular instructional model for science teaching, in which there are five phases i.e. 5E's Engage, Elaborate, Explain, Explore and Evaluate. This model has proved to be highly effective by research. Hence, it is clear that instruction delivered in a systematic sequence has a positive impact on learning. Similarly, brain-targeted teaching model consists of five phases, which highlight the importance of emotional climate and brain learning principles in teaching (Hardiman, 2012). The three phases of relaxed alertness, orchestrated immersion and active processes, act as a model to be used in classroom teaching (Caine & Caine, 2009).

2.2.1 Method of development

Instructions are the backbone of the educational process, which include activities performed in a sequence to ensure effective learning outcomes. Development of instructional model comes under the preview of instructional system design. So, the author proceeded with ADDIE (Analysis, Design, Development, Implement and Evaluation) model as a framework to outline different phases of developmental process (**Figure 11**).

Step1: Analysis:

Need Analysis of instructional model was completed by a survey using survey monkey™ (**Annexure 1**). It was done by sending the e-link of survey to different teachers of different Government schools of Punjab. Total ten questions about the methodology of teaching and resources available in the school were asked, on the basis of which, design requirements were identified. Total 17 teachers participated in the survey. The major result findings were that 46.67 % teachers felt that they have sufficient resources available in school for the teaching learning process. Out of the total, 75 % teachers were moderately satisfied with the academic achievement of their students but, no one showed full satisfaction. The teachers with 56.65 % out of total said that they do not follow any instructional model in their teaching but 81.25%

teachers feel that the instructional model based on brain based research on learning finding would be useful. 87.50% teachers quoted that teacher should constantly update their knowledge for professional growth. 26.67% teachers find brain based learning approach useful for them, 33.33% responded that they follow constructivist approach while 26.67% found behavioristic approach useful for their teaching.

From the analysis of needs of teachers it had emerged that there is need for an instructional model that could include all the approaches of learning i.e. behavioristic, constructivist and brain based learning. The MBE caters to these needs well as discussed earlier in chapter I of this thesis.

Step 2: Design:

A brief outline of the model was prepared by the researcher on the basis of her own teaching experience and instructional guidelines. The review was carried out for different brain based instructional models. The prototype of instructional model was prepared taking guidance from the principles, tenets and instructional guidelines outlined Tokuhamma-Espinoza, (2010) in her ground theory analysis research on MBE. E-mail correspondence with Tracey Tokuhamma was done to clarify the subject.

Step 3: Develop:

This model was developed further by taking suggestions from different teaching professionals to establish face validity, construct validity and content validity. Content validity with MBE principles, tenets and instructional guidelines and construct validity of the model was established on comparison of similar instructional models based on brain learning principles. The instructional manual was prepared and lesson plans were developed based on the content of life sciences.

Step 4: Implement:

The model is to be implemented in the secondary classroom (N=37). Total 14 lesson units were prepared on the basis of life science units and 3 week-long instructional events were delivered to the experimental group. The pre-test and post-test were conducted to assess the effectiveness of the instructional model.

Step 5: Evaluation:

The evaluation of instructional model was done in terms of its effectiveness in congruence to thinking pattern and parental cognitive stimulation by the analysis of data of pre-test, post-test and Parental Cognitive Stimulation.

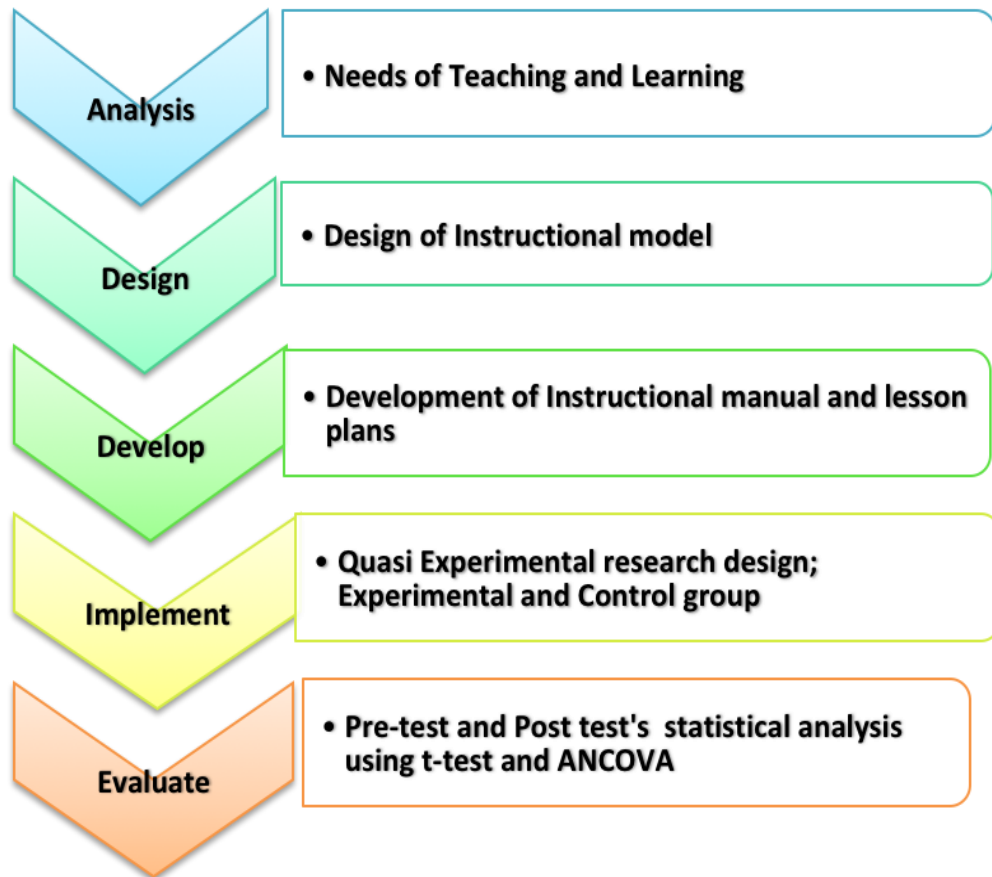


Figure 11: Representation of process of Instructional Model development

Table 1: Principles of Mind Brain and Education outlined by Tokuhamma-Espinoza (2010)

Principle 1:	Each brain is unique and uniquely organized.
Principle 2:	All brains are not equally good at everything.
Principle 3:	The brain is a complex, dynamic system and is changed daily by experiences.
Principle 4:	The search for meaning is innate in human nature.
Principle 5:	Brains have a high degree of plasticity and develop throughout the lifespan.
Principle 6:	Learning is based in part on the brain's ability to self-correct.
Principle 7:	The search for meaning occurs through pattern recognition.
Principle 8:	Emotions are critical to detecting patterns, to decision-making and to learning.
Principle 9:	Learning is enhanced by challenge and inhibited by threat.
Principle 10:	Brains seek novelty.
Principle 11:	Human learning involves both focused attention and peripheral perception.
Principle 12:	The brain conceptually processes parts and wholes simultaneously.
Principle 13:	The brain depends on interactions from other people to make sense of social situations.
Principle 14:	Feedback is important to learning.
Principle 15:	Learning is a constructive process and the ability to learn goes through developmental stages as an individual matures.
Principle 16:	Learning involves conscious and unconscious processes.
Principle 17:	Learning engages the entire physiology.
Principle 18:	Different memory systems (short-term, working, long-term, emotional, spatial, rote) receive and process information in different ways and retrieve through different neural pathways.
Principle 19:	The brain remembers best when facts and skills are embedded in natural contexts.
Principle 20:	Learning relies on memory and attention.
Principle 21:	Neuro-education principles apply to all ages.
Principle 22:	Use it or lose it.

Table 2: Tenets of MBE by Tokuhama-Espinoza (2010)

1: Motivation Impacts How Teachers Teach and How Students Learn	Tenet 6: Faces
Tenet 2: Stress impacts learning	Tenet 7: Movement
Tenet 3: Anxiety	Tenet 8: Humor
Tenet 4: Depression	Tenet 9: Nutrition
Tenet 5: Voices	Tenet 10: Sleep
	Tenet 11: Learning Styles
	Tenet 12: Differentiation

Table 3: Instructional Guidelines in Mind, Brain and Education by Tokuhama-Espinoza (2010)

1: Good Learning Environments are Made, Not Found
2: Sense and Meaning
3: Memory
4: Attention Spans
5: The Social Nature of Learning
6: The Mind-Body Connection
7: Orchestrated Immersion
8: Active Processes
9: Metacognition
10: Learning Throughout the Lifespan

In the present study, principles and tenets, instructional guidelines (**Table 1, Table 2 & Table 3**) are taken into consideration for preparing the outlines of an instructional model. There are two types of characteristics i.e. physiological and instructional characteristics identified based on the review of the related studies of brain and learning. These characteristics helped in conceptualization of prototype of instructional model

Physiological characteristics:

The studies of MBE highlighted many physiological characteristics that impact learning. These include sleep deprivation, nutritional status, home environment, stress, anxiety, attention deficient disorders, learning problems like dyslexia, dyscalculia, etc. These factors should be taken care of by the teacher while planning instructions for the learners. Awareness about different factors, which may affect learning, may be provided to the teachers, with the help of parents, local community members and school head. Workshops or seminars could be organized; parent teachers meeting can be planned accordingly.

Instructional characteristics:

On the basis of data on mind, brain and education related studies, different instructional characteristics has been identified e.g. novelty in presentation, voice modulations, movement, priming, patterns and distributing content in meaningful sequence, immediate feedback and processing the information with meta-cognitive stimulating activities, emotional regulation and enriching emotional engagement, making connection of the content to real-life situations, use of humor to avoid stress and anxiety, etc.

The prototype of the instructional model was prepared (**Figure 12**) with seven steps of instructional model that were designed by the researcher on three basic elements of teaching and learning process as discussed below.

- Assessment of the Learners
- Delivery of Content
- Feedback and Evaluation

Assessment of the learners

Assessment of the learner is a very important aspect of instructional model based on MBE, as learning is a physical change, which happens in the brain and modifies the behavior. It will not solely be helpful, until the teacher is not successful in creating a sound emotional climate in his teaching-learning process, as emotions are the gateway to learning through memory. Long-term memory systems are routed through limbic processing of information, which is the main region for emotional processing of information. Hence, if any information has emotional valence attached,

it would be processed through the limbic system as it is assumed that it is stored in long-term memory systems (Immordino, 2009).

The physiological characteristics play important role in the assessment of the learners. Under school health programme, every child is assessed for various/all health-related issues and findings are recorded in health card of that student. This information can be obtained from school records. Data related to student's socio-economic conditions and family is available in school records. The teacher should have Body Mass Index (BMI) of every child. This is considered as the base of assessment of nutritional status of the learners. The cases of iron deficiency and worm infestations are cured as iron folic acid supplements are provided free of cost to the under-nourished school children in government schools and albendazole supplements are given every six months to avoid worm infections as scheduled by the health department. Along with this, under mid-day meal scheme nutritious meal is provided to students up to 8th standard.

Hence, to create a sound learning environment does not mean only the physical environment of the classroom, which includes light, seating arrangement and air circulation, ventilation and use of audio-visual learning aids. It also includes how a teacher treats his learners and engages them emotionally, motivates them and prepares them to learn. From the above discussion, two factors are identified. It is important to connect to the learners not only to understand them for the better learning experience, but also to create learning environment, which includes physical as well as the psychological environment in which learning could be more effective.

Delivery of Content

Once the teacher is ready with his content, which is based on some set of instructional objectives, the teacher should communicate those objectives to the students. The brain processes the information as a whole and in parts simultaneously. If students are aware of the objectives that are supposed to be met at the end of instructions, they would better understand and relate the information to those objectives of the lesson. The teacher should assess level of pre-existing knowledge which is used to build new knowledge. The teachers are free to choose the pedagogy, based on learners' characteristics and available resources, but information should be presented in a meaningful sequence and in small chunks. Novelty in presentation,

where learners are completely attentive, is more effective. Immediate feedback should be given. Learning is a cognitive phenomenon. Cognitive processing of the content should be there as information is stored in working memory and short-term memory once and from there, with further use, it is transferred to long-term memory (Kendel, 2007).

Feedback and Evaluation

Feedback, especially immediate feedback, has a positive effect on retention. It stimulates thinking; hence, learning is strengthened with the use of information, which is delivered. Feedback should be done by asking the questions in between the delivery of information as well as at the end of the lesson. Students should be given some assignments to be done on the basis of information they have been delivered so that they can apply that information to solve the problems. Analogies could be done to relate the information to real-world phenomenon. The information provided by the teacher is primarily stored into working memory. If the teacher involves the student in activities by asking questions and then let them process the information in their brain and stimulate them by challenging them to perform certain activities related to the content delivered, this will help them use that information and through these activities. They would apply this knowledge to application, analysis and evaluation levels of thinking. Similarly, evaluation of learning should be comprehensive. It should include all the aspects of learning, not only declarative memory, but also how much the students have input in the process of learning and how much they have got it transferred it in their behavior and what is their inclination towards learning. As no two individuals are similar in genetic make-up, hence, individual differences in expression exist and these should be considered in the evaluation process. If any problem is reported in the evaluation process, interventions addressing that problem should be designed, which depends on the nature of the problem. If the problem is about learning difficulties related to physiological structure and functioning of the brain, it should be referred to that particular domain, where the solution is possible. If the problem is slow learning, then remedial measures can be undertaken for giving more time to repeat the cycle of delivery of information and to process that information.

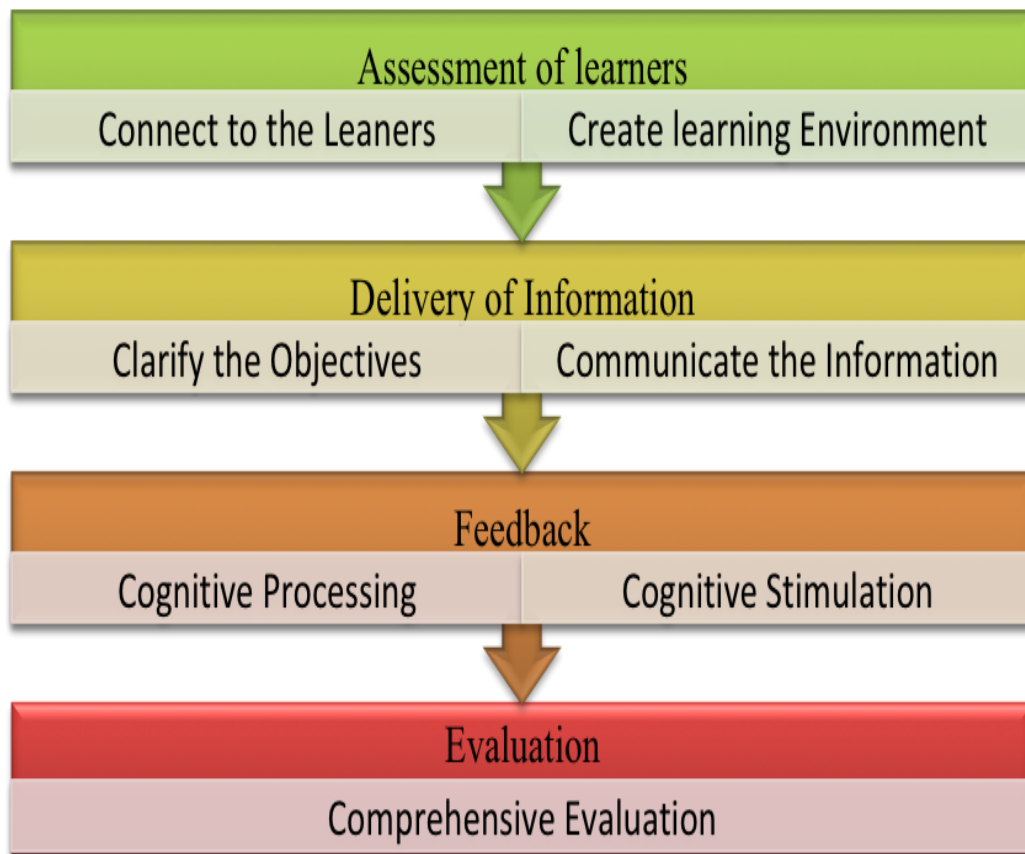


Figure 12: Distribution of different phases of IM development

2.2.2 Validity and reliability

Internal validation of the model was done through subject experts, who had experience in instructional design. An expert from MGSIPA (Mahatma Gandhi State Institute of Public Administration), who was a trainer himself, one subject expert of SISE (State Institute of Science Education), two in-service training lecturers and two education experts were consulted for the design of the model. Apart from this, content validity with principles, tenets and instructional guidelines of MBE was done.

Face validity was established with school heads of 37 different schools of Bathinda, Mansa, Barnala, Sangrur, Faridkot and Muktsar districts of Punjab. In-service training design based on the instructional model has been submitted to MGSIPA, Chandigarh for Design of training programme under the department of personnel and training, Government of India, which got accepted. Comparative account of similar models was prepared to establish construct validity.

External Validation of the model was done through an experiment on classroom teaching of science to 10th standard students at Government High School, Virk Khurd and Government High School, Gillpatti, Bathinda by the researcher herself. It was found to have an impact on students' engagement in the classroom and inclination towards the subject is observed to be positive.

To establish reliability, lesson planning protocol was developed (**Annexure 3**). Total 14 lesson units were prepared (**Annexure 4**) with the lesson planning protocol from the content of life sciences, The researcher constructed 14 lesson plan units of life science which covered all the stated sub-topics as mentioned in **Table 19** to use in the experimentation phase to measure the effectiveness of the instructional model during 3-week intervention in the 10th classroom.

To establish the content validity of the lesson plans, six experts were selected, which included three in-service science teachers, two in-service teacher trainers and one subject expert of SCERT. The agreement of experts for all the lesson plans was recorded on five-point scale, where 1 means 0% agreement and 5 means 100% agreement. The reported agreement for each lesson was above 80%. The observations are listed in **Table 4**.

Table 4: Expert validity of lesson units

Lesson plan Unit	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	Total	% Agreement
Human circulatory system: constituents	4	3	4	5	4	5	25	83
Blood : Its constituents and role	5	4	4	5	4	5	27	90
Structure and function of the human heart	4	5	4	5	4	5	27	90
Endocrine system: Tissues and hormones	3	4	5	5	5	5	27	90
Exchange of gases	4	4	3	4	5	5	25	83
Types of respiration	5	5	5	4	3	4	26	87
Human respiratory system	4	3	4	5	5	4	25	83
Cellular respiration	4	5	3	4	5	5	26	87
Types of nutrition	4	4	4	5	4	4	25	83
Photosynthesis in plants	3	4	5	3	4	5	24	80
Human digestive system	4	5	4	5	3	5	26	87
Enzymes and its role in digestion	3	5	5	4	5	5	27	90
Excretion in plants	5	3	5	3	4	5	25	83
Human excretory system	4	5	3	5	4	5	26	87
Total	56	59	58	62	59	67	361	86
% Agreement	80	84	83	89	84	96	86	

Table 5: Content validity of Instructional Model

CONNECT TO THE LEARNERS			
Principle P1,P2,P16,P17,P21	Tenets	Instructional guidelines	Interventional Resources
<p>Principle 1: Each brain is unique and uniquely organized</p> <p>Principle 2: All brains are not equally good at everything.</p> <p>Principle 16: Learning involves conscious and unconscious processes.</p> <p>Principle 17: Learning engages the entire physiology</p> <p>Principle 21: Neuro education principles apply to all ages.</p>	<p>Tenet 2: Stress impacts learning.</p> <p>Tenet 3: Anxiety</p> <p>Tenet 4: Depression</p> <p>Tenet 6: Faces</p> <p>Tenet 9: Nutrition</p> <p>Tenet 10: Sleep</p>	<p>6: The Mind-Body Connection</p>	<p>School Health and MDM programmes could be helpful in assessment of the nutritional status and physiological needs of the learners.</p>

CREATE LEARNING ENVIRONMENT			
Principle P3;P4;P11;P9;P13;P15	Tenets	Instructional guidelines	Interventional resources
<p>Principle 3: The brain is a complex, dynamic system and is changed daily by experiences.</p> <p>Principle 4: The search for meaning is innate in human nature.</p> <p>Principle 11: Human learning involves both focused attention and peripheral perception.</p> <p>Principle 9: Learning is enhanced by challenge and inhibited by threat.</p> <p>Principle 15: Learning is a constructivist process, and the ability to learn goes through developmental stages as an individual matures.</p>	<p>Tenet 5:Voices</p> <p>Tenet 6: Faces</p> <p>Tenet7:Movement</p> <p>Tenet 8: Humor</p>	<p>1:Good Learning Environments are Made, Not Found</p>	<p>Attention seeking activities to be performed with positive emotions and stress-free environment in the classroom, proper arrangement of light and seating should be there</p>

CLASSIFY OBJECTIVES			
Principle P4;P7;P8;P9;P10;P12;P11	Tenets	Instructional guidelines	Interventional resources
<p>Principle 4: The search for meaning is innate in human nature</p> <p>Principle 7: The search for meaning occurs through pattern recognition</p> <p>Principle 8: Emotions are critical to detecting patterns, to decision-making and to learning</p> <p>Principle 9: Learning is enhanced by challenge and inhibited by threat</p> <p>Principle 11: Human learning involves both focused attention and peripheral perception.</p> <p>Principle 12: The brain conceptually processes parts and wholes simultaneously.</p>	<p>Tenet1: Motivation Impacts How Teachers Teach and How Students Learn</p>	<p>2: Sense and Meaning</p>	<p>Meaningful and sense making sequence with prior knowledge assessment, voice modulation by the teacher are important.</p>

COMMUNICATE THE INFORMATION			
Principle: P1;P13;P19;P20	Tenets	Instructional guidelines	Interventional resources
<p>Principle 1: Each brain is unique and uniquely organized.</p> <p>Principle 13: The brain depends on interactions from other people to make sense of social situations.</p> <p>Principle 19: The brain remembers best when facts and skills are embedded in natural contexts.</p> <p>Principle 20: Learning relies on memory and attention.</p>	<p>Tenet 11: Learning Styles</p> <p>Tenet 5: Voices</p> <p>Tenet 6: Faces</p> <p>Tenet7: Movement</p> <p>Tenet 8: Humor</p> <p>Tenet12: Differentiation</p>	<p>3: Memory</p> <p>4: Attention Spans</p> <p>7: Orchestrated Immersion</p> <p>8: Active Processes</p> <p>9: Metacognition</p>	<p>Novelty should be maintained with natural contextual examples and small group activities stimulating metacognition, engagement of students with attention should be ensured.</p>

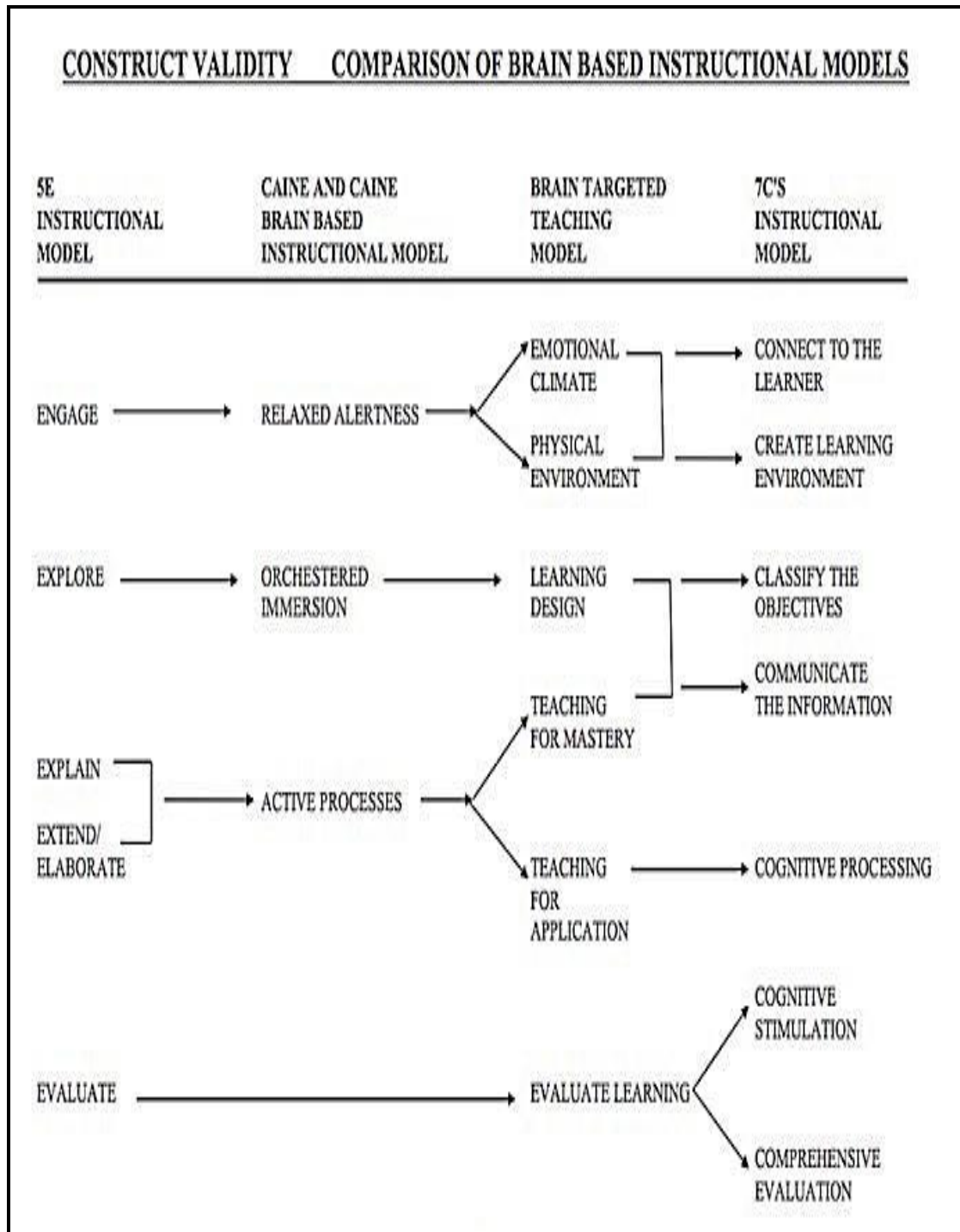
COGNITIVE PROCESSING			
Principle P7;P8;P16;P12;P18;P22	Tenets	Instructional guidelines	Interventional resources
<p>Principle 7: The search for meaning occurs through pattern recognition (i.e., the brain's continual comparison between what it senses and what it already knows).</p> <p>Principle 8: Emotions are critical to detecting patterns, to decision-making and to learning.</p> <p>Principle 12: The brain conceptually processes parts and wholes simultaneously</p> <p>Principle 16: Learning involves conscious and unconscious processes.</p> <p>Principle 18: Different memory systems (short-term, working, long-term, emotional, spatial, rote) receive and process information in different ways, and can be retrieved through different neural pathways.</p> <p>Principle 22: Use it or lose it.</p>	<p>Tenet 4:Depression</p> <p>Tenet12:Differentiation</p> <p>Tenet 3: Anxiety</p> <p>Tenet 1: Motivation</p> <p>Impacts How Teachers Teach, and How Students Learn</p>	<p>5: The Social Nature of Learning</p> <p>8.Active processes</p>	<p>Peer group discussions, motivation with reinforcement and feedback of learning, assigning tasks related to the content delivered.</p>

COGNITIVE STIMULATION			
Principle P5;P6;P14;P15;P18;P20;P22	Tenets	Instructional guidelines	Interventional Resources
<p>Principle 5: Brains have a high degree of plasticity and develop throughout the lifespan.</p> <p>Principle 6: Learning is based in part on brain's ability to self-correct.</p> <p>Principle 14: Feedback is important to learning.</p> <p>Principle 15: Learning is a constructivist process, and the ability to learn goes through developmental stages as an individual matures.</p> <p>Principle 18: Different memory systems (short-term, working, long-term, emotional, spatial, rote) receive and process information in different ways, and can be retrieved through different neural pathways.</p> <p>Principle 20: Learning relies on memory and attention.</p> <p>Principle 22: Use it or lose it.</p>	<p>Tenet 2: Stress impacts learning.</p> <p>Tenet 1: Motivation Impacts How Teachers Teach, and How Students Learn</p>	<p>3: Memory</p> <p>8:Active Processes</p> <p>9:Metacognition</p>	<p>Stimulation of thinking through metacognition, promoting activities with repetition and rehearsal of the content. It could be in the form of asking them to frame questions and prepare Concept map etc. Feedback is important.</p>

COMPREHENSIVE EVALUATION

Principle P2;P3;P5;P9;P15;P12	Tenets	Instructio nal guidelines	Interventional resources
<p>Principle 2: All brains are not equally good at everything.</p> <p>Principle 3: The brain is a complex, dynamic system and is changed daily by experiences.</p> <p>Principle 5: Brains have a high degree of plasticity and develop throughout the lifespan.</p> <p>Principle 9: Learning is enhanced by challenge and inhibited by threat.</p> <p>Principle 12: The brain conceptually processes parts and wholes simultaneously.</p> <p>Principle 15: Learning is a constructivist process, and the ability to learn goes through developmental stages as an individual matures.</p>	<p>Tenet12: Differentiation</p>	<p>10: Learning Throughout the Lifespan</p>	<p>Evaluation should be comprehensive and continuous. It may be summative and formative both. Student’s portfolios should be maintained for comprehensive evaluation of learning.</p>

Table 6: Construct Validity of Instructional Model



2.3 DEVELOPMENT OF PARENTAL COGNITIVE STIMULATION SCALE

Parental cognitive stimulation is engaging children in activities and experiences along with promoting cognitive development. Various research studies have been conducted to understand specific parenting behavior that maximizes children's cognitive abilities.

Cognitive stimulation has many perspectives like economic as well as emotional. In this study, emotional aspect is being highlighted. So, the economic perspective along with emotional engagement of parents with their children, the facilities provided by parents to their children like toys/games, home environment and other facilities to facilitate their learning which includes emotional component of parental involvement along with the physical environment. Home Observation for Measurement of the Environment (HOME) is a descriptive assessment tool to assess the caring environment in which the child is reared. The instrument measures, within a naturalistic context, the quality and quantity of stimulation and support available to a child in the home environment. The child is an active recipient of stimulation from objects, events and interactions in connection with the family surroundings. This inventory is popularly used for assessment of parental involvement related interventional studies (Totsika, V. & Sylva, K., 2004). The HOME inventory is a declaration made by parents and observation of scorer about the home environment. In the present study researcher used the response of children as they perceived about the stimulating factors in their home environment.

2.3.1 Items Content

Different items have been designed by researchers on the basis of suggested parameters quoted in different research papers for parental behavior, parental nurturance, home environment and emotional assurance provided by parents to their children. It has been highlighted that cognitive behavior has stimulating factors in the form of emotional assurance and biological variables like nutrition, sleep and physical health, exercise along with motivation and challenges, provided by parents to their children, by which they are made to think in a meta-cognitive way and perform some activities, which are helpful in developing their cognitive abilities.

2.3.2 Dimensions of PCS

The following three dimensions of PCS were outlined based on literature reviews related to parental behavior, parental involvement and cognitive stimulation, to establish content validity, along with face validity.

- Emotional assurance and motivation
- Challenging home environment
- Biological and physiological well being

Items were prepared on these dimensions for a common scale to assess perceived parental cognitive stimulation by the children. The utmost care has been taken to structure items on the common understandable terms.

2.3.3 Items Format

PCSS is constructed on 5-point Likert rating scale which is commonly used as a scale, the scoring of all the positively favorable items be done by giving scale value 5 to 1. No negative item was included.

Strongly agree Agree No response Disagree Strongly disagree

2.3.4 Validity

To establish the validity of PCS scale, total 43 items were prepared, 21 items in emotional assurance and motivation, 12 in challenging home environment and 10 in biological and physiological well being were structured and sent to experts for validation.

Out of these 43 items, 31 items were retained after the suggestions from experts, which included one clinical psychologist, one neuropsychologist and 2 from educational psychology.

2.3.5 Initial Try out

PCS Scale was administered to a group of 100 pupils of 6th to 10th standard of Govt. High School Virk Khurd. This was done to know the clarity of the items and time taken by the students. The items were again modified based on the results obtained from these students, who participated in the initial try out.

2.3.6 Final Try out:

The PCS was administered with 31 items on a representative sample of 298 students of 14-16 years age group studying in different schools of Bathinda district. Both rural and urban schools were selected for true representation of the population. These included Govt. Senior Secondary School, Sema, Govt. High School, Gidder, Govt. Senior Secondary School, Gobindpura and Dashmesh Public School, Goniana. The students of the 9th and 10th standard were selected. Before the administration of the test, the purpose of the test was made clear to the subjects along with the necessary guidelines about the test. All the response sheets were coded from 1-298 and scored on a 1-5 scale, strongly agree with 5 points, agree 4, no response 3, disagree 2 and 1 for strongly disagree and score sheet was prepared in MS Excel, which was used for carrying out the item analysis.

2.3.7 Item Analysis

The item analysis was carried out based on the guidelines of Ebel and Frisbie (1991). The response sheets were arranged in descending order of magnitude of scores. The scores obtained by the upper (27% of 298) N=81 and lower (27% of 298) N=81 were taken as the upper group and lower group respectively. For the selection of the items in the final test, the Difficulty Index (DI) and Discriminating Power (DP) of each item were found out which are given in the **Table 10** below.

Table 7: Item Analysis of PCS

		High Scorers	Low Scorers	Total
N		81	81	162
Mean		144.87	114.59	129.73
Median		145.00	118.00	132.00
Mode		144.00	119.00	144.00
Std. Deviation		3.76	9.14	16.71
Minimum		139.00	86.00	86.00
Maximum		155.00	125.00	155.00
Percentiles	25	142.00	110.50	118.00
	50	145.00	118.00	132.00
	75	147.00	121.50	145.00

Table 8: Reliability Statistics of PCS

	Level	N	Mean	Std. Deviation	Std. Error Mean	t- value	p-value
PCS	Low	81	114.6173	9.13587	1.01510	27.570	.001**
	High	81	144.8765	3.75627	.41736		

Cronbach's Alpha	N of Items
0.886	31

All the items show high reliability (**Table 8**) with coefficient Cronbach's alpha value of 0.886, which means high reliability. The t-value ($t=27.570$) was used to measure the difference between high scores and low scores, which is highly significant at $p=.001$ at 99% level of confidence.

2.3.8 Norms

Quartiles, Percentiles were calculated. On their basis, three levels of PCS were defined.

- 118 > low PCS,
- 119-144 Average PCS and
- 145 < high PCS group

2.4 DEVELOPMENT OF THINKING PATTERN SCALE

The word thinking pattern is defined as manner of thinking by English dictionary. Thinking could not be measured directly in classroom settings. David Parkins and Sherry Tishman, researchers at Harvard under 'Project zero' has investigated pattern of thinking as a principle investigator. The pattern of thinking was carried over to investigate the nature of thinking and assessment of various thinking dispositions in school set-ups. An email communication with Sherry Tishman was done to understand the assessment tool of thinking pattern. According to her, thinking is a combination of skills, attitude, abilities and habits of mind. These factors determine whether learners use their thinking skills or not. Researcher herself through WIDE WEB online platform of Harvard Graduate School of Education completed making thinking visible course. The review of thinking dispositions was

done and process of making thinking visible was found to be through written expressions. So, it was concluded that in formal classroom setting, the Bloom's taxonomy of cognitive domains is widely used as an assessment tool. Assessment of thinking pattern could be designed by assessing the thinking level at a particular subject according to bloom's taxonomy and a pattern of thinking could be framed based on these levels. These levels are thinking skills that occur in hierarchical order and differentiate the low order thinking to high order thinking. The Blooming Biology Tool (BBT), an assessment tool based on Bloom's taxonomy, to assist science faculty in better aligning their assessments with their teaching activities was developed by Crowe et al (2008). The BBT could successfully align the subject content of life sciences on five levels of knowledge, understanding, application, analysis and evaluation. Hence, a multiple choice questionnaire was developed to assess the five thinking level as variables of thinking pattern.

2.4.1 Selection of test items

In the present study, different levels of thinking, as outlined by Benjamin Bloom's taxonomy of cognitive domain, are used to develop a multiple choice questionnaire of life processes in science. Blooming in Biology was a technique, according to which, questions were framed categorizing different levels of thinking, starting from Knowledge, Understanding, Application, Analysis and Evaluation. Synthesis level is not included as it is difficult to access it in MCQ's terms (**Table 9**)

2.4.2 Validity and Reliability

Total 35 items were prepared which corresponded to different levels. These were discussed with different experts, who deal with measurement evaluation and teaching of biology, including one subject expert from State Institute of Science Education, Punjab, two senior lecturers from Government In-Service Training Centre, Bathinda and three Professors of Education.

Table 9: Blueprint of Thinking Pattern Scale

Thinking variable	Knowledge (K)	Understanding (U)	Application (Ap)	Analysis (An)	Evaluation (Ev)
Item no.	1,3,7,12,13, 27, 28,29, 32,35	2,4,5,6,9,26, 33,34	16,21,22,23, 24,25	10,19,14, 15, 31	8,11,17,18, 20,30
Content	Human circulatory systems (11)	Respiration (11)	Nutrition and excretion (14)	Total items before item analysis (35)	Total items after item analysis (24)
K	1,3	7,12,13,35	27,28,29,32	10	5
U	2,4,5	6,9	26,33,34	8	5
Ap	2,4	21	16,22,23,25	7	6
An	15	10,14	19,31	5	4
Ev	18,20,30	8,11	17	6	4

2.4.3 Item Analysis

This test was administered to 130 students of the 10th standard at Govt. High School, Gillpatti and Govt. Senior Secondary School, Kalyan Sukha and Dashmesh Public School, Goniana for items analysis. On the basis of scores arranged in descending order, 27% high scorers and 27% low scorers were sorted. Before the administration of the test, the purpose of the test was made clear to the subjects along with the necessary guidelines about the test. All the response sheets were coded from 1-130. The response sheets were arranged in descending order of magnitude of scores.

The item analysis was carried out and based on the scores obtained by the upper twenty-seven subjects (27%) N=35 and lower twenty-seven subjects (27%) N=35, they were taken as the upper group and lower group respectively. The Difficulty Index (DI) and Discriminating Power (DP) of each item was found out which is given in **Table 10**.

The item difficulty index is calculated as a percentage of the total number of correct responses to the test items. It is calculated using the formula $DI = \frac{L+H}{2N}$, where DI is the item difficulty index, L+H is the total number of correct responses in low scores and high scorers and 2N is the total number of responses (which includes both correct and incorrect responses). An item was considered difficult when the difficulty index value was less than 30% and the item was considered easy when the index value was greater than 80%. The discrimination power was calculated using the formula $DP = \frac{UG-LG}{N}$. The higher the discrimination power, the test item can discriminate better between students with higher test scores and those with lower test scores. Based on Ebel's (1972) guidelines on classical test theory item Analysis, items were categorized in their discrimination powers. The item with negative discrimination power (DP) was considered to be discarded; DI: 0.0 – 0.19 – poor item – to be revised; DI: 0.2 – 0.29 – acceptable; DI: 0.3 – 0.39 – good; DI: >0.4 – excellent.

Table 10: Difficulty and Discriminatory Index of thinking pattern scale

Q	Level			Difficulty Index	Discriminatory Power
Item	L	H	Total	DI=L+H/2N	DP=H-L/N
1	8	30	38	0.54	0.63
2	20	24	44	0.63	0.11
3	2	6	8	0.11	0.11
4	5	16	21	0.3	0.31
5	7	18	25	0.36	0.31
6	8	14	22	0.31	0.17
7	7	22	29	0.41	0.43
8	6	19	25	0.36	0.37
9	3	15	18	0.26	0.34
10	6	11	17	0.24	0.14
11	8	16	24	0.34	0.23
12	3	6	9	0.13	0.09
13	14	18	32	0.46	0.11
14	3	18	21	0.3	0.43
15	6	18	24	0.34	0.34
16	10	21	31	0.44	0.31
17	7	10	17	0.24	0.09
18	14	22	36	0.51	0.23
19	8	18	26	0.37	0.29
20	12	33	45	0.64	0.6
21	12	29	41	0.59	0.49
22	12	27	39	0.56	0.43
23	5	24	29	0.41	0.54
24	12	23	35	0.5	0.31
25	4	10	14	0.2	0.17
26	4	16	20	0.29	0.34
27	11	15	26	0.37	0.11
28	5	11	16	0.23	0.17
29	19	28	47	0.67	0.26
30	4	11	15	0.21	0.2
31	4	10	14	0.2	0.17
32	7	15	22	0.31	0.23
33	1	11	12	0.17	0.29
34	10	18	28	0.4	0.23
35	8	15	23	0.33	0.2

Table 11: Chi-square Distribution of Thinking Pattern Scale

Item No.	Chi-square value	Chi-square value (Sig.)
1	27.862*	.000
2	.979	.322
3	2.258	.133
4	8.231*	.004
5	7.529*	.006
6	2.386	.122
7	13.246*	.000
8	10.516*	.001
9	10.769*	.001
10	1.942	.163
11	4.058*	.04
12	1.148	.284
13	0.921	.337
14	15.306*	.000
15	9.130*	.003
16	7.006*	.008
17	0.699	.403
18	3.660	.056
19	6.119*	.013
20	27.440*	.000
21	17.014*	.000
22	13.027*	.000
23	21.253*	.000
24	6.914*	.000
25	3.214	.073
26	10.080*	.001
27	.979	.322
28	2.917	.088
29	5.245*	.022
30	4.158*	.041
31	3.214	.073
32	4.242*	.039
33	10.057*	.002
34	3.810	.051
35	3.173	.075

* Significant at .05 level of significance

**Significant at .01 level of significance

Table 12: Reliability of Thinking Pattern Scale

Cronbach's Alpha	No. of Items
0.798	24

Apart from determining Discriminatory Analysis, chi-square test was applied to establish the discriminatory power between high scorers and low scorers (**Table 11**). The items, which had significance at 0.05 levels, were retained, others were discarded. Total 24 items were retained which were further used to access the thinking pattern of the experimental and control group. **Table 12** shows the Cronbach's Alpha of 24 items come out to be 0.798, which means the thinking pattern scale is reliable to be used.

2.4.4 Scoring

Each right answer was given score 1 while the wrong answer was not given any score. The total scores were 24. Further 24 items of thinking pattern scale were sorted at each thinking variable i.e. Knowledge, Understanding, Application, Analysis and Evaluation, sorted by calculating the average percentage achievement score at each variable e.g. if a student scored 4 out of 5 (total) in Knowledge variable, its percentage is calculated by dividing it with maximum score (using the formula $4/5 \times 100$) for that variable. Similarly, scores for other variables were calculated and mean average of the whole group was calculated. After that, the average mean gain score was plotted by putting all variables of thinking pattern at x-axis and their corresponding percentage mean gain on y-axis. Hence, a pattern of thinking of the group was plotted on a line graph.

PHASE 2:

EXPERIMENTATION PHASE:

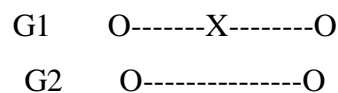
Effectiveness of Instructional Model was established through quasi-experimental research design (**Figure 10**) for implementation of IM based interventions and PCSS and thinking pattern scale was done in this phase of the study. Data were analyzed using SPSS 22.

- Implementation of the tools of study
- Data Analysis and Interpretations

2.5 METHOD OF THE STUDY:

For the present study, the descriptive method of research was employed to study development and effectiveness of instructional model in life science based on mind brain and education science approach in congruence to thinking pattern and parental cognitive stimulation.

The second phase of the study includes pre-test, post-test, non-equivalent control group design. The quasi experimental research design is used in this study where two groups were formed i.e.an experimental and a control group. Pre-test used in the study was used for establishing equivalency and statistical control or generating gain scores. Post-test was done to further establish the effectiveness of instructional model that was developed in this study, after the intervention in Experimental group over Control group where traditional method was used. The graphical representation of research design and method applied is given in **Figure 13**. The G1 below represents Experimental group, G2 Control group, O stands for pre-test/post- test, and X denotes intervention.



Quasi-experimental designs, sometimes, pose problems with internal and external validity (Stephen G. Jurs, 2009). This can be controlled with the establishment of equivalence among groups on independent variables, e.g. I. Q. test scores or pretest scores. Quasi-experimental designs are the experimental designs that are not considered “true experiments.” True experiments are ones in which participants are randomly assigned to different experimental groups. Quasi-experimental designs lack random assignment of participants to experimental groups. These are very common, particularly in the social sciences, because it is often impossible, impractical or unethical to use random assignment.

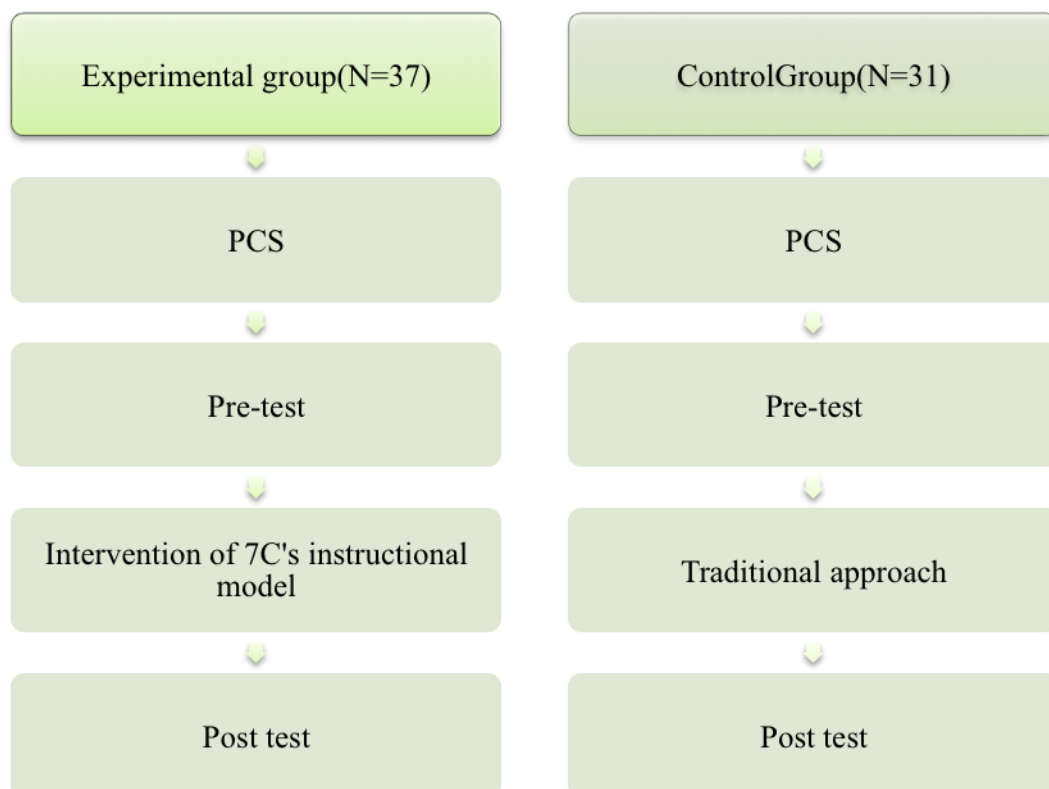


Figure 13: Representation of Quasi-Experimental research design of the study

2.6 SAMPLE OF THE STUDY:

The population comprised of the students studying in Government Senior Secondary School of Punjab, affiliated to Punjab School Education Board. The sample of the experimentation was done from Bathinda district. Purposive sampling technique also known as judgment sampling was used, which is a non-probability sampling wherein the units are selected at the discretion of the researcher, where he may exercise his own judgment based on experience or expert judgment (Kalton, 1983) for including a given subject in the sample. The sample was drawn from the three intact divisions of standard 10th of Government Senior Secondary School Gobindpura, Bathinda, Punjab (India) as Experimental and Control group based on summative assessment scores respectively. The students of 10th standard who belonged to the age group of 14-16 years were chosen. The details of the distribution of sample are given Table 5. The final sample (N=68) consisted of sixty-eight students of which thirty-seven students belong to an experimental group and thirty one to control group. All the students were

from a rural background. The school environment and school resources were also same for both the groups.

Table 13: Distribution of the sample

Group	Boys	Girls	Total
Experimental group	22	15	37
Control group	19	12	31
Total	41	27	68

2.7 VARIABLES OF THE STUDY

Independent variable

An independent variable is a variable that has been manipulated. ‘The independent variable is the factor that is manipulated purposively under observation to ascertain its relationship with the dependent variable. During the experiment, the investigator attempts to keep all the conditions same for two groups of children except for the experimental variable. In other words, all conditions are held constant except the experimental variable, which is manipulated (Dalen & Meyer, 1966). In the present study, the approach to teaching using 7 C’s Instructional model has been considered as manipulated to find out what kind of effect it can produce on the dependent variables.

Dependent Variable

A dependent variable is a measured or observed variable. By observing the dependent variable, the effect of the independent variable can be measured. The dependent variable is the phenomenon that appears, disappears or changes as the researcher applies, removes or varies the independent variable (Dalen & Meyer, 1966 p 244). It was to be tested whether the independent variable i.e. instructional model based instructional delivery would have an effect on the dependent variable i.e. Thinking Pattern which further contains variables like Knowledge, Understanding, Application, Analysis and Evaluation of Experimental group in comparison to Control group. These dependent variables were observed to determine whether the independent variables had any effect. These variables were combined together to understand Thinking Pattern.

Table 14: Variables of the study

Independent variable	Dependent variables	Variables controlled	Controls employed
Instructional model based instructions Parental Cognitive Stimulation	Knowledge Understanding Application Analysis Evaluation	1. Classes to be taught	The only 10th standard was taken for the study .
		2. Academic subjects to be taught in the treatment	Only life Science lessons were used in the treatment
		3. Syllabus	PSEB syllabus was followed
		4. Institutional variations	The same school was selected to make equal resources available
		5. Size of the sample	Classes had a nearly equal number of students
		6. The average age of the sample	The groups had students of age between 14 and 16 years
		7. Situational variables a) Period of treatment b) Duration	a) The groups were taught the selected units for 3weeks b) Both groups were exposed to treatment for 21 periods of 30-35 minutes each.

Intervening Controlled Variables

The Control variable is a variable that has the potential to have an impact on the dependent variable as well as the independent variable, but its effects are removed or controlled by the research design or statistical manipulation. When variables are not amenable to physical or selective manipulation, they may be controlled by statistical techniques. Statistical controls can achieve the same precision as other methods when they are employed to evaluate a variable's effect. Statistical techniques are particularly useful in a situation, where multiple variables may be functionally related to a particular effect, as is often in the case of Education (Dalen & Meyer 1966). The variable that was statistically controlled for the experiment was the

intelligence of the students. Other variables like classes chosen for the experimental treatment, subject content and age of the students were also controlled.

Intervening Uncontrolled Variables

Those variables that have an unpredictable or unexpected impact on the dependent variable could not be controlled. Some of these variables are the absence of some students during the experiment, socio-economic status, home environment, exposure to mass media on the themes related to sustainable development, education of parents, study habits; academic ability in the subjects, and interaction of students with other related sources remained uncontrolled during the treatment. Parental cognitive stimulation of the participants was measured to control it. The **Table 14** has been prepared to show the different variables employed and corresponding controls in the present study.

2.8 TOOLS USED IN STUDY

Following tools were used in this study:

- Instructional Model developed by researcher herself on the basis of Mind, Brain and Education Science (MBE) principles, tenets and guidelines (Tokuhama-Espinoza, 2010)
- Parental Cognitive Stimulation scale developed by the researcher
- Thinking pattern scale developed by the researcher

2.9 DESCRIPTION OF THE TOOLS

The description of the tools used in the present study with their developmental process is given below. The researcher herself prepared the tools used.

2.9.1.1 7 C's Instructional Model

The proposed model in the present study is a 7C's instructional model that has inculcated all the principles of MBE to bring forth a systematic sequence of instructional process to develop high order thinking among learners. The effectiveness of instructional model was monitored and evaluated on the basis of the application of this model in the life science classrooms, as discussed in Chapter 3 and 4.

Instructional model is a step-by-step guide for a teacher to be used in his routine teaching. This is not just pedagogy, but a guiding force to plan pedagogical

practices to achieve maximum benefits of a teaching-learning process. The teacher is a modulator for any learning to happen in the formal system of education. Various educational theorists have identified various views about the role of a teacher. According to the philosophical views, the teacher should act as a friend, philosopher and guide; while teacher should take a lead in the learning process as a facilitator, according to constructivist view. In the views of Mind, Brain and Education (MBE), a teacher should act as an organizer and plan the whole set of events and coordinate the same to achieve the goal of learning in the form of thinking to be developed in the mind of learners. He should focus on the needs of its learners and give them opportunities to express their thoughts in comprehensive ways.

The human brain is the storehouse and processing unit of learning. During the last 100 years, a major accomplishment of psychology has been the development of a science of learning aimed at understanding as to how people learn. In attempting to apply the science of learning, a central challenge of psychology and education is the development of a science of instruction aimed at understanding how to present material in various ways that help people learn better and faster.

If someone gets some new information or stimulus, it is processed in the brain and its experience is stored in the brain to be used in future endeavors. Now learning would be effective in the real sense if someone uses that previously learned experience in his/her future learning situations. The aim of our education, too, is to develop that thinking skill, which enables the individual to maximize the use of learned information to implement in the present situations to solve real-life problems. Any learning is successful if the teacher is able to enable the pupils to record that experience in their brains as a long-term memory.

Every brain is unique, may it be due to genetic factors or environmental influence taking place during the developmental years. In the school set up, the environment could be controlled and could be uniform to a greater extent. The difference in genetic factors, which can't be manipulated but the required environment should be provided for full expression of genes. Instructions are the basic elements of any learning; hence, it is very important to follow the basic principles to make learning more effective and meaningful. In MBE, the role of the teacher is to be aware of the functions of the human brain as to how it works and how

learning takes place in the brain. In schools, where the focus is on teaching, learning is often neglected. It is so because we, as teachers, give more importance to content delivery only although it has been proved by research that learning is a multi-dimensional process. If all the conditions that can have an impact on learning are fulfilled, it can be more effective and meaningful.

The 7 C's Instructional Model has been developed on the basis of principles of MBE Science, which is called the new science of teaching and learning. The MBE science has its roots in interdisciplinary research base, which guides the learning theories and philosophy of education through its evidence-based research findings. These factors are considered in developing this 7C's Instructional Model. There are seven steps as shown in **Figure 14** which are discussed below:

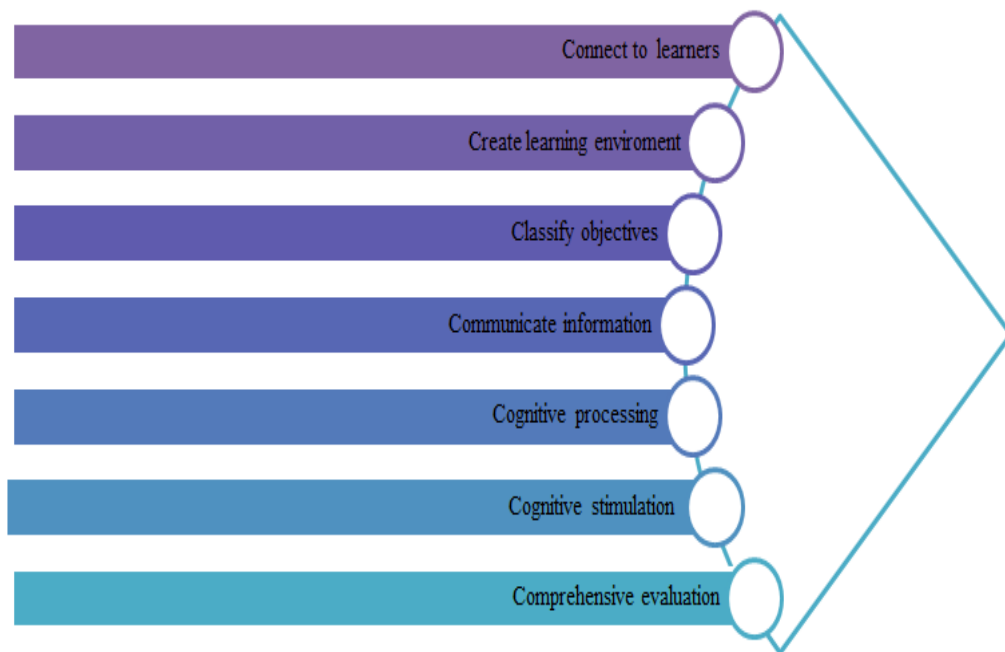


Figure 14: Steps of 7 C's Instructional Model

2.9.1.1 Connect To Learners:

Assessment of Learners' psychological, physiological and sociological well-being is to be done at the start of the session. Factors affecting these three types of well-being are shown in **Figure 15**. Nutritional status impacts learning, hence the value of good nutrition is to be communicated to the parents and children. Sleep

deprivation and stress also affect human learning. Every human brain is unique. So, assessment of students in all these terms should be done, so that the teacher is aware of the needs of their students and appropriate interventions could be provided.

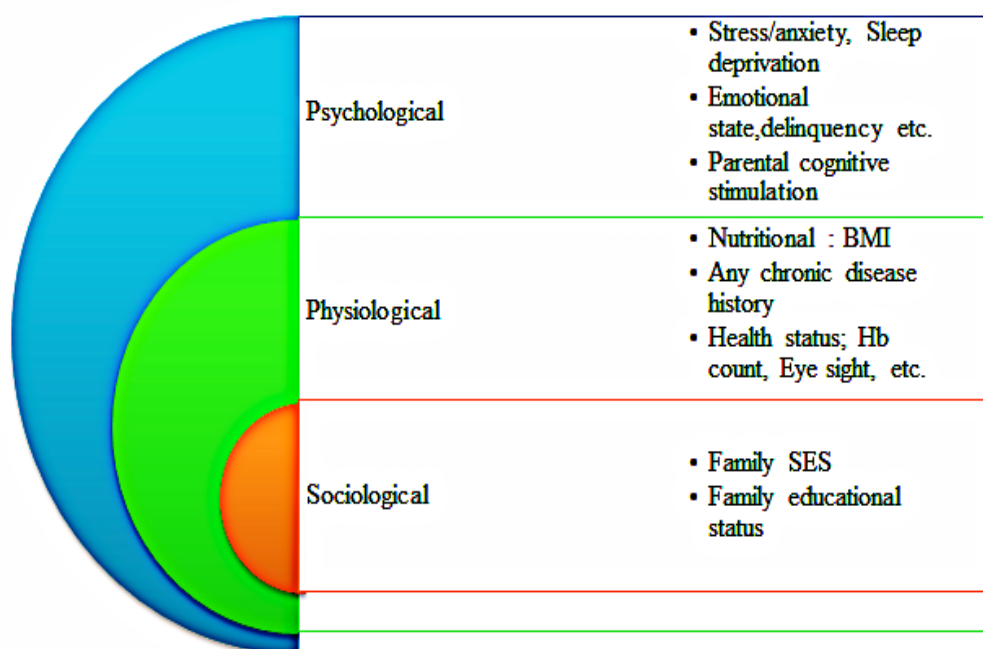


Figure 15: Factors for connecting to the learners

2.9.1.2 Create Learning Environment:

The learning environment is physical as well as psychological. There are a number of factors that constitute these two types of learning environments as shown in **Figure 16** below. The role of positive emotions, stress-free environment, proper seating arrangements, light etc. along with voice and proper eye contact with all the learners should be taken care of by the teacher for planning a good learning environment. Students should be made aware of different memory systems as to how any information is stored in different memory regions for later recall. They should also be given a short view of how learning is processed in the brain and how it promotes meta-cognition and how the emotions have a significant role in memory and recall of information.

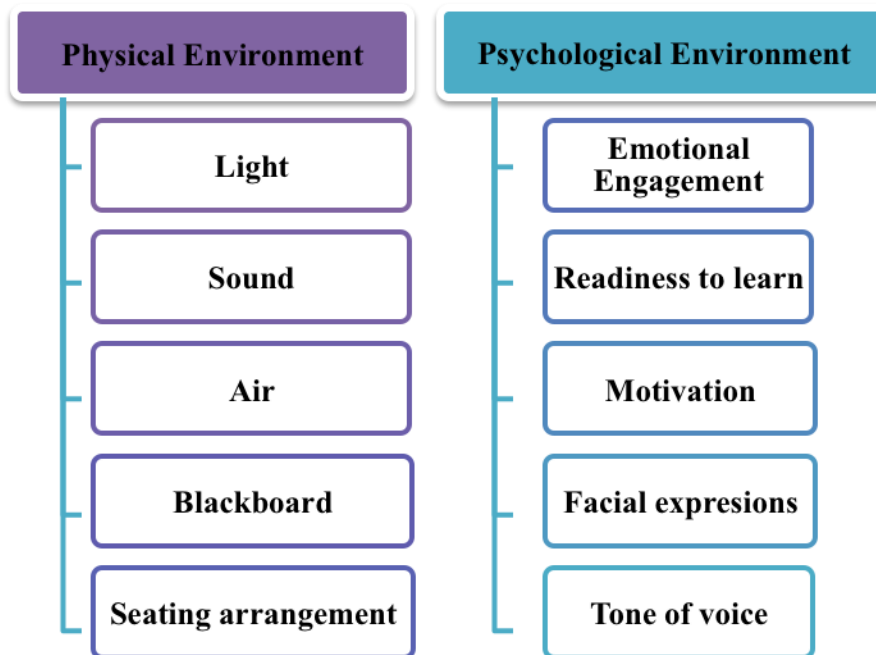


Figure 16: Factors constituting a good learning environment

2.9.1.3 Classify the Objectives

Human brain learns well when the information is provided in certain contexts in an understandable form. Classifying the objectives well before the actual content is to be delivered, is of great importance as it would help in students to understand their own thinking as to how much they know and how they could relate this to their already known information as shown in **Figure 17** below..

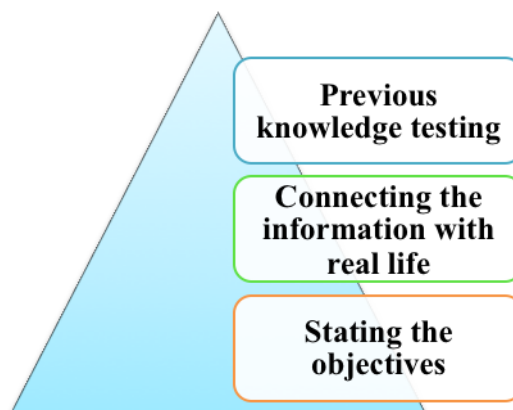


Figure17: Steps to classify the objectives

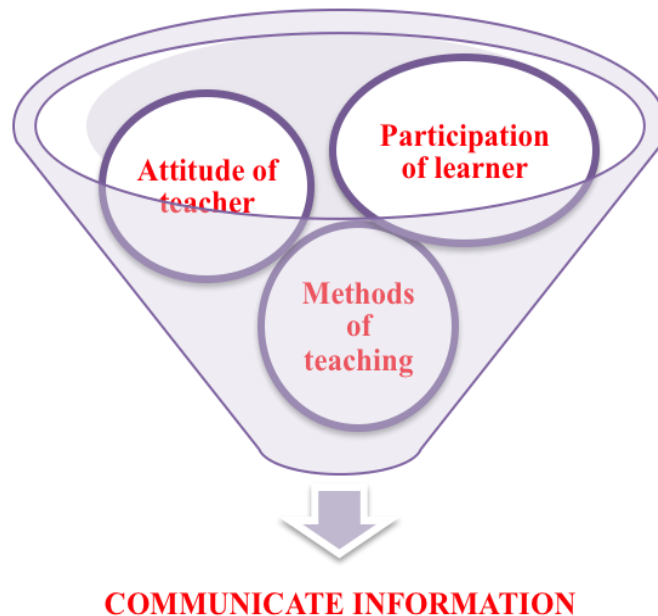


Figure18: Factors for the communication of information

2.9.1.4 Communicate the Information

After the objectives are clear, the whole information is to be delivered using novel ways so that information being presented is not monotonous. Various factors are to be taken care of to communicate the information effectively (**Figure 18**). These factors are shown above. Participation of learners in teaching learning process with attention, positive attitude of teacher and method of teaching are all very important for effective communication of information.

The division of content into small chunks and its systematic flow should be maintained. Use of concept maps and different teaching models could be used. The teacher should ensure the attention of the students to be maintained as the average attention span of the human brain is 30-40 minutes. So, every possible effort should be made to deliver important information within this time period. The voice of the teacher should be proper and non-threatening, humor could be added to avoid boredom and the teacher should not stand at a single point, his movement is necessary so that the students remain attentive in the class. The overall attitude of the teacher in the classroom should be positive and encouraging. The participation of learners should be ensured by asking them questions during the delivery of the content.

2.9.1.5 Cognitive Processing

Cognitive processing involves a number of steps that result in learning as shown below in **Figure 19**. So, after delivery of information, the teacher should provide some time to the students to process the information in their minds. He should ask some questions which can make the student think and process the information about the subject matter. Students should also be encouraged to ask questions if they have any, related to the content. Concept maps could be framed to help the student learn the information easily in understandable terms. Repetition and rehearsal of the content delivered should be performed so that information provided is transferred to long-term memory from short-term memory system. The main contributor to student's positive emotions and motivations is feedback. People always have a need to feel valued, and positive feedback is one way to satisfy that need. When a student is given even the smallest amount of feedback, the brain provides the learner with the correct information to be used in future. Teachers can help students by coaching, facilitating and providing them with authentic feedback. Students need to be encouraged on how to make their work better.

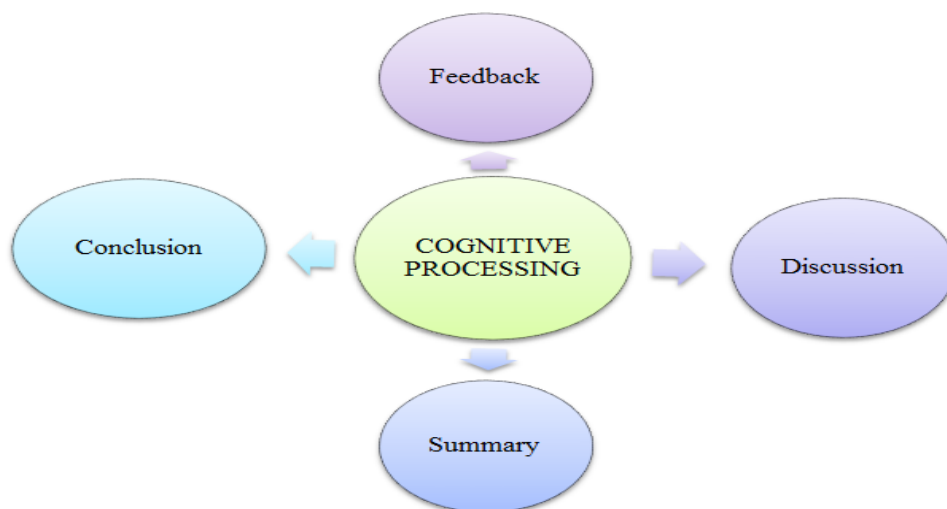


Figure 19: Factors in cognitive processing

2.9.1.6 Cognitive Stimulation

Once the content is delivered and processing of the content is done, students should be stimulated to think in a meta-cognitive way. Various activities play a key role in cognitive stimulation. These activities are shown in **Figure 20** below. Different

activities like making them design some assignment, relating the information to real-life events, framing problems and designing problem-solving strategies can be carried out for cognitive stimulation. Short role plays and other activities can also be organized related to subject content that can be given to stimulate their thinking process.

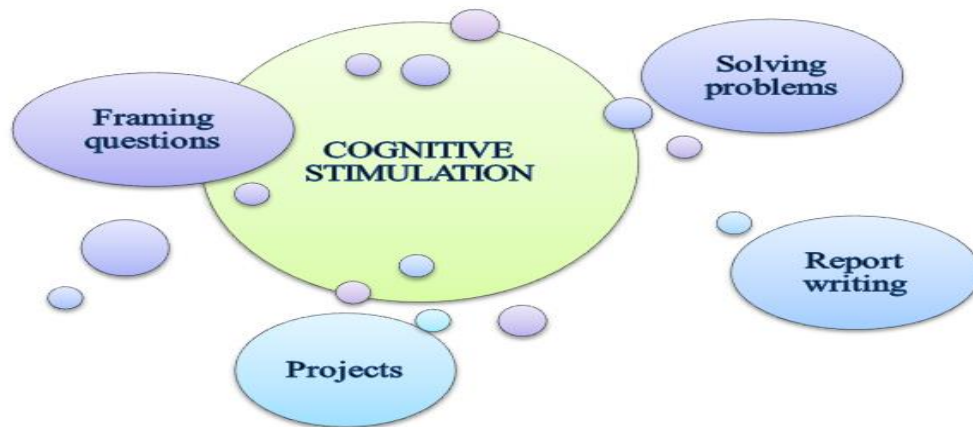


Figure 20: Different activities for cognitive stimulation

2.9.1.7 Comprehensive Evaluation:

Comprehensive and continuous evaluation of learning is to be done on the basis of participation as well as performance in the learning process, interest attention and inclination towards learning, etc.

Figure 21 below shows their inter-relationship. Comprehensive evaluation of performance is to be done in terms of assessment using a standardized test, projects, group discussion etc. and thereafter, appropriate remedial measures need to be designed in terms of extra instructional hours that can be assigned if there is low performance. Remedial measures should be taken at a psychological level to motivate and create interest towards learning for those, who still need special attention towards participation in the learning process. If both participation and performance are low, then learning problems like ADHD dyslexia and cognitive dysfunction etc. should be evaluated. Evaluation of learning should be done using comprehensive tools, which could be both, formative and summative. Comprehensive evaluation of the students should be designed based on their performance in achievement tests as well as participation in the learning process. Assessment rubrics could be prepared to evaluate

participation and performance. Further remedial measures should be suggested based on the comprehensive evaluation.



Figure 21: Inter-relationship of participation and performance in the comprehensive evaluation

2.9.1.8 Social System

To implement the 7C's Instructional Model, resources of school are to be used as it is a perspective for better teaching-learning environment. Teachers should be motivated to bring desired behavioral modifications in their approach towards teaching. Considering children as a psychological and physiological well-being is also a part of teaching and learning process. If a child is psychological and physiologically fit, he may be able to learn faster and that too, in an effective way. In the process of teaching and learning, all activities should be carried out within an emotional climate. The main focus is on the idea of research in social neuroscience, that if we feel, therefore, we learn. Emotions are very important to be taken care of by the teacher, who has a major role to play in the teaching-learning process. His role should be of an anchor and a facilitator, who would act as a catalyst in the learning process. The following steps should be taken into consideration for making the learning process more effective:-

1. Make learning contextual and related to students' interests.
2. Structure learning around real-life problems and in teams.

3. Immerse learners in rich, complex interactive experiences and offer personally meaningful challenges to enhance learning.
4. Humor aids in learning, the teacher should know how to use it to avoid monotony in the classroom.
5. The teacher should not be standing at a single place, instead, he should move in the class while delivering the content but movement should not be distracting rather making the students attentive towards the teacher's speech.
6. Voice of the teacher should be effective and loud so that every student can clearly listen to it, the teacher should know where to lay emphasis during the delivery of the content of the topic. He should repeat the important phrases and words while making proper eye contact with the students.
7. Develop educational tools that are artistic and novel to create brain-friendly environments.
8. Offer two minutes of time to the students to process the information after every ten minutes of information sharing, encourage interaction with students.
9. The brain is able to retain large information. When knowledge is organized in a pattern it is easier to retrieve. The teacher should use this technique to make students learn difficult concepts.
10. The teacher should periodically spread awareness about the value of good nutrition, which is crucial to effective learning. The brain's main fuel is oxygen, with water being the next most important one. Protein helps to boost memory and attention. Hence, to make learning effective, it is important that students have balanced nutrition.
11. Textbooks and reference books available in the library, internet, e-learning material, web-based instruction, CD drives etc. could be used. Resources should be interactive, which must promote students to express their feelings and share their ideas and behavior. Also, the medium of instruction should be in local regional language so that maximum Understanding can take place there. Health record of

students should be maintained and the regular visit of medical practitioners to solve health-related issues must be ensured at the administration level. Psychological analysis of the students with attention and motivation problems can be done with the help of psychologist and counseling of students at the school level.

12. The classroom environment should be relaxed. Students should be trained to develop independent thinking and meta-cognition. Poster presentation and group talks should be permitted. Students should be given time for interaction between groups. The teacher must provide students with the task and some practices to facilitate their learning.

2.9.1.9 Assessment of Learners

Assessment should reflect student’s abilities, attitude and thinking. The student should participate in learning process to develop meta-cognitive abilities. The teacher can determine tools of assessment based on the learning situation. The diversity of tools can be considered that evaluate student’s performance. **Table 15** described the assessment tool for assessment of student’s participation and performance in teaching learning process, If overall score in participation is 5 or 6 and performance score is very good or good, then it can be considered satisfactory. Otherwise, if participation score is 2 and performance score is low or average, then psychological profile and IQ etc. should be done and remedial measures should be provided for improvement. Similarly connect to learner Performa is prepared to gather basic details that every teacher should be aware of his students.

Table 15: Assessment of learners

<p>Participation: It is assessed on two parameters i.e. Attention of students.If they Ask questions or give feedback. (based on teacher’s observation) Scores: Always=3, Sometimes=2 and Never=1; maximum score= 6 and minimum score is =2</p>		Always	Sometime	Never
	Attention			
	Ask Question /Give feedack			

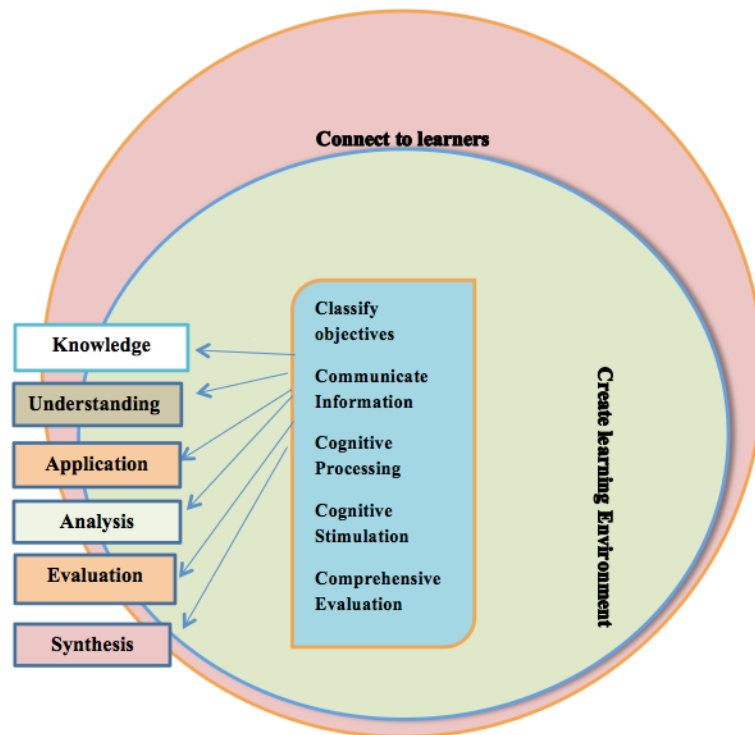


Figure 22: Representation of 7 C's on thinking levels in a Teaching-learning Process

2.9.2 Parental Cognitive Stimulation Scale

Cognitive stimulation is any act or stimulus provided to an individual, which leads to the experience related to the cognitive activity. Any such activity performed is called stimulation. Brain research has proved that human brain has 10 billion neurons and the development of most of these neurons is done during the first five years of age and after that brain changes its shape according to its use. Any new information is stored in the form of nerve connections in different parts of the brain.

According to Tucker Drob, E. M., and Harden, K. P. (2012), parenting is traditionally conceptualized as an exogenous environment that affects a child's development. However, children can also be influenced by the quality of parenting that they receive. Genetic and environmental factors differentially contributed to these effects. Parenting influences subsequent cognitive development through a family-level environmental pathway, whereas children's cognitive ability influenced

subsequent parenting through a genetic pathway. These results suggest that genetic influences on cognitive development occur through a transactional process, in which genetic pre-dispositions lead children to evoke cognitively stimulating experiences from their environments.

Topor et al (2010) in their multi-mediation analysis of parental involvement and student's academic performance. Parent involvement in a child's early education is consistently found to be positively associated with a child's academic performance in many studies. Specifically, children whose parents are more involved in their education have higher academic performance than children whose parents are involved to a lesser extent. The influence of parent involvement on academic success has been noted by many researchers. Parent involvement has been defined and measured in multiple ways, including activities that parents engage in at home and at school and positive attitudes parents have towards their child's education, school and teacher.

Consistent with theoretical models of the gene-environment transaction, we predict that it is initial genetic differences in cognitive ability that predict future levels of parental cognitive stimulation. At the same time, we predict that parental cognitive stimulation predicts future levels of child cognitive ability through environmental pathways. In other words, we predict that genetic influences on very early cognitive development lead children to evoke stimulation of differing levels of quality from their parents and that early level of stimulation of children by parents act as effectual environment in boosting their children's subsequent cognitive development.

Farah et al (2008) studied the effects of environmental stimulation and parental nurturance on brain development of humans through a longitudinal study of home measures of childhood experiences on cognitive ability. There was a selective relation between parental nurturance and environmental stimulation on memory and language development. Both are the direct measure of cognitive ability. In the present study Parental Cognitive Stimulation Scale (**Annexure 5**) was developed by the researcher and reliability and validity was established to use in the present study to access parental cognitive stimulation.

2.9.3 Thinking Pattern Scale

Thinking is the major function of cognition. In the process of teaching-learning, it plays an important role. Teaching activity is done to provide the knowledge component integrated into the thinking process of students. This is also the major objective of the national school curriculum, where the development of higher order of thinking is the objective. Thinking can be visualized through various activities, which could be designed and which required the participants to respond, if they think about it. In making thinking visible a course by WIDE WEB, researcher herself acquired the required knowledge to understand the process of assessment of thinking. Bloom's taxonomy is widely used to understand the cognitive domain at five dimensions i.e. knowledge, understanding, comprehension, application, analysis and application. It is widely used in assessment of learning as it clearly define high order and low order thinking.

Biology in Bloom Tool (BBT) was used to develop multiple choice question test to access thinking skills in life science on five variables of Knowledge, Comprehension, Application, Analysis and Application. The achievement scores on these variables were further plotted on mean values to make a pattern of thinking called Thinking Pattern for the present study. Total 24 items based tool was used to access thinking pattern (**Annexure 4**).

To analyze the thinking pattern, a score of each variable is converted into mean average e.g. in Knowledge variable total items were 5. The achievement score of 3 was converted to mean average gain percentage as $\frac{3}{5} \times 100$ and similarly, overall total score was also converted into average by dividing it with a total maximum score of 24. The mean average gain scores of pre-test were compared with mean average gain scores of post-test. The change in mean average scores was statistically tested using paired t-test within groups and independent t-test using ANCOVA where pre-test was taken as a covariate.

Table 16: Distribution of test items in thinking pattern scale

THINKING CONSTRUCT of Thinking Pattern		NO. OF ITEMS
Knowledge/Recall	LOT	5
Understanding/Comprehension		5
Application		6
Analysis	HOT	4
Evaluation		4
Total test items		24

Table 17: Distribution of variables of Thinking pattern scale

Thinking construct/Variable	No. of Items	Calculation of percentage	% on each construct
Knowledge	5	$5/24 \times 100$	20.83%
Understanding	5	$5/24 \times 100$	20.83%
Application	6	$6/24 \times 100$	25%
Analysis	4	$4/24 \times 100$	16.67%
Evaluation	4	$4/24 \times 100$	16.67%
Total	24	$24/24 \times 100$	100%

2.10 DATA COLLECTION

It is non-equivalent pre-test post-test quasi-experimental design. Two groups of 46 students in the experimental group and 46 students in control group were initially taken for the study. Later 9 students from the experimental group and 11 students from the control group, who could not attend the pre-test or post-test were eliminated from the data. Finally, the sample for the study was reduced to 37 in experimental group and 31 in control group. Total 21 days' intervention was planned with lesson units aligned to instructional model steps. Total 14 lessons were prepared

based on the syllabus prescribed by Punjab School Education Board (PSEB) for 10th life science. Based on the distribution of the content in **Table 19**, lesson units were prepared. Total 14 lessons were prepared and the experimentation was done during the months of September 2016 to October 2016 (**Annexure 3**) A pre-test on thinking pattern scale was taken before the start of intervention followed by post-test and parental cognitive stimulation scale was also administered on both the groups and results were taken into account for both the groups. Both groups were scored on post-test and pre-test at mean gain scores on five levels of thinking and their analysis was done using t-test and ANCOVA using pre-test and PCS as a covariate to measure the effectiveness of IM.

Parental cognitive stimulation scale was administered to both groups and total 68 responses were recorded and on the basis of this High PCS, Average PCS, and Low PCS groups were sorted out. The details of participants as per their grouping on PCS scale are discussed below in **Table 18**.

Thinking pattern scale was administered both as pre-test and post-test .The data was converted into percentage as mean gain on all the variables i.e. Knowledge, understanding, application, analysis and evaluation. There were total 24 items among which distribution of each variable are discussed in **Table16 &17**.

Parental Cognitive Stimulation (PCS) scale was administered to both the groups. Total 68 responses were recorded and on the basis of this, High PCS, Average PCS and Low PCS groups were sorted out in **Table 18**. Similarly, thinking pattern scale based on 24 items (MCQs) was administered to both groups and data was recorded on variables i.e. Knowledge (K), Understanding (U), Application (Ap) Analysis (An) and Evaluation (Ev). The intervention was administered to experimental group by the researcher for 21 days based on lessons prepared on the 7C's Instructional model guidelines and further post-test was administered to assess the effectiveness of instructional model in congruence to parental cognitive stimulation and thinking pattern.

Table18: Distribution of Experimental and Control group based on PCS

PCS	Experimental group(N)	Control group(N)
Low	13	13
Average	23	16
High	1	2

Table19: Content distribution of life science for Experimental study

	Content	Lesson units
Circulatory system	Human circulatory system: constituents	1
	Blood its constituents and role	1
	Structure and function of the human heart	1
	Endocrine system: Tissues and hormones	1
	Exchange of gases	1
Respiration	Types of respiration; aerobic and anaerobic	1
	Human respiratory system	1
Nutrition	Cellular respiration	1
	Types of nutrition	1
	Photosynthesis in plants	1
	Human digestive system	1
	Enzymes and its role in digestion	1
Excretion	Excretion in plants	1
	Human excretory system	1
		14

2.11 STATISTICAL TECHNIQUES

Two statistical techniques were used in the data analysis namely, descriptive statistics and inferential statistics. The descriptive statistics were used to obtain mean, median, mode, standard deviation, skewness and kurtosis of the scores for each group on each dependent variable. The inferential statistics used were t-test, univariate analysis of covariance, multiple regression analysis and Pearson's product moment

correlation. To study the nature of distribution of data, its descriptive Analysis was done before applying inferential statistics, in order to ensure that it satisfies the underlying assumptions and the mean, median, mode, standard deviation, skewness and kurtosis have been computed for all the variables under study. The values of these measures indicated almost normal and comparable distributions for all the variables. Thus, the assumptions for enabling necessary comparison and interpretation of statistical results were ensured.

The statistical analysis was carried out using IBM SPSS (Statistical Package for Social Sciences) statistical version 22. The analysis includes frequency table, bar chart and association of PCS with control and experimental group based on Chi-square test. All quantitative variables were estimated using measures of central location (mean) and measures of dispersion (standard deviation). Normality of data was checked by Kolmogorov–Smirnov tests of normality. Means were compared using Student’s t-test (for two groups). Analysis of co-variance (ANCOVA) was applied to assess interaction effect of PCS with Control and Experimental group students. Pre –test and post-test variable’s means were compared using paired student t-test. From the statistical point of view, ANCOVA is a robust test for detecting minor variance between the means. This approach of data analysis is used to increase statistical power by reducing error variance. Most researchers consider the ANCOVA appropriate for use when treatments have been randomly assigned to intact groups as it can adjust for small pre-existing differences on key variables that may exist among intact groups prior to the research. This assumption was accepted for all the outcome variables addressed in this study. ANCOVA also assumes homogeneity of regression lines and a linear relationship between the covariate and dependent variable. Homogeneity of regression slopes was tested by examining whether an interaction existed between the covariate and method of instruction or not. ANCOVA assumes that the sample is normally distributed. Each of these assumptions was found tenable and ANCOVA was selected for analysis.

All statistical tests were seen at the two-tailed level of significance ($p \leq 0.01$ and $p \leq 0.05$). The p-value is less than or equal to 1% level of significance, then the result is statistically highly significant. If the p-value is less than or equal to 5% level of significance, the result is again statistically significant but if the p-value is greater

than 5% level of significance, the result is statistically non-significant using ($p > 0.05$). As explained earlier, a pre-test, post-test two group quasi-experimental design was used in this study, in which the Experimental group was taught with 7C's instructional model-based approach and the Control group was taught the by using the conventional teaching method. Before the Experimental intervention, a preliminary test was administered on intelligence followed by pre-test. Both the groups were found to be equivalent. After the experimental treatment, post-test was administered on the same variables. The participation and performance of the experimental group and control group were measured through mean gain scores at the end of the intervention. The t-test was used to differentiate both groups statistically both independently as well as comparing with each other. Hence paired and independent tests were used. ANCOVA was used to analyze the result of PCS on five variables of thinking pattern in both groups.

CHAPTER III
RESULTS AND INTERPRETATION

3.1 PRESENTATION OF RESULTS

The data of experimentation was collected as discussed in the previous chapter. Data analysis was done to achieve the objectives stated in the study and to test the hypotheses, which were statistically verified to arrive at the conclusions of the study using SPSS 22. Microsoft Excel was used to plot the graphical representations.

To analyze the data of experiments, the following primary data of both experiment as well as control group is obtained that has been presented in **Table 20** and **Table 21** below.

Table 20: Distribution of Mean scores in Knowledge (K), Understanding (U), Application (Ap), Analysis (An) and Evaluation (Ev) in Experimental and Control group

Group		(K)	(U)	(Ap)	(An)	(Ev)	Total
	No. of test items	5	5	6	4	4	24
(N=37) Experimental	pre-test	48.11	24.32	33.33	23.65	39.86	34.01
	post-test	67.57	42.70	42.79	37.16	56.08	49.21
	Mean diff.	19.46	18.38	9.46	13.51	16.22	15.20
(N=31) Control	pre-test	43.87	23.87	38.71	28.23	37.10	34.68
	post-test	45.81	25.81	40.32	31.45	37.90	36.56
	Mean diff.	1.94	1.94	1.61	3.23	0.80	1.88
(N=68) Total sample	pre-test	46.18	24.12	35.78	25.74	39.71	34.31
	post-test	57.65	35.00	41.67	34.56	47.79	43.44
	Mean diff.	11.47	10.88	5.88	8.82	8.09	9.13

Table 21 : Distribution of Mean scores in Knowledge (K), Understanding (U), Application (Ap), Analysis (An) and Evaluation (Ev) variables in Low, Average and High PCS in both experimental and control group

N	Group		PCS	K	U	Ap	An	Ev	Total
13.00	Experimental	pre-test	Low PCS	44.62	26.15	26.92	15.38	44.23	31.41
		post-test		61.54	46.15	44.87	30.77	53.85	47.76
		Mean diff		16.92	20	17.95	15.39	9.62	16.35
23.00	Experimental	pre-test	Average PCS	51.3	24.35	38.41	28.26	39.13	36.59
		post-test		71.3	40.87	42.75	42.39	56.52	50.54
		Mean diff		20	16.52	4.34	14.13	17.39	13.95
1.00	Experimental	pre-test	High PCS	20	0	0	25	0	8.33
		post-test		60	40	16.67	0	75	37.5
		Mean diff		40	40	16.67	-25	75	29.17
13.00	Control	pre-test	Low PCS	40	21.54	44.87	36.54	50	38.46
		post-test		46.15	24.62	43.59	38.46	34.62	37.82
		Mean diff		6.15	3.08	-1.28	1.92	-15.38	-0.64
16.00	Control	pre-test	Average PCS	46.25	26.25	34.38	23.44	29.69	32.55
		post-test		45	28.75	38.54	28.13	39.06	36.2
		Mean diff		16.92	2.5	4.16	4.69	9.37	3.65
2.00	Control	pre-test	High PCS	50	20	33.33	12.5	50	33.33
		post-test		50	10	33.33	12.5	50	31.25
		Mean diff		0	-10	0	0	0	-2.08

Table 21 shows the Low, Average, and High Parental Cognitive Stimulation data of both experimental and control groups on pre test and post test. It is found that in both experimental and control groups, mean scores have improved in post test than pre test but in experimental group, the results are better than control group. **Table 20** reveals the information regarding distribution of mean scores in Knowledge (K), Understanding (U), Application (Ap), Analysis (An) and Evaluation (Ev) in experimental and control group and it is found that in experimental group, the mean difference of knowledge variable in post test are much better than other variables whereas in control group, all variable are almost equally improved in post test but mean difference is less than that of experimental group.

To test the stated hypothesis the data obtained has been analysed inferentially to arrive at the conclusions. The results have been discussed in the following section. The data of parental cognitive stimulation, pre-test, and post-test was further analyzed using PCS as independent variable and post-test as a dependent variable where pre-test was used as a covariate. The distribution of mean gain scores of both groups with different PCS levels were studied. The groups performances were discussed with PCS, with in group as well as between groups. The interactive effect of group and PCS was also analyzed to observe whether PCS had any effect in experimental and control groups. Further, the data of thinking pattern at each variable was studied, the gain in average mean was calculated and compared with pre-test and post-test, total mean difference was also calculated. To analyze the thinking pattern, score of each variable was converted to mean average percentage gain e.g. in Knowledge variable total no. of test items were 5 if the score at this variable was 3, it was converted to gain percentage e.g. $3/5 \times 100$. The total score was also converted into percentage by dividing it by total maximum score of 24. The mean average gain scores of pre-test were compared with mean average gain scores of post-test of both groups. The change in mean average scores was statistically tested using paired t-test within groups and independent t-test using ANCOVA where pre-test was taken as a covariate.

The data of experiment was collected, It has been analyzed in the following sequence to discuss the results of the present study in relation to all the variables.

3.1.1 Data analysis for Effectiveness of Instructional Model

3.1.2 Instructional Model vis. a vis. Thinking Pattern

3.1.3 Instructional Model vis. a vis. Parental Cognitive Stimulation

3.1.1 DATA ANALYSIS FOR EFFECTIVENESS OF INSTRUCTIONAL MODEL

To establish the effectiveness of Instructional model, data of pre-test and post-test was compared using t-test independent and paired sample t-test was used to compare both the groups. The data of score obtained on pre-test and post-test without converting it into mean average gain percentage was also interpreted as discussed below:

Table 22: Paired sample t test statistics of Experimental and Control group on pre-test and post-test.

	N	Mean	Std. Deviation	Std. Error of Mean	t-value	p- value
Control	31	8.4194	3.60346	.64720	1.161	.255
	31	9.0323	3.57290	.64171		
Experiment	37	8.1622	3.21898	.52920	7.009	.001**
	37	11.8649	3.32634	.54685		
Combined	68	8.2794	3.37615	.40942	5.502	.001**
	68	10.5735	3.69879	.44854		

Table 22 depicted that the paired sample t-test was administered to compare both groups on pre-test and post test ($t=1.161$; $p=.255$) for the control group and experimental group ($t=7.009$; $p=.001$), these values indicated that while there is a significant difference in the experimental group, which is significant at 0.01 level of significance, no significant difference in control group has been found. Hence, instructional model has impact on experimental group over traditional method in control group.

Table 23: Experimental and Control group comparison on pre-test and post-test.

	Group	N	Mean	Std. Deviation	Std. Error Mean	t-value	p-value
Pre-test	Control	31	8.4194	3.60346	.64720	.311	.757
	Experiment	37	8.1622	3.21898	.52920		
Post-test	Control	31	9.0323	3.57290	.64171	3.381	.001**
	Experiment	37	11.8649	3.32634	.54685		

Table 23 shows that mean of the pre-test for the control group is (M=8.4194) and experimental group is (M=8.1622), it had t-test value ($t = .31; p = .757$), which means there is no significant difference between experimental group and control group on pre-test scores. It mean both the groups were equivalent on pre-test. While post-test of the control group (M=9.0323) and experimental group (M=11.8649) have t-test values ($t = 3.38; p = .001$), that signifies that there is a significant difference among control and experimental group on post-test scores.

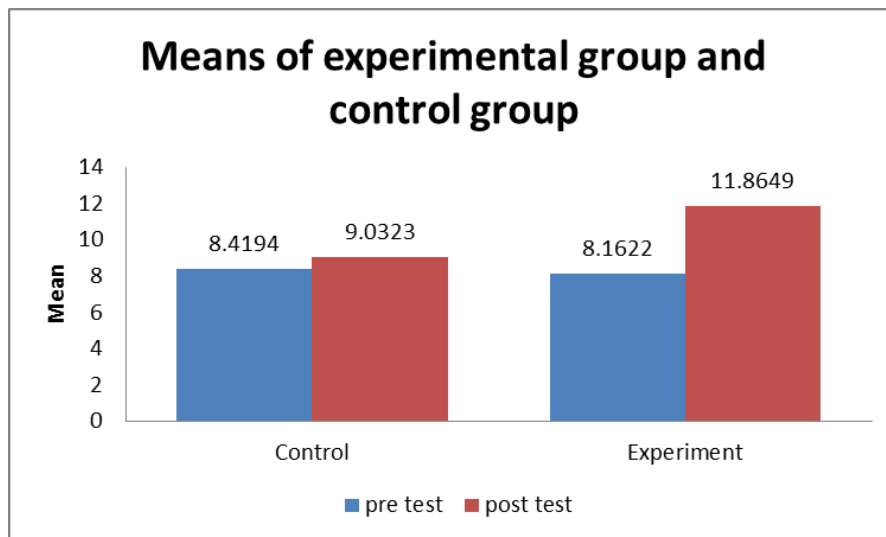


Figure 23

From the data interpretation above it has been concluded that there is a significant difference between experimental and control group in post-test where intervention based on the instructional model has been provided to experimental group whereas the control group was taught through a traditional approach. Control group itself has shown no statistical significant difference in performance while experimental group

shows significant difference at 0.01 level of significance. When comparing the means of both the groups (**Figure23**), the difference is higher in experimental group which means experimental group performance is better than the control group.

Hence, hypothesis1(H1) i.e. Academic **achievement of Secondary school students significantly improves with an Instructional model in life sciences based on Mind, Brain and Education Science approach** is accepted that 7C's instructional model based instructions have a significant impact on the performance of subjects in post-test.

3.1.2 INSTRUCTIONAL MODEL VIS. A VIS. THINKING PATTERN

The students't-test (paired sample) was applied to analyze the data of each variable of thinking pattern scale i.e. Knowledge, Understanding, Application, Analysis and Evaluation and total combined scores of both pre -test and post- test of experimental and control group. To establish total percentage gain at each thinking level, all the test scores were converted to percentage gain score in each of Knowledge, Understanding ,Application, Analysis ,and Evaluation variable. The percentage is calculated by dividing obtained score by the maximum score of that variable. .e.g. Knowledge component has maximum score 5. So, each student's individual score obtained in Knowledge variable is converted to percentage gain by dividing it with 5 and of total scores obtained in test with 24. Further data was analyzed based on these scores and both groups were compared to access if there is a significant difference on post-test at each level.

The experimental group was initially compared using paired sample t-test on pre-test and post test of thinking pattern. The corresponding t values and p values are reflected in the data of pre-test and post-test of experimental group on each variable was also analyzed using paired t-test, the resulting t values and corresponding p value.

The data presented in **Table 24** depicts that the data of pre-test and post-test of experimental group on each variable was also analyzed using paired t test, the resulting t values and corresponding p value reflected that it has significant difference in performance in all the variables i.e. Knowledge, Understanding, Application, Analysis and Evaluation at .05 level of significance.

Table 24: Distribution of Mean, Standard Deviation in Experimental group on different levels of Knowledge (K) Understanding (U) Application (Ap) Analysis (An) and Evaluation (Ev).

experimental group		Mean diff	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t-value	df	p-value
					Lower	Upper			
Knowledge	pre-test post-test	19.45	21.85	3.59	26.74503	12.17389	5.417	36	.000
Understanding	pre-test post-test	18.37	22.79	3.74	25.97793	10.77882	4.905	36	.000
Application	pre-test Post-test	9.46	25.92	4.26	18.10234	0.81766	2.220	36	.033
Analysis	pre-test post-test	13.51	32.59	5.35	24.38061	2.64642	2.522	36	.016
Evaluation	pre-test Post-test	16.21	23.72	3.90	24.12784	8.30459	4.157	36	.000

Table 25: Distribution of Mean, Standard Deviation in Control group in Knowledge (K) Understanding (U) Application (Ap) Analysis (An) and Evaluation (Ev) ; pre-test and post-test.

Control group		Mean diff	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t-value	df	p-value
					Lower	Upper			
Knowledge	pre-test post-test	1.935	27.497	4.938	12.021	8.150	-.392	30	.698
Understanding	pre-test post-test	1.935	22.123	3.973	10.050	6.179	.487	30	.630
Application	pre-test post-test	1.613	23.315	4.187	10.165	6.938	.385	30	.703
Analysis	pre-test post-test	3.225	27.944	5.019	13.476	7.024	.643	30	.525
Evaluation	pre-test post-test	.806	28.492	5.117	11.257	9.644	.158	30	.876

The data of control group is compared using paired t test results in **Table 25** where it is found that on Knowledge ($t=.392$; $p=.698$), Understanding ($t=0.487$; $p=0.630$), Application ($t=0.385$; $p=.703$), Analysis ($t=.643$; $p=.525$), Evaluation ($t=.158$; $p=.876$), p - values are non significant at both the levels of significance.while experimental group data clearly reflect the statistical significance at .05 level of significance on all variables of thinking pattern in **Table 24** .

Hence, it was concluded that there is no significant difference in pre-test, post-test performance of control group on Knowledge, Understanding, Application, Analysis and Evaluation. Hence, on the basis of data, it is concluded that control group has no significant difference in thinking pattern in pre-test and post-test performance while experimental group has significant change in all variables of thinking pattern.

Now the analysis of covariance (ANCOVA) was done to analyse the data of each variable by taking pre test and PCS as covariates.All the variables were discussed below, using ANCOVA where pre test was taken as covariate.

Table 26: Descriptive statistics for Knowledge variable on post-test with respect to PCS and Groups

PCS	Group	Mean	Std. Deviation	N
Low	Experiment	61.538	23.750	13
	Control	46.153	22.188	13
	Total	53.846	23.845	26
Average	Experiment	71.304	16.869	23
	Control	45.000	26.832	16
	Total	60.512	24.915	39
Total	Experiment	67.777	19.872	36
	Control	45.517	24.434	29
	Total	57.846	24.526	65

Table 27: Between-Subjects Effects of Knowledge (K) on post-test with respect to PCS and Groups

Source	Type III Sum of Squares	Df	Mean Square	F-value	p-value
K pre-test	3123.686	1	3123.686	7.042	.010**
PCS	55.186	1	55.186	.124	.726
Group	5507.085	1	5507.085	12.415	.001**
PCS * Group	445.404	1	445.404	1.004	.320
Error	26614.107	60	443.568		
Total	38498.462	64			

Table 26 represents mean and SD of control and experimental groups with low and average PCS in Knowledge variable of thinking pattern scale. Data showed that experiment group mean is high as compared to control group in both low PCS as

well as average PCS students, which also indicates that experimental group performed better with average PCS (M=71.30) than low PCS (M=61.53), while in control group, both the mean are almost equal, hence no much difference in performance is there in low and average PCS students. Overall mean is greater in the experimental group (M=67.77) as compared to the Control in post-test (M=45.51) that reveals that instructional model has a positive impact on the experimental group with both low PCS and average PCS students in Knowledge variable.

Table 27 indicates the influence of independent variable PCS on a dependent variable Knowledge, while removing the effect of the covariate factor (pre-test Knowledge). The covariate (pre-test Knowledge) is statistically significant with the dependent variable (post-test Knowledge) $F=7.042$, $p=0.10$ ($p \leq .01$). After controlling the effect of the covariate, both group (control and experiment) were statistically significantly ($F=12.415$, $p=.001$) differ on post-test in Knowledge variable. PCS (low and average) showed non-significant ($F=0.124$; $p=0.726$) difference on post-test Knowledge. Similarly, the interaction of PCS with a group (control and experiment) was also statistically non-significant ($F=1.004$, $p=0.320$).

It can be concluded that in Knowledge variable of thinking pattern, both the group differs significantly but PCS (low and average) has not shown any significant difference in post-test performance. mean gain in the experimental group is high than the control group. So, this can be concluded that Instructional model has a positive impact on Knowledge variable of thinking pattern in the experimental group.

Table 28: Descriptive statistics for Understanding (U) on post-test with respect to PCS and Group

PCS	Group	Mean	Std. Deviation	N
Low	Experiment	46.1538	26.31174	13
	Control	24.6154	14.50022	13
	Total	35.3846	23.53394	26
Average	Experiment	40.8696	17.55848	23
	Control	28.7500	25.26526	16
	Total	35.8974	21.60872	39
Total	Experiment	42.7778	20.92314	36
	Control	26.8966	20.89146	29
	Total	35.6923	22.21832	65

Table 29: Tests of Between-Subjects Effects of Understanding (U) on post-test with respect to PCS and Group.

Source	Type III Sum of Squares	Df	Mean Square	F-value	p-value
U Pre test	4008.044	1	4008.044	10.374	.002**
PCS	20.476	1	20.476	.053	.819
Groups	4079.782	1	4079.782	10.560	.002**
PCS * Group	177.888	1	177.888	.460	.500
Error	23180.334	60	386.339		
Total	31593.846	64			

Table 28 represents mean and SD of the control and the experimental group with low and average PCS in Understanding variable of thinking pattern. Data reveals that Experiment group mean is high as compared to control group with both Low, as well as Average PCS, which indicates that experimental group performed better in low PCS (M=46.15) than in average PCS (M=40.86) . Control group mean of average PCS (M=28.75) was higher than Low PCS (M=24.61) although the difference is not much high. Overall mean is greater in the experimental group (M=42.77) as compared

to the control group in the post test ($M=26.89$). It reveals that instructional model has a positive impact on the experimental group in both PCS (low and average).

The data was further analyzed on ANCOVA using pre-test of Understanding and PCS as a covariate the results in **Table 29** provide information of F values of Understanding pre-test on post-test ($F=10.374$ $p=0.002$) which is significant at 0.05 and 0.01 level, while PCS ($F=0.053$, $p=0.819$) is non-significant on Understanding post-test of both the groups (experimental and control group). But both experimental and control groups differ significantly on Understanding post-test ($F=10.560$, $p=.002$). The results indicate that experimental group performed well in post-test than the control group with PCS having a non-significant contribution. So, the significant difference in performance is due to Instructional model-based intervention.

Table 30: Descriptive statistics for Application (Ap) on post-test with respect to PCS and Groups

PCS	Group	Mean	Std. Deviation	N
Low	Experiment	44.8615	22.95545	13
	Control	43.5846	25.93880	13
	Total	44.2231	24.00657	26
Average	Experiment	42.7565	26.50322	23
	Control	38.5500	25.61414	16
	Total	41.0308	25.88511	39
Total	Experiment	43.5167	24.96483	36
	Control	40.8069	25.42280	29
	Total	42.3077	25.00886	65

Table 31: Tests of Between-Subjects Effects of the Application(Ap) on post-test with respect to PCS and Groups

Source	Type III Sum of Squares	Df	Mean Square	F-value	p-value
Ap Pre-test	8407.672	1	8407.672	16.125	.001**
PCS	224.653	1	224.653	.431	.514
Groups	603.722	1	603.722	1.158	.286
PCS * Group	258.100	1	258.100	.495	.484
Error	31284.133	60	521.402		
Total	40028.346	64			

Table 30 above represents mean and standard deviation of control and experimental groups with low and average PCS in Application variable of thinking pattern. The above data indicated that experimental group mean is slightly high as compared to control group in both low, as well as average PCS students, which revealed that experimental group performed better in low PCS ($M=44.86$) than in average PCS ($M=42.75$) students. While in control group mean of low PCS ($M=43.58$) was higher than average PCS ($M=38.55$) that indicate that PCS has no significant role in Application variable of thinking pattern. Overall mean is greater in the experimental group ($M=43.51$) as compared to the control in post-test ($M=40.80$), which reveals that instructional model has a positive impact on the experimental group with both low and average PCS combined together.

The data was further analyzed using ANCOVA using pre-test of Application (Ap) variable as a covariate in **Table 31** above and the results shown indicated that although there is slight difference in mean of experimental ($M=43.51$) and control group ($M=40.80$), hence, both groups were equal in performance at this variable with $F=1.158$, $p=0.286$, while there is a significant difference in performance with pre-test and post-test ($F=16.125$, $p=0.001$), which is significant at 0.01 level of significance. PCS has a uniform impact on both groups as it has a non-significant effect on both groups ($F=0.431$, $p=0.514$). The results indicates that 7C's instructional model has positive impact on the performance of experimental group

Table 32: Descriptive statistics for Analysis on post-test with respect to PCS and Group

PCS	Group	Mean	Std. Deviation	N
Low	Experiment	38.4615	33.25311	13
	Control	30.7692	29.14376	13
	Total	34.6154	30.88440	26
Average	Experiment	42.3913	28.63840	23
	Control	28.1250	31.45764	16
	Total	36.5385	30.26536	39
Total	Experiment	38.1944	28.96187	36
	Control	32.7586	32.11548	29
	Total	35.7692	30.28808	65

Table 33: Tests of Between-Subjects Effects of Analysis(An) on post-test with respect to PCS and Groups

Source	Type III Sum of Squares	Df	Mean Square	F-value	p-value
An pre-test	7899.910	1	7899.910	9.783	.003**
PCS	7.405	1	7.405	.009	.924
Groups	730.255	1	730.255	.904	.345
PCS * Groups	376.363	1	376.363	.466	.497
Error	48448.857	60	807.481		

Table 32 showed the descriptive statistics of mean and standard deviation of Analysis variable among low and average PCS group students. It reflects that mean of post-test in Analysis variable of experimental group was higher in average PCS group (M=42.391) than low PCS group (M=38.461), while in control group mean was high in Low PCS (M=30.769) than Average PCS (M=28.125). Average PCS group performed better than low PCS in experimental group while in control group performance of students with low PCS was high in terms of mean values. Hence from the analysis of mean values it may be concluded that instructional model has impacted the average PCS students more than low PCS student in Analysis variable of thinking pattern scale.

From the discussion of data in **Table 33** it represents the effect of PCS and instructional model in experimental group and its comparison to control group related to analysis variable in both groups .where both the groups shown non significant difference($F=.904$ $p=.345$) in post test performance but both group differ significantly when pre test was taken as covariate($F=9.783$; $p=.003$) at the same time PCS ($F=0.053$; $p=0.819$) is non-significant on Analysis variable for both the experimental and control group. Overall, the results indicate that experimental group performed well in Analysis variable in post-test of average PCS with high mean ($M=38.194$) than control group ($M=32.758$), similarly, in low PCS experimental group students were better in performance. Which clearly indicates that difference in performance of experimental group is due to 7C's instructional model.

Table 34: Descriptive statistics for Evaluation (Ev) on post-test with respect to PCS and Experimental group and Control group

PCS	Group	Mean	Std. Deviation	N
Low	Experiment	53.8462	20.01602	13
	Control	34.6154	21.74296	13
	Total	44.2308	22.70208	26
Average	Experiment	56.5217	20.25041	23
	Control	39.0625	27.33854	16
	Total	49.3590	24.66031	39
Total	Experiment	55.5556	19.92048	36
	Control	37.0690	24.65900	29
	Total	47.3077	23.84974	65

Table 35: Tests of Between-Subjects Effects of Evaluation (Ev) on post-test with respect to PCS and Groups

Source	Type III Sum of Squares	Df	Mean Square	F-value	p-value
Ev Pre	4070.267	1	4070.267	9.166	.004**
PCS	981.972	1	981.972	2.211	.142
Group	4791.023	1	4791.023	10.789	.002**
PCS * Group	208.406	1	208.406	.469	.496
Error	26643.179	60	444.053		
Total	36403.846	64			

Table 34 represents the mean and SD of Evaluation post-test in control and experimental groups with low and average PCS students. Data showed that experimental group mean is high as compared to control group mean in both low as well as average PCS students, which indicates that experimental group performed better in average PCS (M=56.52) than low PCS (M=53.84) students. Control group

mean with average PCS (M=39.06) was higher than low PCS (M=34.61). But, overall mean is greater in experimental group (M=55.55) as compared to the control in post-test (M=37.06), which reveals that Instructional model has a positive impact on the experimental group with both low PCS and average PCS students at Evaluation variable of thinking pattern Scale.

In Evaluation variable of thinking pattern, experimental group and control group have a significant difference at both 0.01 and 0.05 level of significance (**Table 35**) with $F=10.789$; $p=.002$, and there is also a significant difference in each group over the pre-test and post-test performance with $F=9.166$; $p=.004$, while there is the non-significant impact of PCS on Evaluation with $F=2.211$ and $p=0.142$ which is non-significant at both the levels of significance. The PCS and Group interactive effect is also non-significant ($F=0.469$; $p=0.496$) at both the levels of significance. . Hence, It can be said that 7C's instructional model is effective on Evaluation variable as experimental group performance is better than control group in both low as well as average PCS.

Now, the analysis data of thinking pattern was done by plotting graphs of mean values at five levels of Knowledge, Understanding, Application, Analysis and Evaluation in pre-test and post-test for experimental and control groups. The thinking levels were taken in hierarchical order as defined by Bloom's Taxonomy; a pattern of thinking was plotted on the basis of performance of each group at these levels using values as shown in **Table 20**. The line graphs (**Figure 24 & Figure 25**) using Microsoft Excel application was prepared to monitor any change in thinking pattern, the x-axis represents the variable of the thinking pattern and the y-axis denotes mean scores at each level. The thinking levels were taken in hierarchical order as defined by Bloom's taxonomy, a pattern of thinking was plotted on the basis of performance of each group at these levels. With the analysis of line graphs, it is visible that pattern has improved significantly in both groups, although the improvement in experimental group is higher as compared to control group. The data of mean values of experimental group and control group in pre test and post test were compared observing the mean gain at each variable of thinking Pattern i.e. Knowledge, Understanding, Application

,Analysis and Evaluation .All levels have improved significantly with instructional model based interventions in the experimental group as compared to control group.

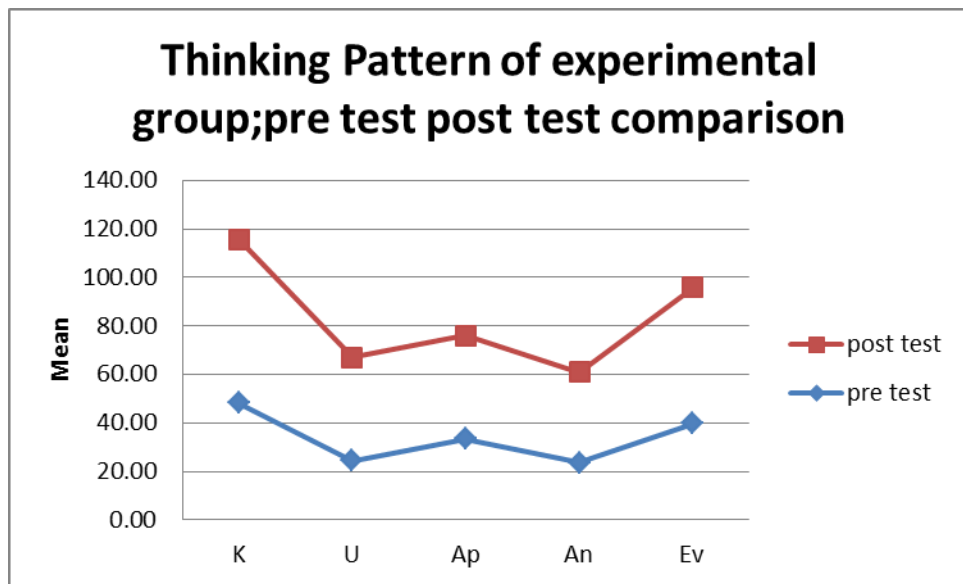


Figure 24

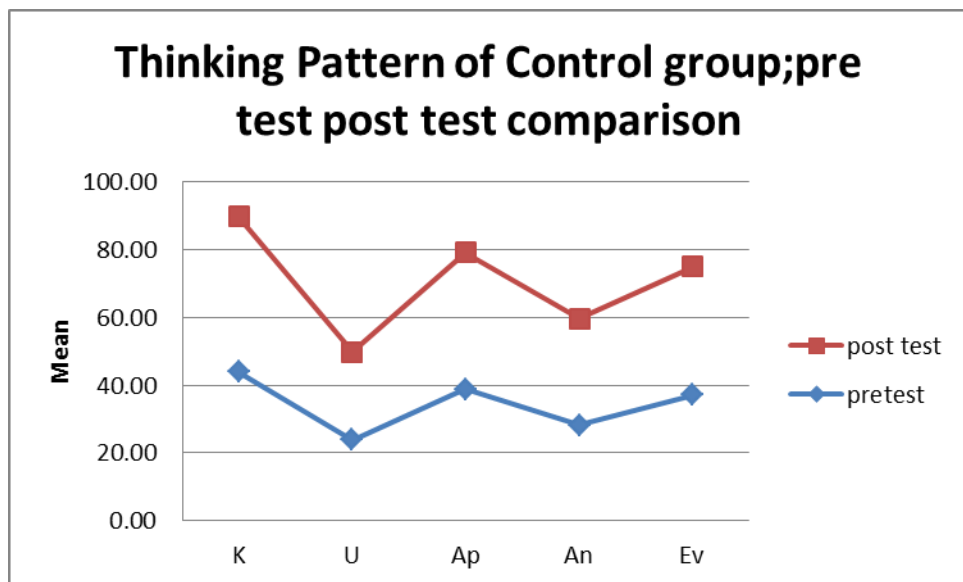


Figure 25

The data discussed in above section revealed that there was statistically significant difference on 0.05 level of significance on all variables of thinking pattern in experimental group. The overall increase in mean at each thinking variables of thinking pattern scale in experimental is higher as compared to control group. Hence, experimental group has performed better with high mean gain difference from pre test to post test. It can be concluded that instructional model has congruence with thinking pattern. It does improve the thinking pattern in terms of higher mean gain in post-test in the experimental group as compared to control group.

From the discussion and presentation of results above it can be concluded that H2 i.e. **There is no significant change in Thinking Pattern of Secondary School students with an Instructional model in life sciences based on Mind, Brain and Education Science approach** is rejected.

3.1.3 INSTRUCTIONAL MODEL VIS. A VIS. PARENTAL COGNITIVE STIMULATION

The Instructional model based interventions were provided to the experimental group and traditional approach was used for control group as discussed in chapter 2 The data of PCS was differentiated into high PCS, average PCS and low PCS in both the groups (**Table 21.**) Total students of experimental group and control group were grouped as their level of parental cognitive stimulation i.e. low average and high .only single student with high PCS was found in experimental group that may be accredited to low socioeconomic status or lack of education to provide cognitive stimulation. Only 1 students as high PCS, 13 low PCS, 23 students with average PCS students were reported in experimental & , 2 student with high PCS, 13 low PCS, 16 students with average PCS students in control group.

The Analysis of this data using t test as well as ANCOVA was done .The data of only Low and Average PCS students was analyzed statistically because with High PCS.(N=1) and in control group(N=2).number of students was less so, statistical analysis was not possible. Hence, only gain percentage score of pre-test and post-test were compared as shown in **Table 35 .**

Table 36: Distribution of achievement score in high PCS experimental group on Knowledge (K), Understanding (U), Application (Ap), Analysis (An) and Evaluation (Ev)

Variables		N	Score%	Score Difference %
K	Pre	1	20.00	40.00
	Post	1	60.00	
U	Pre	1	.00	40.00
	Post	1	40.00	
Ap	Pre	1	.00	16.70
	Post	1	16.70	
An	Pre	1	25.00	-25.00
	Post	1	.00	
Ev	Pre	1	.00	75.00
	Post	1	75.00	
Total	Pre	1	8.30	29.20
	Post	1	37.50	

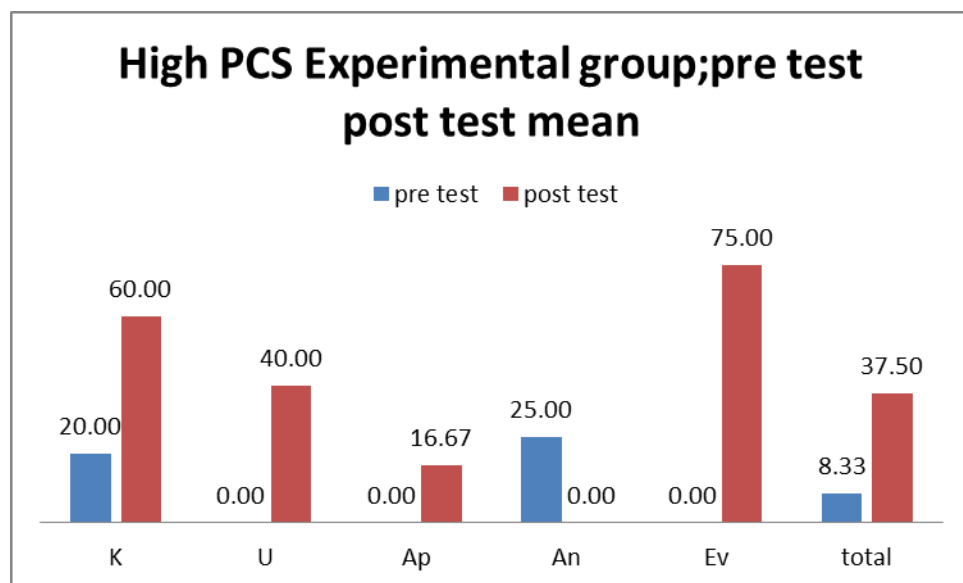


Figure 26

There is total difference of 29.20% in performance of achievement between pre-test and post-test scores (Table 36). Comparison of pre test and post test scores was done in Figure 26 by plotting the values on each variable of thinking pattern scale

Table 37: Distribution of mean, in high PCS control group in Knowledge (K), Understanding (U), Application (Ap), Analysis (An) and Evaluation (Ev)

Variables		N	Mean	Standard Deviation	Mean Difference
K	Pre	2	50.00	42.43	0.00
	Post	2	50.00	14.14	
U	Pre	2	20.00	.00	-10.00
	Post	2	10.00	14.14	
Ap	Pre	2	33.30	.00	0.00
	Post	2	33.30	.00	
An	Pre	2	12.50	17.68	0.00
	Post	2	12.50	17.68	
Ev	Pre	2	50.00	.00	0.00
	Post	2	50.00	.00	
Total	Pre	2	33.35	11.81	-2.10
	Post	2	31.25	2.90	

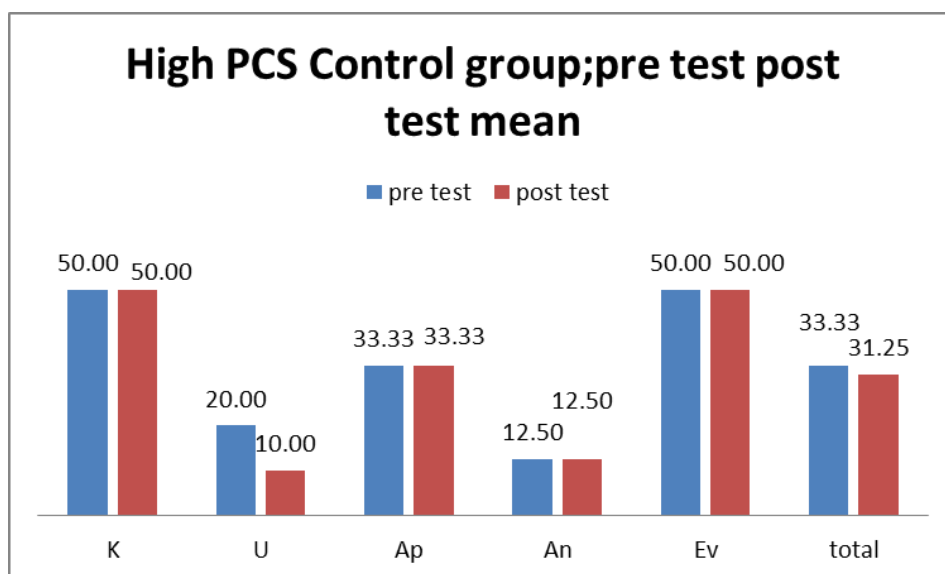


Figure 27

Table 37 depicts in control group (N=2) there is a negative value shown in mean difference (M difference = -2.10).The pre test mean (M=1.81) had declined to mean value (M=2.90) of post-test (**Figure 27**). From these mean values, it could be interpreted that with high PCS there is a positive change in performance of the experimental group than control group, where instructional model based intervention was provided.

Table 38: Distribution of mean,standard deviation in average PCS experimental group in Knowledge (K), Understanding (U), Application (Ap), Analysis (An) and Evaluation (Ev)

		N	Mean	Std. Deviation	Mean Difference	t-value	p-value
K	Pre	23	51.3043	17.91504	20.00000	4.796	.001**
	Post	23	71.3043	16.86965			
U	Pre	23	24.3478	15.90486	16.52174	3.694	.001**
	Post	23	40.8696	17.55848			
Ap	Pre	23	38.4000	22.14920	4.35652	.845	.407
	Post	23	42.7565	26.50322			
An	Pre	23	28.2609	30.43655	14.13043	1.924	.067
	Post	23	42.3913	28.63840			
Ev	Pre	23	39.1304	19.69380	17.39130	4.362	.001**
	Post	23	56.5217	20.25041			
Total	Pre	23	36.5870	13.65222	13.95652	6.077	.001**
	Post	23	50.5435	14.06788			

Table 38 reveals that the experimental group data of average PCS it represent pre-test post-test mean difference M dif=13.952 t=6.07,p=.001 in experimental group, which is significant at .01 Level of significance, it shows that average PCS performed well in experimental group where instructional model based intervention was provided. **Figure 28** represents the mean of average PCS experimental group in pre-test and post-test. Average PCS experimental group significantly differ in Knowledge, Understanding and Evaluation variable while no statistical difference has been found in Application and Analysis variable although mean gain has been reported.

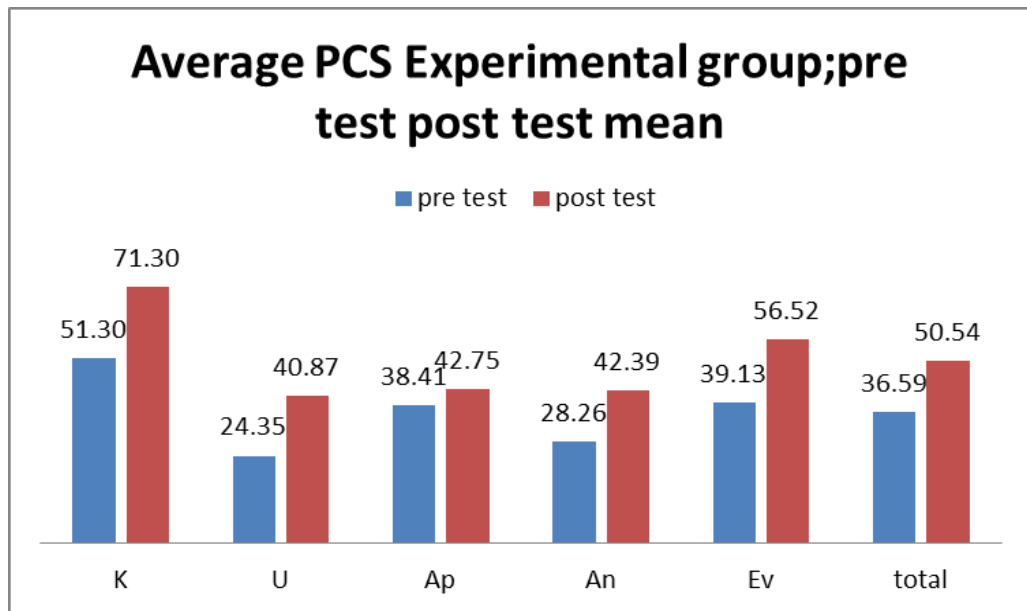


Figure 28

Table 39: Distribution of mean, standard deviation in average PCS control group in Knowledge (K), Understanding (U), Application (Ap), Analysis (An) and Evaluation (Ev)

		N	Mean	Std. Deviation	Mean Difference	t-value	p-value
K	Pre	16	46.2500	25.00000	-1.25000	.180	.860
	Post	16	45.0000	26.83282			
U	Pre	16	26.2500	21.56386	2.50000	.460	.652
	Post	16	28.7500	25.26526			
Ap	Pre	16	34.3625	23.92234	4.18750	.640	.532
	Post	16	38.5500	25.61414			
An	Pre	16	23.4375	23.21772	4.68750	.545	.594
	Post	16	28.1250	31.45764			
Ev	Pre	16	29.6875	24.52677	9.37500	1.307	.211
	Post	16	39.0625	27.33854			
Total	Pre	16	32.5500	17.36813	3.64375	1.138	.273
	Post	16	36.1938	18.49438			

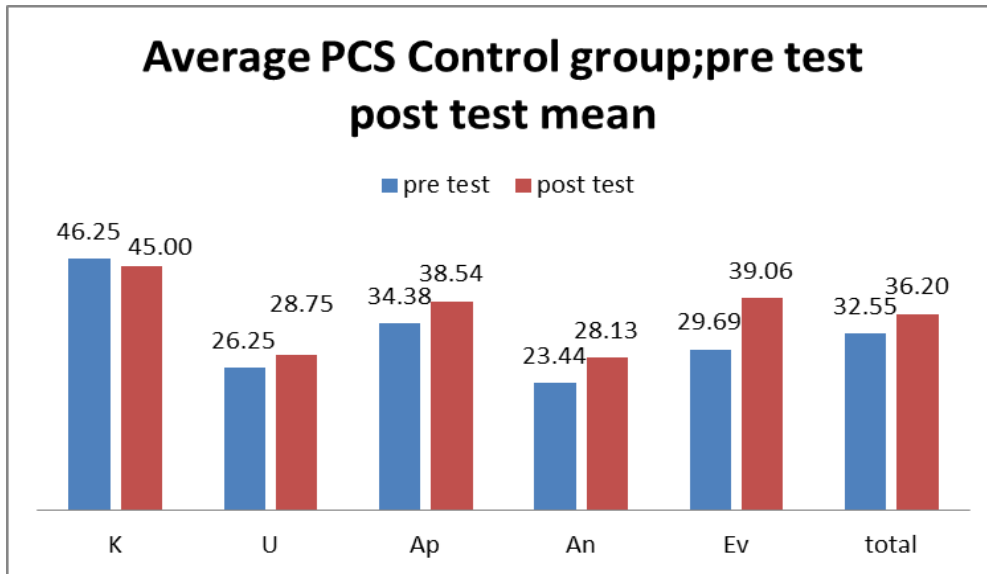


Figure 29

In control group overall mean difference (M dif=3.64375) of average PCS of pre test and post test, it has been reported not significant ($t=1.138$, $p=.273$) at even 0.05 level of significance.

The other data of mean difference and corresponding t and p values of average PCS control group in **Table 39** showed no statistical difference with p values $>.05$ in all the variables of thinking pattern i.e. Knowledge, Understanding, Application, Analysis and Evaluation. The small difference in performance of pre test and post test of average PCS control group using data of mean values is also represented in **Figure 29** above.

From the above data analysis, it can be concluded that in control group average PCS has not shown significant difference in performance while in experimental group due to 7C's instructional model there is significant change in performance of average PCS.

In **Table 40** it is reported that in low PCS experimental group, Knowledge, Understanding and Application has shown significant difference at .05 level of significance with $t=2.382, p=.035; t=2.793, p=0.16; t=2.344, p=.037$ respectively .Whereas ,Analysis and Evaluation variables were not statistically significant at 0.05 level of significance with $p \geq .05$. The total score on pre-test and post-test of low PCS experimental group showed $M \text{ diff}=16.346, t=3.472, p=.005$, which is significant at 0.01 and 0.05 level of significance, which means there is a significant difference in the pre-test and post-test performance of the experimental group. **Figure 30**, represents the mean of pre-test and post –test in low PCS experimental group.

Table 40: Distribution of mean, standard deviation, t-values in low PCS experimental group in Knowledge (K), Understanding (U), Application (Ap), Analysis (An) and Evaluation (Ev)

Variables		N	Mean	Std. Deviation	Mean Difference	t-value	p-value
K	pre-test	13	44.6154	16.64101	16.92308	2.382	.035*
	post-test	13	61.5385	23.75084			
U	pre-test	13	26.1538	18.94662	20.00000	2.793	.016*
	post-test	13	46.1538	26.31174			
Ap	pre-test	13	26.9154	17.39276	17.94615	2.344	.037*
	post-test	13	44.8615	22.95545			
An	pre-test	13	15.3846	16.26109	15.38462	1.979	.071
	post-test	13	30.7692	29.14376			
Ev	pre-test	13	44.2308	20.80126	9.61538	1.328	.209
	post-test	13	53.8462	20.01602			
Total Test	pre-test	13	31.4000	11.11920	16.34615	3.472	.005**
	post-test	13	47.7462	14.19751			

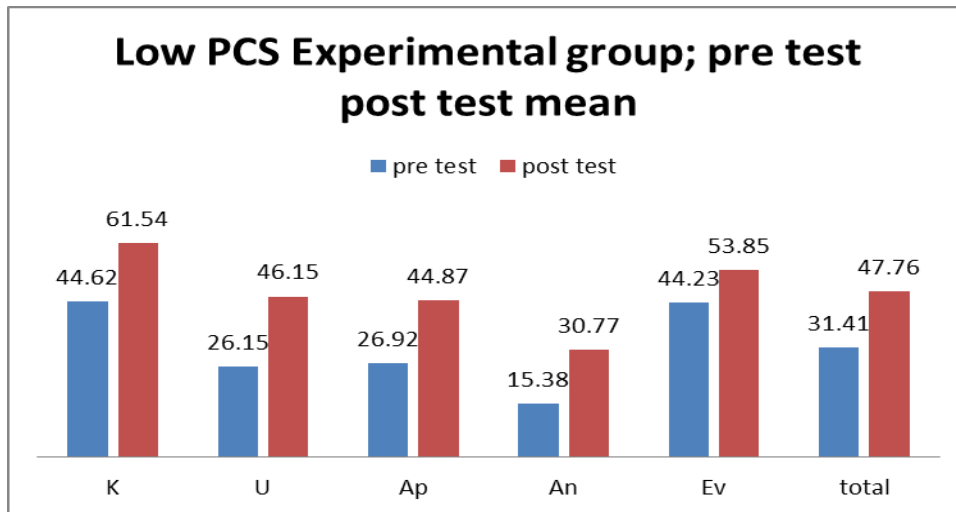


Figure 30

Table 41: Distribution of mean, standard deviation in low PCS control group in Knowledge (K), Understanding (U), Application (Ap), Analysis (An) and Evaluation (Ev)

Variable		N	Mean	Std. Deviation	Mean Difference	t-value	p-value
K	pre-test	13	40.0000	16.32993	6.15385	-.887	.392
	post-test	13	46.1538	22.18801			
U	pre-test	13	21.5385	26.40901	3.07692	-.457	.656
	post-test	13	24.6154	14.50022			
Ap	pre-test	13	44.8769	26.67696	-1.29231	.212	.836
	post-test	13	43.5846	25.93880			
An	pre-test	13	36.5385	24.18545	1.92308	-.322	.753
	post-test	13	38.4615	33.25311			
Ev	pre-test	13	50.0000	22.82177	-15.38462	1.979	.071
	post-test	13	34.6154	21.74296			
Total Test	pre-test	13	38.4615	12.39237	-.63846	.202	.843
	post-test	13	37.8231	13.12657			

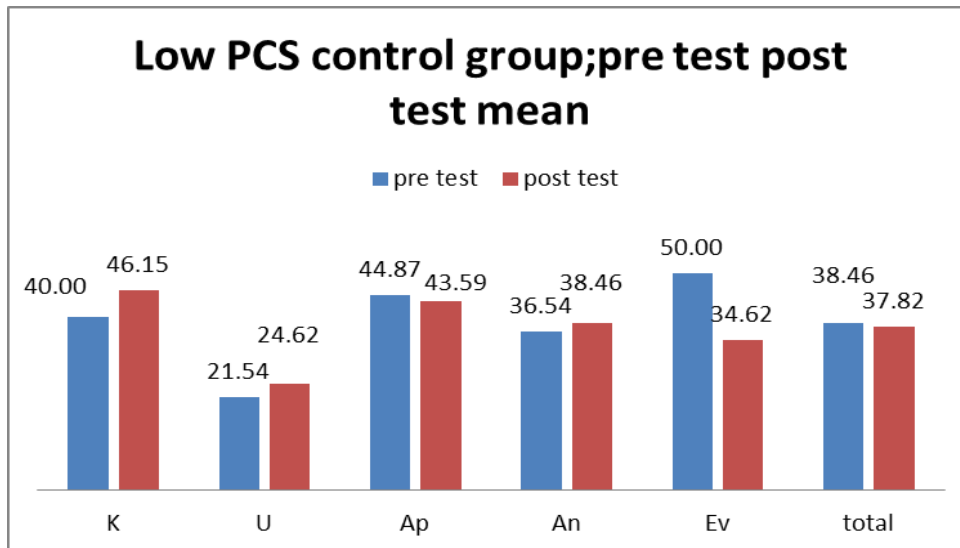


Figure 31

Table 41 shows the Low PCS control group (N=13) and there is no significant difference ($t=0.202, p=0.843$) has been observed in the pre-test and post-test performance as the Low PCS data has not shown any significant difference even at any of variable from Knowledge to Evaluation of thinking pattern. **Figure 31** clarifies the picture with representation of mean values of pre-test and post test of low PCS control group.

From the analysis of data it is concluded that low PCS experimental group performance is better than low PCS control group . There is significant difference in experimental group ($t=3.472; p=.005$), where 7C's instructional model has been effective in producing significant change in performance of low PCS experimental group in Knowledge ,Understanding and Application variables of thinking pattern.

In **Table 42 & Table 43**, The data was further analyzed for observing the impact of PCS on post-test of experimental and control group using ANCOVA, where pre-test was taken as covariate and post-test as dependent variable. The data was analyzed and interpreted to measure the impact of parental cognitive stimulation on thinking pattern of both the groups.

Table 42: ANCOVA on PCS and pre-test, post-test of experimental and control group

		Value Label	N
PCS	Pre Test	Low	26
	Post Test	Average	39
Group	Pre Test	Experiment	36
	Post Test	Control	29

Table 43: Descriptive statistics of ANCOVA using post-test as the dependent variable

PCS	Group	Mean	Std. Deviation	N
Low	Experiment	47.7462	14.19751	13
	Control	37.8231	13.12657	13
	Total	42.7846	14.31999	26
Average	Experiment	50.5435	14.06788	23
	Control	36.1937	18.49438	16
	Total	44.6564	17.34141	39
Total	Experiment	49.5333	13.97727	36
	Control	36.9241	16.05499	29
	Total	43.9077	16.10937	65

Table 44: Between-subject effects of ANCOVA on PCS and pre-test using post-test as the dependent variable

Source	Type III Sum of Squares	Df	Mean Square	F-value	p-value
Pre-test	5208.152	1	5208.152	35.660	.001**
PCS	10.430	1	10.430	.071	.790
Group	2648.154	1	2648.154	18.132	.001**
PCS * Group	31.128	1	31.128	.213	.646
Error	8762.909	60	146.048		
Total	16608.746	64			

Analysis of the data above in **Table 43** shows that both groups significantly differ in pre-test ($F=35.660$, $p=0.001$) while PCS and group ($F=0.213$; $p=0.646$) interactive effect is non-significant . It has been reported that although there is significant difference in pre-test, post-test performance of both groups with $F=18.132$; $p=.001$. But, PCS alone also does not have any impact ($F=0.071$; $p=.790$) on both groups, as it is statistically non-significant at both the levels of significance. From above discussions, It is concluded PCS has not shown any significant difference on the performance of groups.

It make obvious that PCS has its role to play in experimental group but it is in congruence to instructional model as performance of low PCS experimental group is high ($M=47.74$) than low PCS control group ($M=37.82$), similarly it is in average PCS experimental group ($M=50.54$) mean is high than control group ($M=36.19$). This shows that impact of the 7C's instructional model is there in experimental group; otherwise, PCS alone with the traditional method in the control group had not shown any significant impact on the post-test performance of control group.

From the results discussed above, it is clear that academic achievement of secondary school students does not vary with Parental Cognitive Stimulation alone as it has shown non-significance in ANCOVA with F values which are not significant at both the levels of significance. This shows that parental cognitive stimulation does not have an effect on post-test performance but, the significant difference between experimental group and control group is due to the 7C's Instructional model intervention.

Hence, null hypothesis H3 i.e. **Academic Achievement of Secondary School Students does not vary with Parental Cognitive Stimulation** is accepted.

3.2 INTERPRETATION OF RESULTS

The results discussed above are interpreted as below in the following sub-sections:

3.2.1 Achievement of the Objectives of the Study

3.2.2 Effectiveness of 7c's Instructional Model in Congruence to Parental Cognitive Stimulation

3.2.3 Effectiveness of 7 C's Instructional Model in Congruence to Thinking Pattern

3.2.1 Achievement of the Objectives of the Study

The interpretation of results was done to discuss the achievement of the objectives of the study. Following four objectives were framed in the present study .these are discussed as below:

1. To develop an Instructional Model for life sciences based on Mind, Brain, and Education Science approach.
2. To find out the effectiveness of Instructional Model for life sciences based on Mind, Brain, and Education Science approach.
3. To explore the impact of an instructional model for life sciences based on mind brain and education science approach in congruence to thinking pattern of secondary school students.
4. To reveal the influence of instructional model for life sciences based on mind, brain, and education science approach in congruence to parental cognitive stimulation of secondary school students.

The four objectives were framed in this study, the achievements of which have been discussed here to arrive at the conclusions.

Objective 1 : To develop an instructional model for life sciences based on mind, brain, and education science approach.

To achieve this objective, an instructional model called 7 C's has been developed. The detailed process of development of this model has been discussed in Chapter 2. The model named 7C's has seven steps named below:

1. Connect to the learners
2. Create learning environment
3. Classify objectives
4. Communicate the information
5. Cognitive processing
6. Cognitive stimulation
7. Comprehensive evaluation

The 7 C's Instructional Model has guidelines for the teacher to follow in the process of teaching and learning. The instructional model includes the brief of how learning happens and what are different regions of the brain that could have an

impact on learning, the application of 7C's instructional model, the role of teacher and evaluation system is also mentioned. Lesson plans were prepared in the form of lesson units (**Annexure 3**) and instructional planning manual was created to guide the teachers.

Objective 2 : To find out the effectiveness of instructional model for life sciences based on mind, brain, and education science approach.

To achieve this objective, lesson plans were developed and a quasi-experimental design was formed based on two groups i.e. experimental and control group. In experimental group, instructional model based lessons in life science were delivered by the researcher herself. Total 3-week intervention was given and then post-test was undertaken to establish effectiveness of the model. **Hypothesis 1** was tested while comparing post-test scores with pre-test scores in experimental group itself as well as with control group, where traditional approach was used. It has been reported that experimental group showed significant difference from control group on post-test ($t=3.381$; $p=0.001$). It significantly differs at 0.01 level of significance while both the groups were at equal level of performance on pre-test ($t=0.311$; $p=0.757$) (**Table 20**; **Table 21**). Hence, it can be predicted that 7C's instructional model has been effective on student's performance in life sciences.

On analysis of similar studies, it was found that interventions based on brain based learning principles were effective in many other studies like a meta-analysis of brain based learning studies done by Yasar (2017), It was found that the effect size of 1.382 brain based learning on achievement, which is high and 0.416 effect size was found on attitude in meta-analysis of different studies using brain based learning in science. The results showed a positive and significant effect of brain based learning on achievement and attitude of learners.

Akyurek & Afacan (2013) studied the effectiveness of brain based learning approach in science classes. The experimental and control group consisted of total 57 participants. The result showed that brain based approach had significant difference in motivation and achievement in the experimental group. Similarly, Saleh (2012) in his study has reported that Caine and Caine's instructional model i.e. relaxed alertness, orchestrated immersion and active process improved understanding of Newtonian Physics. So, it can be concluded that brain based teaching learning

principles have significant effect on achievement, attitude, motivation and understanding of the students. The 7C's instructional model's effectiveness in this study is justified with the results discussed above.

Objective 3 : To explore the impact of an instructional model for life sciences based on mind brain and education science approach in congruence to thinking pattern of secondary school students.

This objective was fulfilled with a comparison of post-test and pre-test scores of thinking pattern scale at different thinking levels of Bloom i.e. Knowledge, Understanding, Application, Analysis and Evaluation which are used as variables of thinking pattern scale. The mean of scores obtained at each variable was calculated and mean gain was calculated by subtracting post-test mean from pre-test mean. **Hypothesis 2** was tested using ANCOVA and t-test on paired as well as independent sample data.

All the variables of thinking pattern i.e. Knowledge, Understanding, Application, Analysis and Evaluation were analyzed separately using t-values on pre-test and post-test performance between groups were also observed. ANCOVA using pre-test as covariate and post-test as dependent variable was done. The data was analyzed using ANCOVA. When pre-test used as covariate, both the groups differ significantly ($F=18.132$; $p=0.001$) as shown in **Table 44** where the significant difference in experimental and control group was reported. Both the groups differ significantly at all the variables of thinking pattern except at Application and Analysis variable where there was the non-significant difference reported with p values $p=0.286$; $p=0.345$ respectively (**Table 31** and **Table 33**).

It has been reported in **Table 24** and **Table 25** that the experimental group is significantly different at 0.05 level of significance, while the control group is non-significant at 0.05 level of significance over all the variables of thinking pattern scale. Hence, it can be predicted that instructional model has significant impact on thinking pattern as it improved significantly in experimental group.

Objective 4 : To reveal the influence of instructional model for life sciences based on mind, brain, and education science approach in congruence to parental cognitive stimulation of secondary school students.

This objective was achieved through comparison of parental cognitive stimulation in both the groups and testing of Hypothesis 3 was done. The data of PCS scale at three levels i.e. high PCS, average PCS and low PCS of experimental and control group was analyzed statistically. The three groups of PCS were compared in both experimental and control groups with respect to performance on post-test and pre-test scores at five thinking variables of thinking pattern scale. ANCOVA was performed to establish the impact of PCS on the experimental as well as the control group.

From the analysis of data of PCS, it has been figured out that PCS did not impact the achievement of students in both the groups as ANCOVA (**Table 44**) produced $F=0.071$ $p=0.790$, which is non-significant and interactive effect of PCS and group is also non-significant ($F=0.213$; $p=0.646$). But from the comparison of experimental and control group, it was found to have a significant difference in performance of experimental group with low PCS as well as average PCS (**Table 38 & Table 40**). While in control group with low PCS and average PCS, no statistical significant difference in performance in post test was reported. (**Table 39 & Table 41**) So, it can be concluded that PCS is in congruence to the instructional model. It has been effective in influencing the achievement of the experimental group.

There are many studies on positive role of parental support and parental involvement on academic achievement in elementary education but no specifically related study of parental cognitive stimulation was reported. Although Topor et al., 2010 in their mediation analysis study on parental involvement and academic achievement of children reported in one variable of perceived cognitive competency that it is related to academic achievement while it was contrary to teacher's rating of academic performance, which indicated that cognitive stimulation as perceived may be different from cognitive stimulation actually being imparted, but in the present study parental cognitive stimulation as perceived by students was reported. Hence, no comparison with similar studies can be done. The present data analysis of this study has shown that instructional model is in congruence to PCS.

3.2.2 Effectiveness Of 7 C's Instructional Model In Congruence To Thinking Pattern

The model was applied in secondary school students whose thinking skills at five variables i.e. Knowledge, Understanding, Application, Analysis and Evaluation were tested using pre-test and post-test. The data of performance on pre-test and post-test was compared on mean gain and it has been found that experimental group with instructional model based intervention has performed well over control group where 7C's model based intervention was not given. There was a significant difference at every variable of thinking pattern in experimental group. When graphical representation of thinking pattern on these five variables of thinking at mean gain was plotted on a line graph, it clearly showed that there is improvement in thinking pattern in both experimental and control group but mean gain of experimental group is more than control group, which is sufficient to say that 7C instructional model is in congruence with thinking pattern and it is effective in improvement of thinking levels.

The analysis of results of both groups obtained on all variables (Knowledge, Understanding, Application, Analysis and Evaluation) of thinking pattern scale was done using ANCOVA. The data interpretation revealed that Knowledge, Understanding and Evaluation variable showed significant difference in experimental group from control group while in Application and Analysis variable, there was no statistically significant change in experimental group and control group. But, the mean of experimental group in post-test was higher as compared to control group which indicates the better performance of experimental group over control group in Analysis and Application variable of thinking pattern. On the other hand, in control group, no significant difference in pre-test, post-test performance at any of five variables of Knowledge, Understanding, Application, Analysis and Evaluation has been reported. Experimental group differ significantly in performance in pre-test to post-test at all five variables of thinking pattern. It is concluded that thinking pattern has improved with mean gain at all the variables of thinking pattern. The change in mean is significant in experimental group, where instructional model based interventions were applied. It can be concluded that instructional model is in congruence with thinking pattern.

3.2.3 Effectiveness Of 7c's Instructional Model In Congruence To Parental Cognitive Stimulation

The 7 C's instructional model was developed based on brain and learning principles of mind, brain and education science, which highlights the importance of emotional climate and stimulating environment at school and particularly in the classroom. So, it was necessary to measure the impact of Parental Cognitive Stimulation (PCS) on the performance of students, while measuring the effectiveness of 7C's instructional model. The three groups at different PCS levels i.e. high PCS, average PCS and low PCS were compared on their performance at pre-test and post-test at different variables of thinking pattern scale in both experimental and control group. From data analysis, it was found that low PCS group in the experimental condition, where intervention on the basis of 7 C's instructional model was given, performed significantly better than low PCS control group. Similarly, average PCS experimental group's performance was significant than the control group, while in high PCS experimental group, the only single subject was there, who performed exceptionally well in post-test performance over the control group, where two subjects were there, whose performance declined in post-test.

It has been concluded from the data analysis that although parental cognitive stimulation had no independent impact on the performance in both groups while in congruence to instructional model, it had shown impact as seen in high PCS, average PCS and low PCS, experimental group students as they performed significantly well as compared to control group with increased parental cognitive stimulation from low to high. The performance of students in experimental group increased as compared to the control group in terms of mean difference of pre-test and post-test performances.

Hence, it can be concluded that 7 C's instructional model is in congruence to parental cognitive stimulation.

CHAPTER IV

CONCLUSIONS, IMPLICATIONS, LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

4.1 CONCLUSIONS

The main objective of the present study was to develop instructional model based on mind brain and education science approach. It has been developed with seven instructional steps to be followed by the teachers. The details are given in chapter 2. The analysis of data and testing of hypotheses with the interpretation and discussion of results in relation to the achievement of other objectives of the study were done in the previous chapter. This chapter deals as stated earlier to arrive at the conclusions and implications of this study. The results were analyzed using SPSS. The statistical analysis using t-test and ANCOVA were performed to find the difference between groups on pre-test and post-test variables like Knowledge, Understanding, Application, Analysis and Evaluation along with Parental Cognitive Stimulation. During the analysis of data, it has been found that:

1. The experimental and control group were equivalent on pre test as there was no statistically significant difference was reported ($t=0.311$, $p=0.757$) but both groups statistically differ in performance of post test after instructional model based interventions were provided to experimental group ($t=3.381$, $p=0.001$)
2. The experimental group has been given interventions based on instructional model while in control group traditional approach was adopted. Both pre test and post test was done to measure the effectiveness of the instructional model in comparison to traditional approach. The instructional model has been found to be effective in experimental group on all variables of thinking pattern scale with significant difference in post test performance ($t=7.009$, $p=.001$) than control group ($t=1.161$, $p=.255$) where there was no significant difference has been found.
3. The instructional model in experimental group was compared to traditional approach in control group for low parental cognitive stimulation as well as

average parental cognitive stimulation. The data analysis has shown that low PCS students in experiment group performed significantly well ($M=61.538$; $sd=23.750$) than low PCS control group students ($M=46.153$; $std=22.188$) there was significant difference at 0.01 levels of significance ($t=3.472$, $p=0.005$) in post test of low PCS experimental group but low PCS control group shown non-significant difference in post test performance ($t=0.202$, $p=0.843$).

4. Average PCS students in experimental group performed significantly well ($t=6.077$, $p=.001$) than control group students with average PCS ($t=1.138$, $p=.273$); it means there is statistical significant difference in experimental group with instructional model based interventions is found but, no such statistically significant difference has been reported in control group.
5. Performance of low PCS in mean gain is higher ($Mdif=16.34615$) than average PCS ($Mdif=13.95652$) in experimental group. In both there was statistical significant difference reported. While in control group low PCS mean gain difference decreased ($Mdif=-0.63846$) than average PCS with ($Mdif=3.64375$) and non-significant difference was reported.
6. There is significant difference at 0.05 level of significance in experimental group in pre test post test performance on all variables of thinking pattern i.e. Knowledge ($t=5.417$; $p = .00$), Understanding ($t=4.905$; $p=.000$), Application ($t=2.220$; $p=.033$) Analysis ($t=2.522$; $p=.033$) and Evaluation ($t=4.157$; $p=.000$) with instructional model based intervention has been found. While in control group, no significant difference at all variable of thinking pattern has been observed like knowledge ($t=-.392$; $p=.698$), understanding ($t=.487$, $p=.630$), application ($t=.385$, $p=.703$), analysis ($t=.643$, $p=.525$) and evaluation ($t=.158$, $p=.876$).
7. The mean gain difference is high in experimental group is much higher from control group in pre test post test performance means of all variables of thinking pattern. In Knowledge (experimental group $Mdif = 19.46$, control group $Mdif=1.94$), Understanding (experimental group $Mdif=18.38$; control group $Mdif=1.94$), Application (experimental group $Mdif=9.46$; control group

Mdif=1.61), Analysis (experimental group Mdif=13.51; control group Mdif=3.23) and Evaluation (experimental group Mdif=16.22; control group Mdif=0.80).

8. PCS did not impact the achievement of students in both the groups as ANCOVA produced $F=0.071$ $p=0.790$, which is non-significant and interactive effect of PCS and group is also non-significant ($F=0.213$; $p=0.646$). But from the comparison of experimental and control group, it was found to have a significant difference in performance of experimental group with low PCS as well as average PCS. In control group with low PCS and average PCS, no statistical significant difference in performance in post test was reported.

From the research findings of the study it has been concluded that all four objectives of the study have been achieved, the following conclusions can be derived from the major findings of the study.

1. The 7C's instructional model has effectiveness in terms of achievement at all variables of thinking pattern scale in comparison to traditional approach of teaching.
2. The low PCS, average PCS and high PCS students in experimental group performed better than the respective control group students.
3. The performance on mean gain among students in experimental group is higher with low parental cognitive stimulation than average parental cognitive stimulation as compared to the control group.
4. The thinking pattern shows significant impact in performance of students in experimental group with 7C's instructional model as compared to control group.
5. The 7 C's instructional model is in congruence with thinking pattern as it showed significant difference in performance of experimental group.
6. PCS has no interactive effect on both the experimental and control group. The significant performance of the experimental group is credited to 7C's instructional model based interventions.
7. The 7 C's instructional model is also said to be in congruence to parental cognitive stimulation as it improved lower order thinking skills of thinking

pattern significantly in low and average parental cognitive stimulation experimental group.

4.2 EDUCATIONAL IMPLICATIONS

In the present age, knowledge is expanding at a very fast pace. Students are equipped with new technologies and flow of information is very fast. We need to design the process of teaching such that learning could be more effective in terms of educational objectives. This can be done by adopting new science of teaching and learning and updating old methodologies. Thus, the present study has several implications for teaching and learning process through the use of 7 C's instructional model which is developed and its effectiveness has been established in congruence to thinking pattern and parental cognitive stimulation. It focus on seven different phases of teaching learning process, each one has its implication for teaching and learning process of a school in general and specifically for teachers ,school principals and other stakeholder of education .

1. The 7 C's instructional model will be helpful in designing the teaching process more effectively. The learning will be effective as a teacher can focus on every aspect of learner, may it be psychological, emotional and physiological conditions related to learning to connect to the learners.
2. Learning through instructional model would be more meaningful, as a teacher would be able to create the learning environment, locate the problem in communication and design the pace of learning and suggest remedial measures for slow learners.
3. The 7 C's instructional model focuses on psychological as well as physiological well-being of learners. An adequate measure could be taken with the help of school health programme and mid-day meal scheme already running into practice to make learning more effective.
4. The instructional model suggests to provide as enough time for different activities for cognitive stimulation. Assessment of the students should be comprehensive to assess performance and participation of students so, more methods of assessment like assignments, presentations, portfolios, project work etc. should be included.

5. The 7 C's instructional model could be easily adopted for all subjects irrespective of age and grade levels. So, every subject teacher could use it in their teaching practice.
6. The 7 C's instructional model is more useful in improving academic achievement in low order thinking level of knowledge and understanding of students with low as well as average PCS.
7. Low and Average PCS students get benefitted from instructional model in terms of academic achievement at all thinking levels; it could be more beneficial if parents are made aware of stimulating factors that could act in congruence to 7C's instructional model to improve high order thinking of students.
8. The parents and teacher should work in coordination to provide better environment that is congenial to learning both at home and school. Awareness program for parents with low parental cognitive stimulation could be done.
9. The 7 C's instructional model could be easily adopted in schools by providing training to the teachers and school administrators to follow the basic steps to ensure that their teaching learning process becomes more effective.

4.3 LIMITATIONS OF THE STUDY

The study was development of instructional model hence experimentation part was limited by the number of participants. Only single group of 37 students represented the experimental group and 31 students were reported in the control group. Time constraints and the selection of the nature of the course of study were other limitations. Only three weeks were dedicated to the experiment and only life science subject was chosen for the study.

4.3 FUTURE RESEARCH DIRECTIONS

The present study has been concluded with the following future research direction to do further research on 7C's instructional model for classroom teaching.

1. 7C's instructional model could be applied to all the classrooms, irrespective of teaching subject, gender or age i.e. not only limiting it to life sciences or secondary students.
2. The time table of the school should be flexible according to the guidelines of the instructional model and due time for cognitive stimulation activities and remedial measures should be allotted. It can be studied comprehensively. Action plan for implementation of 7C's instructional model in Government schools of Punjab has been submitted in the form of proposal to Department of School Education ,Punjab(Annexure 6)
3. The study could be duplicated with a larger sample that is randomly chosen to assess the impact of instructional model on motivation, interest and attitude of students towards learning.
4. It is recommended to experiment to measure the effect of instructional model on the development of higher order of thinking skills and overall educational effectiveness.
5. The assessment tools for students on the basis of psychological and physiological parameters can be suggested carefully through research based inputs. An appropriate remedial measure that should be taken to make teaching learning process effective.
6. Research on instructional model in relation to teacher effectiveness, motivation and interest can also be studied.
7. To overcome the nutritional deficiencies and other shortcomings, new strategies or action steps can be taken by the school authorities in collaboration with parents and social agencies.
8. The seven steps of instructional model involve different aspects of a child and teaching learning process, hence each step can be evaluated independently.

Apart from above suggestions with the application of 7C's instructional model curriculum of schools and teacher training programmes,rationalization of teachers should be reviewed in lines to application of 7C's instructional model.

SUMMARY

Instructions are the base of all learning activities. The instructional process involves learning theories based on which, instructional delivery is designed. The educational system of every country follows certain learning theories to meet learning objectives. Based on the needs of that particular country, different learning theories have been followed till date like behaviorist, cognitivist and constructivist. All the theories are focused on the change in behavior of the learners through information retention in different memory systems of the brain. So, focus of instructions is on memory and thinking i.e. how that information stored in memory is transferred to thinking to further elicit the desired behavior to solve the problems or take decisions in real life. Hence, the behavior of an individual is the reflection of thinking involved to act in a particular way. So, the focus of the instruction is to develop thinking skills. Bloom et al.'s taxonomy of cognitive domain has clearly outlined different thinking levels in cognitive domain i.e. knowledge to evaluation. Since the new technologies have emerged and now learning in the brain is being studied from a different perspective, so, the birth of the science of learning has put forward a new theory of learning based on the principles of brain and learning interaction through the lens of behavior under-pinning. Mind, Brain, and Education (MBE) has started gaining momentum as the new science of teaching and learning with the efforts of researchers in this area from around the world have put forward different aspects of brain and learning. They are exploring the links of human learning with different human sciences from neurosciences to developmental biology and psychology. The idea behind is to make learning more effective. Till now, only major feeding science for educational theories was psychology, but now, other science fields also have their role to play in various learning problems from dyslexia, dyscalculia and attention deficient hyperactivity syndrome. The research data of neuroscience, genetics, and psychology are filtered through the lens of education to become an interdisciplinary field of MBE, which is exploring new challenges and finding ways to solve various educational problems, may it be learning disabilities, motivational problems, memory, development of thinking or similar sort of teaching learning problems. The 7C's instructional model has been designed based on the principles of MBE. The

objective of 7C's instructional model is to focus on the development of higher order of thinking among learners to make the process of learning more meaningful and interesting for the learners using positive emotions in teacher student interactions and maximum use of the technology in creating a good learning environment. The role of teacher is very important in any teaching activity, who acts as a catalyst for learning to take place in the teaching learning process. It is expected that the 7C's model is useful in the alignment of teaching learning activities to bring desired changes in learner's thinking.

STATEMENT OF THE PROBLEM

The present study is entitled as:

Development and Effectiveness of Instructional Model in Life Sciences based on Mind, Brain, and Education Science approach in congruence to Thinking Pattern and Parental Cognitive Stimulation

OBJECTIVES OF THE STUDY

The main objectives of this study were:

1.To develop an instructional model for life sciences based on Mind, Brain and Education Science approach.

2.To find out the effectiveness of an instructional model for life sciences based on Mind, Brain and Education Science approach.

3.To explore the impact of an instructional model for life sciences based on Mind, Brain, and Education Science approach in congruence to thinking pattern of secondary school students.

4.To reveal the influence of instructional model for life sciences based on Mind, Brain and Education Science approach in congruence to Parental Cognitive Stimulation of secondary school students.

HYPOTHESES OF THE STUDY

On the basis of objectives, following hypotheses were proposed to be tested:

H₁.Academic achievement of secondary school students significantly improves with an Instructional model in life sciences based on Mind, Brain, and Education Science approach.

H₂. There is no significant change in thinking pattern of secondary school students with an Instructional model in life sciences based on Mind, Brain, and Education Science approach.

H₃. Academic achievement of secondary school students does not vary with Parental Cognitive Stimulation.

DELIMITATIONS OF THE STUDY

The present study is delimited to 10th standard life science students of Government Schools of Punjab.

RESEARCH DESIGN

The present study is to develop an Instructional Model and to measure its effectiveness both the approaches are used. Hence, it's more pertinent to call it a mixed method research. Qualitative methods were applied for the development of Instructional model and scale of Parental Cognitive stimulation (PCS) and Thinking pattern (TP), whereas Quantitative research method quasi-experimental was used to measure the effectiveness of the Instructional Model (IM). Quasi-experimental research involves the use of single intact groups in an experiment rather than randomly assigning subjects to experimental groups. The whole study is divided into two phases i.e. development and the experimentation phase.

PHASE 1:

Developmental Phase:

- Development of an Instructional Model
- Development of Parental Cognitive Stimulation Scale (PCSS)
- Development of Thinking Pattern Scale

PHASE 2:

Experimentation Phase:

- Application of tools of study and data collection
- Analysis and Interpretation of data

Method of the study:

The second phase of the study includes application of instructional model and other tools of the study. The quasi experimental research design is used in this study, where two groups were formed i.e. an experimental group and a control group. In the study, pre-test was used for establishing equivalency and statistical control or generating gain scores. Post-test was done to further establish the effectiveness of instructional model in terms of thinking pattern. PCS and thinking pattern both were studied in congruence to instructional model.

Sample of the study:

The sample comprised of the students studying in various Senior Secondary Schools of Bathinda District of Punjab affiliated to Punjab School Education Board. The sample comprised standard 10th of Government Senior Secondary School Gobindpura, Bathinda, Punjab (India) as experimental and control group based on summative assessment scores respectively. The students of 10th standard who belonged to the age group of 14-16 years were chosen. The final sample (N=68) consisted of sixty-eight students of which thirty-seven students belonged to an experimental group and thirty one to control group. All the students were from a rural background. The school environment and school resources were also same for both the groups.

Tools Used:

Following tests were used in this study:

- 7C's Instructional Model developed by researcher
- Parental Cognitive stimulation scale developed by the researcher.
- Thinking pattern scale developed by the researcher.

The main objective of the study is to develop an instructional model based on mind, brain, and education guidelines and to measure its effectiveness in terms of congruence to thinking pattern of learners and parental cognitive stimulation.

Development of an Instructional model

Instructions are the base of any educational process. They help in aligning groups of activities to be performed in a sequence to ensure effective instructional outcome. Development of an Instructional Model comes under the preview of instructional system design, so, researcher proceeded with ADDIE (Analysis, Design, Development, Implement and Evaluation) model as a framework to outline different phases of the developmental process.

Step1: Analysis:

Need Analysis of an instructional model was completed by using a survey on different teaching learning needs of different teachers of government schools of Punjab.

Step 2: Design:

A brief outline of model was prepared by the author on the basis of own teaching experience and instructional guidelines the reviews of different brain based instructional models.

Step 3: Develop:

This model was developed further by taking suggestions from different teaching professionals.

Step 4: Implement:

The model was implemented in the secondary classrooms (N=68). Experimental and control groups were formed.

Step 5: Evaluation:

The evaluation of Instructional Model was done in terms of its effectiveness in congruence to thinking pattern and parental cognitive stimulation. The t-test and ANCOVA were used along with measures of central tendency i.e. mean and standard deviation. The data were analyzed using SPSS 22. The two tailed testing of hypotheses was done at both level of significance i.e. .01 and .05.

7 C's Instructional Model

The 7 C's Instructional model has been developed on the basis of principles of Mind, Brain and Education Science, which is called the new science of teaching and learning. It is a step-by-step guide for a teacher to be used in his routine teaching. This

is a guiding force to plan pedagogical practices to achieve maximum benefits of a teaching-learning process. The MBE has its roots in interdisciplinary research base, which guides the learning theories and philosophy of education through its evidence-based research findings.

There are many theories of learning which are guiding the process of teaching. Among those, there is behaviorism, cognitivism and neo constructivism. These all are philosophies of learning based on cognitive psychology. Behavior is the manifestation of thinking, the person's thinking is dependent on neuro-chemical and electrical impulses generated in the brain, that processes the information stored in the brain and suggest an active thought to be produced and reflected in behavior. Genetics also has an impact on thinking as the genetic makeup of an individual has variations. Hence, the behavior is an individualized thing, but it can be changed through training and learning. These factors are considered in developing the 7 C's Instructional Model.

Parental Cognitive Stimulation Scale

Cognitive stimulation is any act or stimulus provided to an individual, which leads to the experience related to the cognitive activity. Any such activity performed is called stimulation. Brain research has proved that human brain has 10 billion neurons and the development of most of these is done during first five years of age after that brain changes its shape according to its use, any new information is stored in the form of nerve connections in different parts of the brain.

Dimensions of PCS Scale

The following three dimensions of PCS scale were outlined based on literature reviews related to parental behavior, parental involvement and cognitive stimulation.

- Emotional assurance and motivation
- Challenging home environment
- Biological and physiological well being

Items were prepared on these dimensions for a common scale of parental cognitive stimulation which is perceived by the children. The utmost care has been taken to structure items on the common understandable terms.

Items Format

PCSS is constructed on 5 points Likert Rating Scale which is commonly used as a scale, the scoring of all the positively favorable items be done by giving scale value 5 to 1. No negative item was included.

Strongly agree Agree No response Disagree Strongly disagree

Validity

To establish the validity of PCSS, total 43 items were prepared and sent to experts for validation. Out of these 43 items, 31 items were retained after the suggestions from experts, among which one was a clinical psychologist, one was a neuropsychologist and 2 were from educational psychology.

Initial try out

PCSS was administered to a group of 100 pupils of 6th to 10th standard of Govt. High School Virk Khurd. This was done to know the clarity of the items and time taken by the students. The items were again modified based on the results obtained from these students, who participated in the initial try out.

Final Try out

The PCS was administered with 31 items on a representative sample of 298 students of 14-16 years age group studying in different schools of Bathinda district. Both rural and urban schools were selected for true representation of the population.

Reliability

All the items show high reliability with coefficient Cronbach's alpha =.0886, which means high reliability. t-value ($t=27.570$) was used to measure the difference between high scores and low scores, which is highly significant at $p=.001$ at 99% level of confidence.

Norms

Quartiles, Percentiles were calculated on the basis of that three levels of PCS were defined.

118> low PCS,

119-144 Average PCS and

145< high PCS group

Thinking Pattern Scale

Thinking is the major function of cognition. In the process of teaching-learning, it plays an important role. In the present study, different levels of thinking, as outlined by Benjamin Bloom's taxonomy of cognitive domain, are used to develop a multiple choice questionnaire of life processes in science to access thinking pattern. Blooming in Biology was a technique, according to which, questions were framed categorizing different levels of thinking, starting from knowledge, understanding, application, analysis and evaluation.

Validity and Reliability

Total 35 items were prepared which corresponded to different levels. These were discussed with different experts, who deal with measurement, evaluation and teaching of biology, including one subject expert from State Institute of Science Education, Punjab, two senior lecturers from Government In-Service Training Centre, Bathinda and three professors of education.

Item Analysis

This test was administered to 130 students of the 10th standard at Govt. High School, Gillpatti and Govt. Senior Secondary School, Kalyan Sukha and Dashmesh Public School, Goniana for items analysis.

The item analysis was carried out based on the scores obtained by the upper twenty-seven subjects (27%) N=35 and lower twenty-seven subjects (27%) N=35 were taken as the upper group and lower group respectively. The difficulty index and discriminating power of each item were found out. The item with negative discrimination power was considered to be discarded. Apart from determining discriminatory analysis, chi-square test was applied to establish the discriminatory power between high scorers and low scorers. The items which had significance at 0.05 levels were retained, others were discarded. Total 24 items were retained which were further used to access the thinking pattern of the experimental and control group.

Reliability

Cronbach's Alpha of 24 items retained comes out to be 0.798, which means the thinking pattern scale is reliable to be used.

Scoring

Each right answer was given score 1 while the wrong answer was not given any score. The total scores were 24. Further 24 items of thinking pattern scale were sorted at each thinking variable i.e. Knowledge, Understanding, Application, Analysis and Evaluation. The data was sorted by calculating the average percentage achievement score at each variable. After that, the pattern of thinking was plotted by plotting all variables in hierarchical order at x-axis and corresponding percentage mean gain on y-axis. Hence, a thinking pattern of the group was plotted on a line graph.

Data Collection

Two groups of experimental group (N=37) and control group (N=31) were formed. Total 21 days' intervention was planned with lesson units aligned to instructional model steps. Lessons were prepared based on the syllabus prescribed by Punjab School Education Board (PSEB) for 10th life science. Total 14 lessons were prepared and the experimentation was done during the months of September 2016 to October 2016. A pre-test was taken before the start of intervention followed by post-test and parental cognitive stimulation scale was administered to both groups and total 68 responses were recorded and on the basis of this high PCS, average PCS and low PCS groups were sorted out. Both groups were scored on post-test and pre-test at mean gain scores on five variables of thinking pattern scale and their analysis was done using t-test and ANCOVA using pre-test and PCS as a covariate to measure the effectiveness of instructional model.

Data Analysis and Testing of Hypotheses

In Chapter 3 the data was analyzed and hypotheses were tested to establish the effectiveness of instructional model, data of pre-test and post-test was compared using t-test independent and paired sample t-test was used to compare both the groups which showed values ($t = 0.31; p = 0.757$), which means there is no significant difference between experimental group and control group on pre-test scores at 0.5 level of significance. It mean both the groups were equivalent on pre-test. While post-test of the control group ($M=9.0323$) and experimental group ($M=11.8649$) have t-test values ($t = 3.38; p = 0.001$), that signifies that there is a significant difference among

control and experimental group on post-test scores. The data of paired sample t-test was administered to compare both groups on pre-test and post-test for the control group ($t=1.161$; $p=.255$) and experimental group ($t=7.009$; $p=.001$), these values indicated that while there is a significant difference in the experimental group, which is significant at 0.01 level of significance, no significant difference in control group has been found. Hence, instructional model has impact on experimental group over traditional method in control group.

From the data interpretation, it has been concluded that there is a significant difference between experimental and control group in post-test, where intervention based on the instructional model has been provided to experimental group. The control group was taught through a traditional approach. It has shown no statistical significant difference in performance. The experimental group has shown significant difference at 0.01 level of significance. While comparing the means of both the groups, the difference was higher in experimental group which means experimental group performance was better than the control group.

Hence, hypothesis (H1) i.e. **Academic achievement of Secondary school students significantly improves with an Instructional model in life sciences based on Mind, Brain and Education Science approach** is accepted that 7C's instructional model based instructions have a significant impact on the performance of subjects in post-test.

Instructional Model Vis. A Vis. Thinking pattern

The data of each variable of Thinking pattern scale i.e. Knowledge, Understanding, Application, Analysis, and Evaluation along with combined scores of both pre -test and post- test of experimental and control group was analyzed statistically. The percentage gain at each thinking variable was established by converting all the test scores to percentage gain score in each variable i.e. Knowledge, Understanding, Application, Analysis and Evaluation.

The experimental group was compared using paired sample t-test on all variables i.e. Knowledge, Understanding, Application, Analysis and Evaluation. In the experimental group, significant difference was reported in the pre-test and post-test performance at 0.01 level of significance. It was also concluded that pre-test and post-test differ in performance, It reflects that instructional model based interventions had

a positive impact on post-test performance in thinking pattern as compared to control group where no such intervention was given.

The data of pre-test and post-test of experimental group on each variable was also analyzed using paired t-test. The resulting t-values and corresponding p-value (**Table 23**) reflected that it has significant difference in performance in all the variables i.e. Knowledge, Understanding, Application, Analysis, and Evaluation at 0.05 level of significance. Moreover, Knowledge, Understanding and Evaluation variables were significantly different in performance at 0.01 level of significance.

While in control group on the basis of data analysis, it is found that on Knowledge ($t=0.392$; $p=0.698$), Understanding ($t=0.487$; $p=0.630$), Application ($t=0.385$; $p=0.703$), Analysis ($t= 0.643$; $p=0.525$) and Evaluation ($t=0.158$; $p=0.876$) are non-significant at both the levels of significance. There is no significant difference in pre-test, post-test performance of control group on Knowledge, Understanding, Application, Analysis and Evaluation. Hence, on the basis of data, it was concluded that in control group, no significant difference in improvement of thinking pattern in pre-test and post-test performance while experimental group has significant change in all variables of thinking pattern.

The data was further analyzed on ANCOVA at each variable of Thinking pattern scale i.e. Knowledge, Understanding, Application, Analysis and Evaluation by taking pre-test and PCS as a covariate on post-test as the dependent variable. The results of ANCOVA clearly indicated that experimental group performed better ($F=18.132$; $p=0.001$) than control group. Data at each variable was also studied independently in both groups using t –test. In Knowledge, Understanding and Evaluation variable there was significant change in experimental group from control group while in Application and Analysis variables of Thinking pattern, there is not a significant difference in the performance of both groups was found , but experimental group mean ($M=55.555$) is higher than control group mean ($M=37.069$) which indicates that experimental group's performance is better than control group in Evaluation variable of thinking pattern although it was non-significant statistically. It was reported from the data analysis that thinking pattern of experimental group improved significantly through Instructional model-based intervention than the control group. Hence, it was

concluded that instructional model has positive impact on the thinking pattern and it improved significantly with an instructional model in the experimental group.

The line graphs of the mean gain at each variable i.e. Knowledge, Understanding, Application, Analysis and Evaluation in pre-test and post-test was also plotted. It was visible that mean values of pre-test and post-test has the difference in performance and shows the mean gain on all variables of thinking pattern. Hence, Instructional model based interventions have a positive impact on the thinking pattern it improved significantly with instructional model based interventions in the experimental group as compared to the control group. It was be concluded that instructional model has congruence with thinking pattern.

From the discussion and presentation of results it was concluded that H2 i.e. **There is no significant change in thinking pattern of secondary school students with an instructional model in life sciences based on Mind, Brain and Education Science approach** is rejected.

Instructional Model Vis. A Vis. Parental Cognitive Stimulation

The data of PCS was differentiated into high PCS, average PCS and low PCS in both the groups(**Table 17**).The Analysis of this data was further done in context to PCS and their performances in pre-test and post-test. From the results discussed in Chapter 3, it was clear that academic achievement of secondary school students does not vary with parental cognitive stimulation as PCS has shown non-significant difference in ANCOVA, and with F values which were not significant at both the levels of significance. This had been deduced that parental cognitive stimulation does not have an effect on post-test performance. The significant difference between experimental group and control group is due to the 7C's Instructional model intervention, whereas low PCS group performed better in experimental group with significant difference in pre-test and post-test performance $t=3.472$ and $p=0.005$ which is significant at both the levels of significance ,whereas control group, with low PCS has t value= 0.63846 and $p=0.843$ which was non-significant at 0.01 level. Similarly , with high PCS (N=1) experimental group has shown improvement with instructional model based intervention with greater difference $M\ dif=29.30$ in pre-test and post-test performance while control group with High PCS (N=2) has negative mean difference in pre-test and post-test ($M\ dif=-2.10$), which indicates decline in

performance (**Table37**). Average PCS (N=23) experimental group performed significantly different at both levels of significance with $t=6.077$, $p=0.001$ over the control group (N=16) with a low value of $t=1.138$, $p=0.273$ (**Table39**). The t-test differences showed that with average PCS experimental group performed better with 7C's Instructional model based intervention than control group. From the analysis of data it was concluded that PCS has congruence with instructional model in experimental group.

The data was analyzed for the effect of PCS on experimental and control group ANCOVA, using pre-test as covariate and post-test as dependent variable. It has been reported that although there is significant difference in pre-test post-test performance of both groups with $F=35.660$; $p=0.001$ while PCS has no significant effect with $F=0.071$; $p=0.790$, So, PCS has no individual effect on post-test performance of both experimental and control group. So, from the discussion of data above it was concluded PCS alone did not impact the academic achievement of both the groups but the that7 C's Instructional model had been affective in congruence to PCS in experimental group.

Hence, null hypothesis H3 i.e. **Academic Achievement of Secondary School Students does not vary with Parental Cognitive Stimulation** is accepted.

Results and Discussion

The results of analysis of data obtained in the previous chapter have been interpreted in the chapter 4 with the discussion. This chapter deals with the discussion of results in relation to the achievement of objectives of the study as stated earlier.

Objective 1.To develop an instructional model for life sciences based on mind, brain and education science approach.

To achieve the objective, an instructional model called 7 C's has been developed. The 7 C's instructional model has guidelines for the teacher to follow in the process of teaching and learning. The instructional manual includes the brief of how learning happens and what are different regions of the brain that could have an impact on learning.

Objective 2. To find out the effectiveness of instructional model for life sciences based on mind, brain, and education science approach.

A quasi-experimental design based on two groups were formed i.e. experimental and control group where in experimental group instructional model based lessons in life science were delivered by the researcher herself, total 3 weeks intervention was given, post test was undertaken to establish effectiveness of the model. It was predicted that 7C's instructional model has been effective on student's performance in life sciences.

Objective 3. To explore the impact of an instructional model for life sciences based on mind brain and education science approach in congruence to thinking pattern of secondary school students.

A comparison of post- test and pre-test scores of thinking pattern scale at different variables based on thinking skill levels of Bloom i.e. Knowledge, Understanding, Application, Analysis and Evaluation was done to achieve this objective of study. Hypothesis 2 was tested using ANOVA as well as ANCOVA and t-test.

All the variables of thinking pattern i.e. Knowledge, Understanding, Application, Analysis and Evaluation were analyzed separately using t-values on pre-test and post-test performance between groups were observed. Experimental group showed statistically difference in all variables in post test from pre test while control group does not have statistically significant difference in any of five variables of thinking pattern (**Table 23** and **Table 24**). The data was further analyzed using ANOVA where both the groups differ significantly at all the variables except Application and Analysis where there was the non-significant difference with p values $p=0.286$; $p=0.345$ respectively as reported in experimental and control group (**Table 31** and **Table 33**) but the mean gain in post test was higher in experimental group than control group. Hence, it was predicted that instructional model has significant impact on thinking pattern in experimental group. It is in congruence to thinking pattern of secondary school students.

Objective 4. To reveal the influence of instructional model for life sciences based on mind, brain, and education science approach in congruence to parental cognitive stimulation of secondary school students.

This objective was achieved through comparison of parental cognitive stimulation data of PCS scale at three levels i.e. high PCS, average PCS, and low PCS. From the analyses of results of PCS, it has been found that experimental group performed significantly different in low and average PCS while in control group no significant difference was reported. The ANCOVA results showed that PCS alone did not impact the achievement of students in both the groups ($F=0.071$; $p=0.790$) (Table 44), which is non-significant and even interactive effect of PCS and group was also non-significant ($F=0.213$; $p=0.646$). But, from the comparison of experimental and control group, there was significant difference in performance of experimental group in low PCS as well as average PCS than control group (Tables 38-41). The instructional model has shown significant difference in performance in both low PCS as well as average PCS students in experimental group. The 7 C's instructional model is in congruence with parental cognitive stimulation as, with increased parental cognitive stimulation from low to high, performance of students in experimental group increased as compared to the control group in terms of mean difference of pre-test and post-test performances. So, it was concluded that instructional model is in congruence to parental cognitive stimulation.

Effectiveness of 7 C's Instructional Model in Congruence to Thinking Pattern

The experimental group has shown statistical significant difference in all variables of thinking pattern. The graphical representation of Thinking pattern at five variables of thinking i.e. Knowledge, Understanding, Application, Analysis and Evaluation on mean average gain was also plotted on a line graph, which clearly showed that there was an upward change in thinking pattern in both experimental and control group, but mean gain of experimental group was more than control group, which was sufficient to say that 7C's instructional model is in congruence with thinking pattern and it was effective in improvement of thinking variables i.e. Knowledge, Understanding, Application, Analysis and Evaluation in experimental

group.

Effectiveness of 7C's Instructional Model in Congruence to Parental Cognitive Stimulation

The effectiveness of 7C's instructional model on the performance of students with respect to PCS was measured. The three groups at different PCS levels i.e. high PCS, average PCS and low PCS were compared on their performance at pre-test and post-test on different variables of thinking pattern scale in both experimental and control group. From the data analysis, it had been concluded that parental cognitive stimulation had no independent impact on the performance of both the groups. But, it was in congruence to instructional model as it has shown significant difference in average PCS students and low PCS experimental group, where level of PCS with control group was same but experimental group performed significantly well as compared to corresponding control group. Hence, it has been assumed that 7 C's instructional model is in congruence to parental cognitive stimulation.

Conclusions and implications

- The 7C's instructional model has been effective in terms of achievement at variables of thinking pattern scale in life science. PCS has no interactive effect on post-test performance of groups. Hence, it is predicted that the performance of the experimental group is due to instructional model.
- The 7 C's instructional model was in congruence with parental cognitive stimulation as, with increased parental cognitive stimulation from Low to High, performance of students in experimental group is higher as compared to the control group in terms of mean difference of pre-test and post-test performances.
- The 7C's instructional model was in congruence to thinking pattern of students as it showed significant impact on performance of students in experimental group as compared to control group.

The major limitation of the study is that the instructional model was implemented in a single school classroom only, but it could be expanded to whole school classrooms, irrespective of subjects or age, not limiting it to life sciences or secondary students only. The present study has revealed several implications for teaching and learning process.

BIBLIOGRAPHY

- Abbott, J., & Ryan, T. (2001). *The unfinished revolution: Learning, human behavior, community, and political paradox*. Alexandria, VA: Association for Supervision and Curriculum Development.
- Ablin, Jason L. (2008): Learning as Problem Design Versus Problem Solving: Making the Connection Between Cognitive Neuroscience Research and Educational Practice. In *Mind Brain Education* 2 (2), pp. 52–54. DOI: 10.1111/j.1751-228X.2008.00030.x
- Akyurek, E., & Afacan, O. (2013). Effects of Brain-Based Learning Approach on Students' Motivation and Attitudes Levels in Science Class. *Online Submission*, 3(1), 104-119.
- Aziz-Ur-Rehman., Bokhari, Maqsood Alam (2011). Effectiveness of brain-based learning theory at secondary level, *International Journal of Academic Research; Vol. 3 (4) p354*
- Baddeley, A. D. (2002). Is Working Memory Still Working? *European Psychologist*, 7(2)pp. 85–97 DOI: 10.1027//1016-9040.7.2.85
- Bas, Gokhan. (2010). The effect of brain based learning method on students' attitudes and attitudes towards English course. *Elementary Education-Online*, 9 (2), 488-507.
- Blakemore, Sarah-Jayne., Frith, Uta (2005): The learning brain: lessons for education: a précis. In *Developmental science* 8 (6), pp. 459–465. DOI: 10.1111/j.1467-7687.2005.00434.x.
- Bloom, B., Englehart, M. D., Furst, E. J., Hill, W. H., & Krathwohl, D. R. (1956). *Taxonomy of educational objectives: The classification of educational goals*. Handbook I: Cognitive domain. New York, NY: David McKay
- Bloom, Benjamin S. (1972). *Taxonomy of educational objectives. The classification of educational goals*. New York: David McKay Company Inc.

- Boddy, N., Watson, K., & Aubusson, P. (2003). A trial of the five Es: A referent model for constructivist teaching and learning. *Research in Science Education*, 33, pp 27–42, <https://doi.org/10.1023/A:1023606425452>
- Bonnema T. (2009). Enhancing Student Learning With Brain-Based Research <http://www.eric.ed.gov/PDFS/ED510039.pdf>
- Brain facts; A Primer on the Brain and Nervous System, Society for Neurosciences (www.sfn.org)
- Bransford JD, Brown AL, Cocking RR. (2000). *How People Learn: Brain, Mind, Experience and Practice*. Washington, D.C.: National Research Council, National Academic Press; Washington D.C.
- Bransford, J.D.; Brown, A.L.; Cocking, R.R., eds. (1999). *How people learn: Brain, mind, experience, and school*. Washington, D.C.: National Academies Press. <http://www.nap.edu/catalog/9853.htm>
- Brinkerhoff, Delroy A. (2001). Survey of instructional development models, third edition. In *TECH TRENDS* 45 (1), pp. 48–50. DOI: 10.1007/BF02763388.
- Bruer, John T. (1997). Education and the Brain: A Bridge Too Far. In *Educational Researcher* 26 (8), p. 4. DOI: 10.2307/1176301.
- Bruer, John T. (1999). In Search of...Brain-Based education. *Phi Delta Kappan*, 80(9), 648-654.
- Cahill, L. Haier, R., Fallon, J., Alkire, M., Tang, C., Keator, D., Wu, J., and McGaugh, J.L. (1996). Amygdala activity at encoding correlated with long-term, free recall of emotional information. *Proc. Natl. Acad. Sci.* 93: 8016-8021.
- Caine, G., Caine, R.N., McClintic, C., Klimek, K. (2005). *12 brain/mind learning principles in action*. Thousand Oaks, CA: Corwin Press.
- Caine, G., Nummela-Caine, R., & Crowell, S. (1999). *Mind shifts: A Brain-Based Process for Restructuring Schools and Renewing Education*, 2nd edition. Tucson, AZ: Zephyr Press. ISBN: 1569760918.

- Caine, Geoffrey, Renate Nummela Caine. (1994). *Making Connections: Teaching and the Human Brain*. Menlo Park, CA: Addison-Wesley.
- Caine, Renate Nummela, Caine, Geoffrey (1997). *Education on the edge of possibility*. Alexandria, Va.: ASCD.
- Calvo, Rafael A., D'Mello, Sidney K (2011). *New Perspectives on Affect and Learning Technologies*. New York, NY: Springer New York.
- Carin, A.A., Bass, J.E., Contant, T.L. (2005). *Teaching science as inquiry*. Upper Saddle River, NJ: Pearson Merrill Prentice Hall.
- Case, R. (1978). Implications of developmental psychology for the design of effective instruction. In: Lesgold, A.M., et al., eds. *Cognitive psychology and instruction*, p. 441–63. New York, Plenum.
- Christoff, Kalina (2008). Applying Neuroscientific Findings to Education: The Good, the Tough, and the Hopeful. *Mind Brain Education* 2 (2), pp. 55–58. DOI: 10.1111/j.1751-228X.2008.00031.x.
- Coward, Andrew. (1990). *Pattern Thinking*. New York: Praeger Publishers.
- Craig, Jennifer L. (1987). The Evaluation of a Course in Interviewing for first year Medical Students. *Assessment & Evaluation in Higher Education* 12 (3), pp. 191–201. DOI: 10.1080/0260293870120304.
- Creswell, J. W. (2009). *Research design: Qualitative, quantitative, and mixed methods approaches*. Los Angeles: Sage.
- Crowe, Alison., Dirks, Clarissa., Wenderoth, Mary Pat (2008). Biology in Bloom: Implementing Bloom's Taxonomy to Enhance Student Learning in Biology. *LSE* 7 (4), pp. 368–381. DOI: 10.1187/cbe.08-05-0024.
- Davis, Catherine L., Tomporowski, Phillip D., McDowell, Jennifer E., Austin, Benjamin P., Miller, Patricia H., Yanasak, Nathan E. (2011). Exercise improves executive function and achievement and alters brain activation in overweight children: A randomized, controlled trial. *Health Psychology* 30 (1), pp. 91–98. DOI: 10.1037/a0021766.

- Dalen, V.D.B., Williams, M.J. (1966). *Understanding Educational Research: An Introduction*. USA: Mc Graw-Hill, Inc.
- Diamond, M. & Hopson, J. (1998). *Magic trees of the mind: How to nurture your child's intelligence, creativity, and healthy emotions from birth through adolescence*, New York: Plume.
- Diamond, Marian Cleeves (1988). *Enriching heredity. The impact of the environment on the anatomy of the brain*. London: Collier Macmillan.
- Dick, Wand Cary ,L (1990). *The Systematic Design of Instruction*,(3rd ed.), Harper Collins.
- Dillon, J. (2002). Perspectives on environmental education-related research in science education. *International Journal of Science Education*, 24, pp 1111–1117
- Donmez, Mehmet, Cagiltay, Kursat (2016). A Review and Categorization of Instructional Design Models.
- Dudai, Yadin, Karni, Avi, Born, Jan (2015). The Consolidation and Transformation of Memory. *Neuron* 88 (1), pp. 20–32. DOI: 10.1016/j.neuron.2015.09.004.
- Dugard, Pat, Todman, John (1995). Analysis of Pre-test-Post-test Control Group Designs in Educational Research. *Educational Psychology* 15 (2), pp. 181–198. DOI: 10.1080/0144341950150207.
- Duman, B. (2006). The effect of brain-based instruction to improve on students' academic achievement in social studies instruction. *International Conference On Engineering Education* , San Juan, Puerto Rico July 23-28. ICEE-2006
- Duman, Bilal (2010). The Effects of Brain-Based Learning on the Academic Achievement of Students with Different Learning Styles. *Educational Sciences: Theory and Practice* ,10.
- Ebel, R. L., & Frisbie, D. A. (1991). *Essentials of educational measurement*. Englewood Cliffs, N.J: Prentice Hall.

- Erkan & Özlem (2013). Effects of Brain-Based Learning Approach on Students' Motivation and Attitudes Levels in Science Class. *MIJE* 3 (1), 104–119. DOI: 10.13054/mije.13.08.3.1.
- Ertmer, P. & Newby, T. (1993). 'Behaviorism, cognitivism, constructivism: comparing critical features from an instructional design perspective'. *Performance Improvement Quarterly*, 6(4),pp 50-72.
- Farah, M. J., Betancourt, L. , Shera, D. M., Savage, J. H., Giannetta, J. M., Brodsky, N. L., Malmud, E. K. and Hurt, H. (2008). Environmental stimulation, parental nurturance and cognitive development in humans.*Developmental Science*, 11,pp 793-801. doi:[10.1111/j.1467-7687.2008.00688.x](https://doi.org/10.1111/j.1467-7687.2008.00688.x)
- Fischer, Kurt W., Goswami, Usha., Geake, John (2010). The Future of Educational Neuroscience.*Mind, Brain, and Education* 4 (2),pp 68–80. DOI: 10.1111/j.1751-228X.2010.01086.x.
- Fischer, Kurt W.; Daniel, David B.; Immordino-Yang, Mary Helen, Stern, Elsbeth., Battro, Antonio., Koizumi, Hideaki (2007). Why Mind, Brain, and Education ? Why Now?. *Mind, Brain, and Education* 1 (1),pp 1–2. DOI: 10.1111/j.1751-228X.2007.00006.x.
- Freeman, W.(1995). *Societies of Brains*. Hillsdale, N.J.: Lawrence Erlbaum and Associates.
- Gagne, R. (1985). *The Conditions of Learning* (4th Ed) New York: Holt, Rinehart & Winston.
- Gagne, Robert M. (1962). Military training and principles of learning. *American Psychologist* 17 (2), pp. 83–91. DOI: 10.1037/h0048613.
- Gagné, Robert M. (1977). *The conditions of learning*. (3rd ed.) New York: Holt, Rinehart and Winston.
- Gais, S. (2006): Sleep after learning aids memory recall. *Learning & Memory* 13 (3), pp. 259–262. DOI: 10.1101/lm.132106.

- Gardner, H. (1993). *Frames of mind: the theory of multiple intelligences*. New York: basicbooks
- Gardner, Howard (1993). *Multiple intelligences. The theory in practice*. New York, NY: Basic Books.
- Geake, John., Cooper, Paul (2003). Cognitive Neuroscience: implications for education? *Westminster Studies in Education* 26 (1), pp. 7–20. DOI: 10.1080/0140672030260102.
- Gias et.al (2010). Sleep after Learning Aid Memory Recall; *Learning and Memory*. 2006 13:259-262
- Goleman, Daniel (1996). *Emotional Intelligence: Why It Can Matter More Than IQ*. Bantam Books. ISBN 978-0-553-38371-3.
- Goswami, U. (2004). Neuroscience and Education. *British Journal of Educational Psychology*, 74(1), 1-14
- Goswami, Usha (2006). Neuroscience and education: from research to practice? *Nature Review Neuroscience* 7 (5), pp. 406–413. DOI: 10.1038/nrn1907.
- Greenleaf, R (2003). Motion and Emotion Academic Research Library .*Principle leadership* May 2003 pg.14
- Griffiee, Dale T. (2012). *An introduction to second language research methods*: TESL-EJ Publications.
- Gros, B., Elen, J. Kerres, M. Merrienboer, J. & Spector, M. (1997). Instructional design and the authoring of multimedia and hypermedia systems: Does a marriage make sense? *Educational Technology*, 37(1), 48-56.
- Gustafson, Kent L.; Branch, Robert Maribe (2002). *Survey of instructional development models*. Fourth edition. Syracuse, New York: ERIC Clearinghouse on Information & Technology.
- Haghighi M.(2013). *The effect of brain- based learning on Iranian EFL achievement and retention*. *Procedia - Social and Behavioral Sciences*. (70),pp508 – 516.

- Hall, J. (2005). *Neuroscience and education: A review of the contribution of brain science to teaching and learning*. Scottish Council for Research in Education, Glasgow <http://www.scre.ac.uk>
- Hardiman, Mariale (2012). Informing Pedagogy through the Brain-Targeted Teaching Model. In *Journal of Microbiology & Biology Education* 13 (1), pp. 11–16. DOI: 10.1128/jmbe.v13i1.354.
- Healy, Jane. (1990). *Endangered Minds: Why Our Children Can't Think*. New York: Simonand Schuster.
- Hinton, Christina.; Fischer, Kurt W. (2008). Research Schools: Grounding Research in Educational Practice. In *Mind, Brain, and Education* 2 (4), pp. 157–160. DOI: 10.1111/j.1751-228X.2008.00048.x.
- Iacoboni, M.; Woods, R.P.; Brass, M., Bekkering, H., Mazziotta, J.C., & Rizzolatti, G. (1999). Cortical mechanisms of human imitation. *Science*, 286 5449, 2526-8.
- Immordino-Yang , M. H . (2007). A Tale of Two Cases: Lessons for Education from the Study of Two Boys Living with Half their Brains .*Mind, Brain, and Education* , 1 , 66 – 8
- Immordino-Yang, M.H. (2008). The Smoke Around Mirror Neurons: Goals as Sociocultural and Emotional Organizers of Perception and Action in Learning. *Mind Brain Education* 2 (2), pp. 67–73. DOI: 10.1111/j.1751-228X.2008.00034.x.
- Immordino-Yang, M.H.(2011). Implications of Affective and Social Neuroscience for Educational Theory. *Educational Philosophy and Theory* 43 (1), pp. 98–103. DOI: 10.1111/j.1469-5812.2010.00713.x.
- Immordino-Yang, M.H.; Damasio, A. (2007). We Feel, Therefore We Learn: The Relevance of Affective and Social Neuroscience to Education. *Mind, Brain, and Education* 1 (1), pp. 3–10. DOI: 10.1111/j.1751-228X.2007.00004.x.

Immordino-Yang, Mary Helen., Singh, Vanessa (2011). Perspectives from Social and Affective Neuroscience on the Design of Digital Learning Technologies. In Rafael A. Calvo, Sidney K. D'Mello (Eds.): *New Perspectives on Affect and Learning Technologies*. New York, NY: Springer New York, pp. 233–241.

International Mind, Brain, and Education Society (2007). *Mind, brain, and education*. Official journal of the International Mind, Brain, and Education Society. Oxford: Blackwell. Available online at <http://onlinelibrary.wiley.com/BLDSS>.

Jensen, E. (2005). *Teaching with the brain in mind* (2nded.). Alexandria, VA: ASCD

Jensen, Eric (2000). *Brain Based Learning*, Brain Store Publishing, USA.

Johnson, M. & Hallgarten, J. (2002). *From Victims of Change to Agents of Change: the future of the teaching profession* (London, Institute of Public Policy Research).

Jonassen, D.H. (1991). Evaluating constructivist learning. *Educational Technology*, 28 (11), 13-16.

Joyce, Bruce, Marsha Weil, & Emily Calhoun. (2009). *Models of Teaching*. Boston: Pearson.

Kalton, G. (1983). *Introduction to survey sampling*. Newbury Park, CA: Sage

Kandel, E. R. (2009). The Biology of Memory: A Forty-Year Perspective. In *Journal of Neuroscience* 29 (41), pp. 12748–12756. DOI: 10.1523/JNEUROSCI.3958-09.2009.

Kandel, Eric R.; Dudai, Yadin., Mayford, Mark R. (2014). The Molecular and Systems Biology of Memory. In *Cell* 157 (1), pp. 163–186. DOI: 10.1016/j.cell.2014.03.001.

Kawthar Shabatat & Mohammed Al-Tarawneh (2016).The Impact of a Teaching-Learning Program Based on a Brain-Based Learning on the Achievement of the Female Students of 9th Grade in Chemistry. *Higher Education Studies*;

Vol. 6, No. 2; 2016 ISSN 1925-4741 E-ISSN 1925-475X ,Canadian Center of Science and Education. <http://dx.doi.org/10.5539/hes.v6n2p162>

- Kemp, Jerrold E.; Morrison, Gary R.; Ross, Steven M. (1998). *Designing effective instruction*. (2nd Ed). Upper Saddle River, New York: Merrill; Wiley.
- Kennedy, T. J.,. (2006). Language Learning and Its Impact on the Brain: Connecting Language Learning with the Mind Through Content-Based Instruction. *Foreign Language Annals*, 39(3),471-486
- Kent, Alexis (2013). Synchronization as a Classroom Dynamic: A Practitioner's Perspective. *Mind, Brain, and Education* 7 (1).pp. 13–18. DOI: 10.1111/mbe.12002.
- Khalil, Mohammed K.; Elkhider, Ihsan A. (2016). Applying learning theories and instructional design models for effective instruction. *Advances in Physiology Education* 40 (2), pp. 147–156. DOI: 10.1152/advan.00138.2015.
- Kovalik, S. & Olsen, K. (1997). *Integrated thematic instruction: the model* (3rd. Ed.). Covington, WA: Books for Education, Inc. .
- Kuhn, Deanna (1999). A Developmental Model of Critical Thinking. In *Educational Researcher* 28 (2), pp. 16–46. DOI: 10.3102/0013189X028002016.
- Kurt W. Fischer and David B. Daniel (2009). Need for Infrastructure to Connect Research with Practice in Education. *Mind Brain and Education*,3(1), International Mind, Brain, and Education Society and Wiley Periodicals, Inc.
- Kurt W. Fischer et al (2007) .Why Mind, Brain, and Education ? Why Now? *Mind Brain and Education*1(1),pp.1-2,https://doi.org/10.1111/j.1751228X.2007.00006.x
- LaBar, K.S. and Cabeza, R. (2006) Cognitive Neuroscience of Emotional Memory. *nature Reviews Neuroscience*,7(1), pp.54-64. <http://dx.doi.org/10.1038/nrn1825>
- Laughbaum, E.D. (2008) Implications of neuroscientific research on teaching algebra; *Int. J. Cont. Engineering Education and Life-Long Learning*, 18, pp.5-6.

- Laughbaum, E.D.(2010).The Neuroscience of Connections, Generalizations, Visualizations and Meaning; Pre print Knights, C. &Oldknow, A., eds. *Enhancing Mathematics with Digital Technologies*. Continuum Press. London, UK.www.math.ohio-state.edu/~elaughba/elaughba@math.ohio-state.ed
- LeDoux, J. (1994).Emotion, memory and the brain. *Scientific American*, 270(6),pp. 50-57.
- LeDoux, J. (1996).*The Emotional Brain: The Mysterious Underpinnings of Emotional Life*. New York; Simon and Schuster
- Leou, M., Abder, P., Riordan, M., &Zoller, U. (2006).‘Using HOCS-centered learning’ as a pathway to promote science teachers’ metacognitive development. *Research in Science Education*, 36(1–2),pp.69–84.
- MacNabb, Carrie; Schmitt, Lee., Michlin, Michael., Harris, Ilene., Thomas, Larry., Chittendon, David (2006).Neuroscience in Middle Schools: A Professional Development and Resource Program That Models Inquiry-based Strategies and Engages Teachers in Classroom Implementation. *LSE* 5 (2), pp. 144–157. DOI: 10.1187/cbe.05-08-0109.
- Maguire, E. A., Vargha-Khadem, F. &Mishkin, M(2001).The effects of bilateral hippocampal damage on fMRI regional activations and interactions during memory retrieval. *Brain*, 124, pp.1156–1170.
- Maguire, E. A.; Nannery, R.; Spiers, H. J. (2006).Navigation around London by a taxi driver with bilateral hippocampal lesions.*Brain* 129 (11), pp. 2894–2907. DOI: 10.1093/brain/awl286.
- Maquet, Pierre., Laureys, Steven., Peigneux, Philippe., Fuchs, Sonia., Petiau, Christophe., Phillips, Christophe (2000).Experience-dependent changes cerebral activation during human REM sleep. *Nature Neuroscience* 3 (8), pp. 831–836. DOI: 10.1038/77744.

- Mekarina, M.; Ningsih, Y. P. (2017).The Effects of Brain Based Learning Approach on Motivation and Students Achievement in Mathematics Learning.*J. Phys.: Conf. Ser.* 895, p. 12057. DOI: 10.1088/1742-6596/895/1/012057.
- Meltzoff, A. N. (1999).Origins Of Theory Of Mind, Cognition And Communication. *Journal of Communication Disorders*, 32(4),pp.251–269.
- Mergel, B. (1998).Instructional design & learning theory.*Educational communications and technology*. University of Saskatchewan.
- Moellem, M. (2001).Applying constructivist and objectivist learning theories in the design of a web-based course: Implications for practice.
- National Curriculum Framework (2005) National council of educational research and training., NCERT publication, 2005 ;ISBN 81-7450-467-2
- National Science Education Standards (1996).Washington, D.C.: National Academies Press.
- Neuroscience Research in Education Summit (2009).*The Promise of Interdisciplinary partnerships between Brain Sciences and Education* ,University of California ,Irvine June 22-24
- Ozdemir & Sadik (2016).The Effect Of Mathematics Education on Academic Success and Attitude - Brain Based Learning Theory. In *International Journal of Social Science Research*, 5 (1), 16-32. www.ijssr.net ijssresearch@gmail.com ISSN: 2146-8257 retrieved from <http://dergipark.gov.tr/download/article-file/382008>
- Ozden, M. &Gultekin, M. (2008).The effects of brain-based learning on academic achievement and retention of knowledge in science course. In *Electronic Journal of Science Education* ;12(1)
- Perkins, D. N., Tishman, S., Ritchhart, R., Donis, K., & Andrade, A. (2000).Intelligence in the wild: A dispositional view of intellectual traits. *Educational Psychology Review*, 12(3), 269–293

- Petitto, L. A., & Dunbar, K. (2004). New findings from educational neuroscience on bilingual brains, scientific brains, and the educated mind. *Monograph: Mind, Brain and Education*.
- Petitto, Laura-Ann., Dunbar, Kevin Niall (2009). Educational Neuroscience: New Discoveries from Bilingual Brains, Scientific Brains, and the Educated Mind. In *Mind Brain Education* 3 (4), pp. 185–197. DOI: 10.1111/j.1751-228X.2009.01069.x.
- Pinker, S. (2007). *The Language Instinct* (1994/2007) . New York, NY: Harper Perennial Modern Classics.
- Potkin, Katya Trudeau., Bunney, William E. (2012). Sleep Improves Memory: The Effect of Sleep on Long Term Memory in Early Adolescence. *PLoS ONE* 7 (8), e42191. DOI: 10.1371/journal.pone.0042191.
- Purdy, Noel., Morrison, Hugh (2009). Cognitive neuroscience and education: unravelling the confusion. *Oxford Revs. of Educ.* 35 (1), pp. 99–109. DOI: 10.1080/03054980802404741.
- Remadevi K. (2014). Application of brain based learning in teaching chemistry at secondary level. A minor research project (education). 2014;9-15. Available: <http://www.nsstcpdlm.org/pdf/dr.%20k-remadevi-minor-project.pdf>
- Resnick, L. B. (1983). Mathematics and science learning: a new conception. *Science* 220 (4596), pp. 477–478. DOI: 10.1126/science.220.4596.477.
- Resnick, L.B.(1987). *Education and Learning to Think. Committee on Mathematics, Science, and Technology Education, Commission on Behavioral and Social Sciences and Education*, National Research Council. Washington, DC: National Academy Press. Available at :<http://www.nap.edu>.
- Rodriguez, Vanessa (2013). The Human Nervous System: A Framework for Teaching and the Teaching Brain. *Mind, Brain, and Education* 7 (1), pp. 2–12. DOI: 10.1111/mbe.12000.

- Roehrig, G. H.; Michlin, M.; Schmitt, L.; MacNabb, C.; Dubinsky, J. M. (2012). Teaching Neuroscience to Science Teachers: Facilitating the Translation of Inquiry-Based Teaching Instruction to the Classroom. *LSE* 11 (4), pp. 413–424. DOI: 10.1187/cbe.12-04-0045.
- Saleh, Salmiza (2012). The effectiveness of Brain-Based Teaching Approach in dealing with the problems of students' conceptual understanding and learning motivation towards physics. *Educational Studies* 38 (1), pp. 19–29. DOI: 10.1080/03055698.2011.570004.
- Sarva Shiksha Abhiyan (2011). *Framework For Implementation Based On The Right Of Children To Free And Compulsory Education act, 2009*. Department Of School Education And Literacy Ministry Of Human Resource And Development Government Of India .
- Scandura, J. (2001). Structural Learning Theory: Current status and new perspectives. In *Instructional Science*, 29(4/5), 311-336..
- Schiller, P., & Willis, C. (2008). Using brain-based teaching strategies to create supportive early childhood environments that address learning standards. *Young Children*, 63(4), 52–55.
- Serep.T., & Demirel, M. (2009). The effect of brain based learning on achievement, retention, attitude and learning process. *Procedia Social and Behavioral Sciences*. 1782-1791. Elsevier.
- Simon, Herbert A. (1996). *The sciences of the artificial*. 3rd ed. Cambridge, Mass.: MIT Press.
- Smilkstein, R. (2011). *We're born to learn: Using the brain's natural learning process to create today's curriculum*. Corwin Press.
- Society for Neuroscience (2012). *Brain facts. A primer on the brain and nervous system*. (7th ed). Washington DC USA: Society for Neuroscience.
- Sousa, D. (2006). *How the brain learns (with learning manual)*. Thousand Oaks, CA: Corwin Press Incorporated.

- Sousa, David A. (2001). *How the brain learns. A classroom teacher's guide.* (2nd ed.) Thousand Oaks, Calif., London: Corwin Press.
- Stern, E. (2005). Pedagogy Meets Neuroscience. *Science* 310 (5749), p. 745. DOI: 10.1126/science.1121139.
- Tokuhama-Espinosa, T. N. (2008). *The scientifically substantiated art of teaching: A study in the development of standards in the new academic field of neuroeducation (mind, brain, and education science)* (Doctoral dissertation, Capella University).
- Tokuhama-Espinosa, T.N. (2010). *Mind Brain And Education Science ;A Comprehensive guide to the New Brain Based Teaching.* ISBN 978-0-393-70607-9, WW Norton Company New York London
- Tokuhama-Espinosa, T.N. (2011). Why Mind, Brain, and Education Science is the " New" Brain-Based Education. *New Horizons for Learning*, 9(1).
- Tomporowski, Phillip D.; Davis, Catherine L.; Miller, Patricia H.; Naglieri, Jack A. (2008). Exercise and Children's Intelligence, Cognition, and Academic Achievement. *Educ Psychol Rev* 20 (2), pp. 111–131. DOI: 10.1007/s10648-007-9057-0.
- Topor, D. R., Keane, S. P., Shelton, T. L., & Calkins, S. D. (2010). Parent involvement and student academic performance: a multiple mediational analysis. *Journal of prevention & intervention in the community*, 38(3), pp.183-97.
- Totsika, V. and Sylva, K. (2004), *The Home Observation for Measurement of the Environment Revisited.* *Child and Adolescent Mental Health*, 9: pp.25-35. doi:[10.1046/j.1475-357X.2003.00073.x](https://doi.org/10.1046/j.1475-357X.2003.00073.x)
- Tucker-Drob, E. M. and Harden, K. P. (2012). Early childhood cognitive development and parental cognitive stimulation: evidence for reciprocal gene–environment transactions. *Developmental Science*, 15: pp.250-259. doi:[10.1111/j.1467-7687.2011.01121.x](https://doi.org/10.1111/j.1467-7687.2011.01121.x)

- Understanding the brain: Birth of a learning science(2002).New Insights On learning Through Cognitive and Brain science ;OECD/CERI International Conference “Learning in the 21st Century: Research, Innovation and Policy.R(S)
- Vygotskiĭ, L. S.& Cole, Michael (1978).*Mind in society. The development of higher psychological processes*. Cambridge: Harvard University Press.
- Wilks, S. (1995).*Critical and creative thinking: Strategies for classroom inquiry*. Armidale, NSW: Eleanor Curtain
- William Cameron and Eric Chudler (2003).A role for neuroscientists in engaging young minds .*Nature Reviews Neuroscience*, 4 , September 2003
- Wills Judy. (2007).Neuroscience of Joyful Education; Engaging the whole child. (*online only*) *Education leadership* ,vol.84
- Wolfe, P. (2006).Brain-compatible learning: fad or fashion? *School Administrator*, 63(11), pp10-15.
- Wortock, J. M. M. (2002).Brain based principles applied to the teaching of basic cardiac code to associate degree nursing students using the human patient simulator. Unpublished Doctorate's Thesis. University Of South Florida. <https://elibrary.ru/item.asp?id=5431405>
- Yano, Kazuo (2013).The Science of Human Interaction and Teaching.*Mind, Brain, and Education* 7 (1), pp. 19–29. DOI: 10.1111/mbe.12003.
- Yasar, M. Diyaddin (2017).Brain Based Learning in Science Education in Turkey: Descriptive Content and Meta Analysis of Dissertation.*Journal of Education and Practice*, 8 (9),pp161-168.
- Zheng, L., & Smaldino, S. (2003).Key instructional design elements for distance education.*The Quarterly Review of Distance Education*, 4(2),pp153-166
- Zohar, A., & Dori, Y. J. (2003).Higher order thinking skills and low achieving students: Are they mutually exclusive?..*Journal of the Learning Sciences*, 12(2), pp145–183

Need Assessment of a Teacher

The present survey is designed to ascertain the needs of teachers and to help them in making their teaching more fruitful, kindly fill the survey with utmost care and with honest responses.

1. Does your school has all the resources for good teaching and learning environment ?

- plentiful
- sufficient enough
- Moderate
- Slightly
- Not at all

2. Do you think the ICT based Teaching learning material and other TLMs used in science teaching are useful for better teaching and learning?

- very much useful
- useful
- moderately useful
- less useful
- not at all useful

3. As a teacher which approach or learning theory you like to follow for better teaching?

- behaviouristic
- cognitivist
- constructivist
- brain based

4. Do you use all the resources you need to teach at this school like educational DVDs and Internet and Laboratory experimentation?

- Very Often
- Occasionally
- does not use at all
- want to use but does not know when to use

5. Are you satisfied with ther student achievement of your students?

- Extremely satisfied
- Very satisfied
- Moderately satisfied
- Slightly satisfied
- Not at all satisfied

6. Do you follow any specific model of teaching or instructions during your teaching ?

- no
- occasionally
- yes (specify the name of that model)

7. Do you agree that brain based research findings on learning would be useful for your teaching?

- Extremely useful
- Very useful
- Moderately useful
- Slightly useful
- Not at all useful

8. Whether a teacher should constantly update its knowledge of latest research and do his professional growth?

- A great deal
- A lot
- A moderate amount

- A little
- None at all

9. Do you feel the need of an instructional model to guide your teaching process?

- A great deal
- A lot
- A moderate amount
- A little
- None at all

10. Does the new model of instruction should be developed using the evidence based brain based research on learning ?

- Extremely agree
- Moderately agree
- Slightly agree
- Neither Agree nor disagree
- Moderately disagree
- Extremely disagree

Done

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Create your own [free online survey](#) now!

APPENDIX 2

LESSON PLANNING PROTOCOL

1)Assessment of the learners

<i>Name</i>
<i>Age:</i>
<i>Height :</i>
<i>Weight:</i>
<i>BMI:</i>
<i>History of illness:</i>
<i>Family history of illness:</i>
<i>Any other ailment /problem reported by parent or child(related to family home environment which may have negative effect on psychological well being of the child)</i>
<i>Parental education status:</i>
<i>Income of parents:</i>

Preparation of learning environment

Create learning environment

Learning environment has two components i.e. Physical environment: light, seating arrangement and voice the classroom environment including physical facilities like light ,seating arrangements , air circulation and visibility of every child, making children comfortable with teacher some informal conversations to make them familiar and comfortable in the classroom and Abstract environment that include psychological and physiological factors like attention, interest, curiosity ,engagement of mind , and readiness for learning. Teacher would gain the attention of the students with loud and plausible voice, every effort would be done to modulate the voice so that maximum attention would be attained by using suitable words/vocabulary ,teacher should act enthusiastic and have positive emotional attitude in the classroom, no negative comments and facial expressions should be there.

Delivery of the Content

Classify the objectives:

Lesson to be delivered has certain aims and objectives, which should be communicated to the students in a very understandable terms.

Communication of information:

After explaining the objectives and testing their previous Understanding of the subject area new information related to that should be communicated in meaningful way, care has to be taken that all information is distributed into small chunks so that brain takes new information in understandable format. Attention span should be taken into consideration so that delivery of content should not be too long of time that brain start getting new information discarded. Maximum use of audio as well as visual stimulus be done. Use of ICT based visual aids can be done. Teacher can choose its preferred method based on the needs of students and availability of resources.

Immediate Feedback

Cognitive processing:

Immediate and intermittent feedback is required to both maintaining attention and cognitive processing of new information to make it stored in related brain areas. Making pattern and relating the new information to old and to real life examples is required to make it stored in working memory to long term memory. Questions that elicit meta cognition among students should be asked .

Repetition and rehearsal

Cognitive stimulation:

Repetition of all the content that is delivered in the form of summary or concept map should be done. Important keywords be listed so that students get to know about their learning, repetition or summarizing of the content should preferably be done by the students themselves.

For doing rehearsal of the work been done in the classroom some related assignments be given to the students to reinforce their thinking and make them use of thinking processes about the learned concepts.

Evaluation and assessment:**Comprehensive Evaluation:**

Evaluation in the form of assessment of the learning should be done on the basis of thinking skills developed. Assessments of the learners should be done on the comprehensive scale.

Remedial measures:

If there is a problem in learning, these problems should be discussed with the students and their difficulties should be attended through different activities and further assessment can be done.

SR.NO.	NAME OF LESSON UNIT
1.	Human circulatory system: Constituents
2.	Blood its constituents and role
3.	Structure and function of the human heart
4.	Endocrine system: Tissues and hormones
5.	Exchange of gases
6.	Types of respiration; aerobic and anaerobic
7.	Human respiratory system
8.	Cellular respiration
9.	Types of nutrition
10.	Photosynthesis in plants
11.	Human digestive system
12.	Enzymes and its role in digestion
13.	Excretion in plants
14.	Human excretory system

Lesson Unit 1: Human Circulatory System

10th science

Connect to learners

Teacher has data of students and is aware of students' health and physiological status along with any other health and psychological issues.
The students with poor vision should be asked to sit on front seats and who has poor attention may also be called to shift their seats.

Create learning Environment

Hello children...!!
So are you ready?
How had your previous class gone?
Do you remember what we discussed yesterday?
Ok tell me what you gained out of it yesterday?
Do you know about how transportation of nutrients and oxygen occurs in our body?
What is the main medium of transportation?

Classify the objectives

In our lesson today we will know about how blood act as medium of transport in body?
What are its constituents?
Do you have any idea about this?
Tell me. Ok.

Communicate the information

Transport in Humans

'**Circulatory system**' or '**Blood circulatory system**' is the main transport system in human beings. In this blood carries oxygen, digested food and other chemicals like hormones and enzymes to all parts of the body and take away waste products like carbon dioxide and urea. Therefore, Human blood circulatory system consists of the heart which pumps and receives blood and the blood vessels through which blood flows in the body.

In the circulatory system, blood flows through three types of blood vessels: Arteries, veins and capillaries. The blood vessels are present in all parts of the human body so, that blood reaches everywhere in the body.

There is another system with the blood circulatory system for the transport in human beings is **Lymphatic System**. Lymph is the liquid which circulates and carries materials in the lymphatic system. Thus, we can conclude that in Human beings, the various substances are transported through two liquids called 'blood 'and 'lymph.

The circulatory system is one of the most important systems in the body. Made up of the **heart, blood and blood vessels**, the circulatory system is your body's delivery system. Your heart plays an important part in being healthy. It keeps all the blood in your circulatory system flowing. Blood helps oxygen get around your body. When you **exercise** you can feel your pulse, it tells you how fast your heart is pumping.

The body's circulatory system is responsible for transporting materials throughout the entire body. It **delivers nutrients, water, and oxygen** to your billions of body cells and **carries away wastes** such as carbon dioxide that body cells produce. It is an amazing highway that travels through your entire body connecting all your body cells.

At the center of this system is the heart, an amazing organ. **The heart beats about 3 billion times during an average lifetime.** It is a muscle about the size of the fist. The heart is located in the center of the chest slightly to the left. **Its job is to pump blood and keep the blood moving throughout the body.** The blood is pumped around a complex network of blood vessels extending to every part of the body.

Blood carries the oxygen and nutrients needed to fuel the activities of the body's tissues and organs, and it plays a vital role in removing the body's waste products. An average-sized adult carries about 5 liters (9 pints) of blood.

LC7490

The Circulatory System in Humans

+

The circulatory system is made up of **blood, blood vessels** and the **heart**.

Blood: Blood is a liquid consisting of **plasma**, in which **erythrocytes(RBC's)**, leucocytes (WBC's) and **platelets** are placed in it.

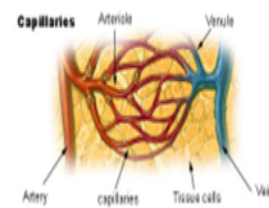
- **RBC's carry oxygen**
- WBC's prevent infection
- **Platelets help in blood clotting**

Blood as a part of circulatory system transports oxygen, carbon-di-oxide, waste, nutrients and hormones.

Blood vessels are of three types : arteries, veins and capillaries.

Arteries	Veins
Carry blood away from the heart to organs and tissues.	Return blood to the heart from the organs and tissues.
Walls are thick and elastic	Walls are thin
Transport oxygenated blood except pulmonary artery	Transport deoxygenated blood except pulmonary artery
Have narrow passage way	Have wide passage way
Have no valves	Have valves
Blood at high pressure	Blood at low pressure

Capillaries are finer vessels. They connect arteries and veins.



wikimedia commons;



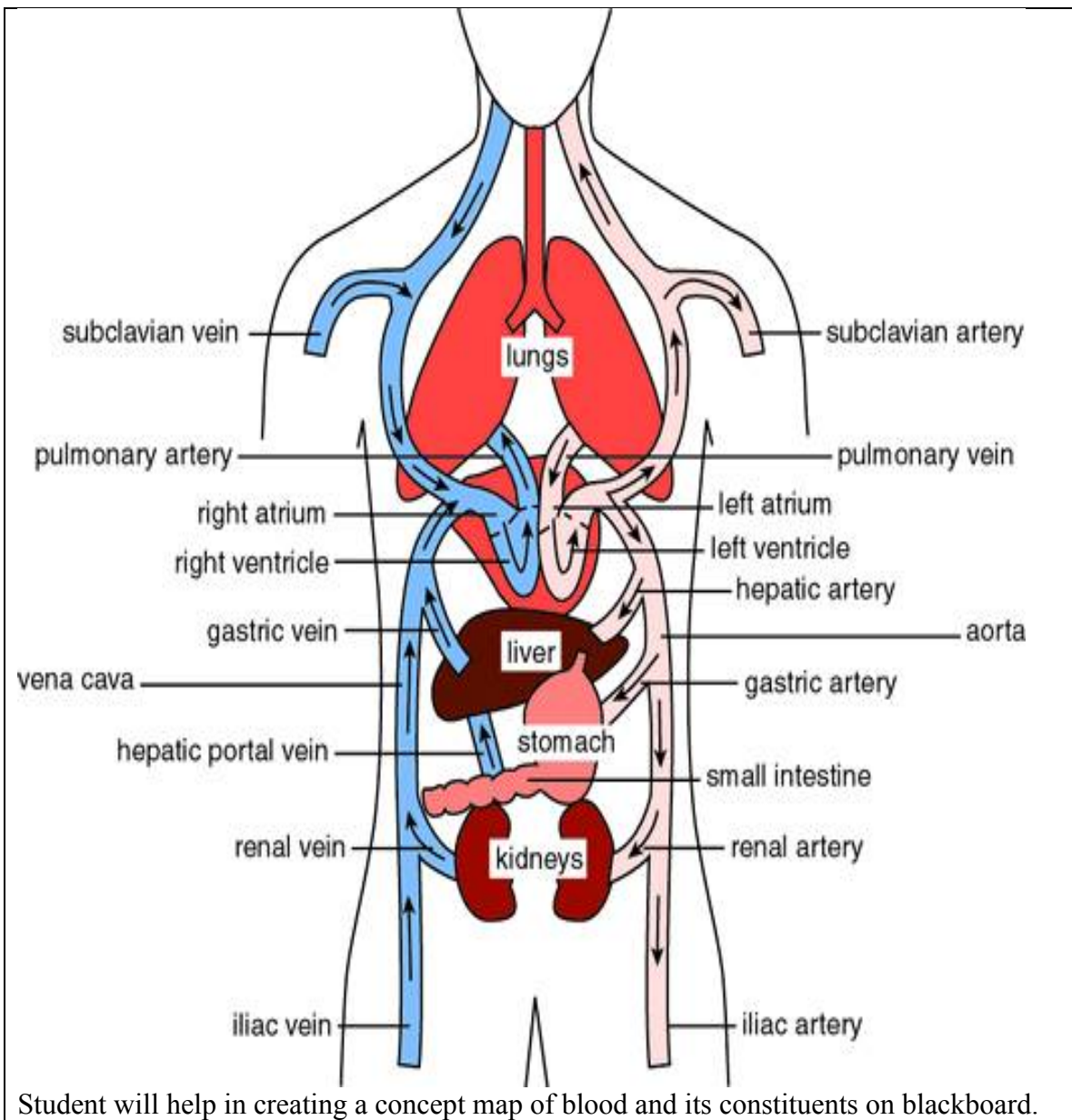
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C8-33/56

HA1

Cognitive processing

Now you repeat the information...one of the students would get up and explain the process rest of students would participate in discussion.



Cognitive stimulation

Practice sheets should be given and students should be asked to draw the concept map on your notebooks.
 What are different constituents of circulatory system?
 How are they different from each other?
 Make an assignment on different types of available with examples paste the pictures if available.

Comprehensive evaluation

Define human circulatory system.
 How does the blood circulate in human body?
 Draw a conceptual diagram of human circulatory system.

Lesson Unit 2: Blood and its constituents

10th Science

Connect to learners

Teacher has data of students and is aware of students' health and physiological status along with any other health and psychological issues.
The students with poor vision should be asked to sit on front seats and those with poor attention may also be asked to shift their seats.

Create learning Environment

Hello children...!!
So you are ready?
How was your previous class gone?
Do you remember what we discussed yesterday?
Ok students tell me what you gained out of it yesterday?
Do you know how transportation of nutrients and oxygen occurs in our body?
What is the main medium of transportation?

Classify the Objectives

Today we will know how blood acts as a medium of transport in our body?
What are its constituents?
Do you have any idea about this?
Tell me.....Ok
Where does the food go after it is digested in our stomach?
What is the role of digestion and what helps in digesting our food?
What are the different organs of digestive system?
What is the role of different enzymes in digestion?

Communicate the Information

Blood is composed of cells, cell fragments and an aqueous solution (plasma). **Blood** makes up about 8% of the human body weight. It contains erythrocytes, leucocytes, thrombocytes (platelets) and plasma. Blood is a red-coloured liquid which circulates in our body. It is red in color because it contains a red pigment called haemoglobin in its red cells. Blood is a connective tissue consisting of four things namely- plasma, red blood corpuscles (red blood cells or RBCs), white blood corpuscles (white blood cells or WBCs) and platelets. Plasma is a liquid also known as fluid matrix. It consists of three types of cells which keep floating in it. They are red blood cells, white blood cells and platelets.

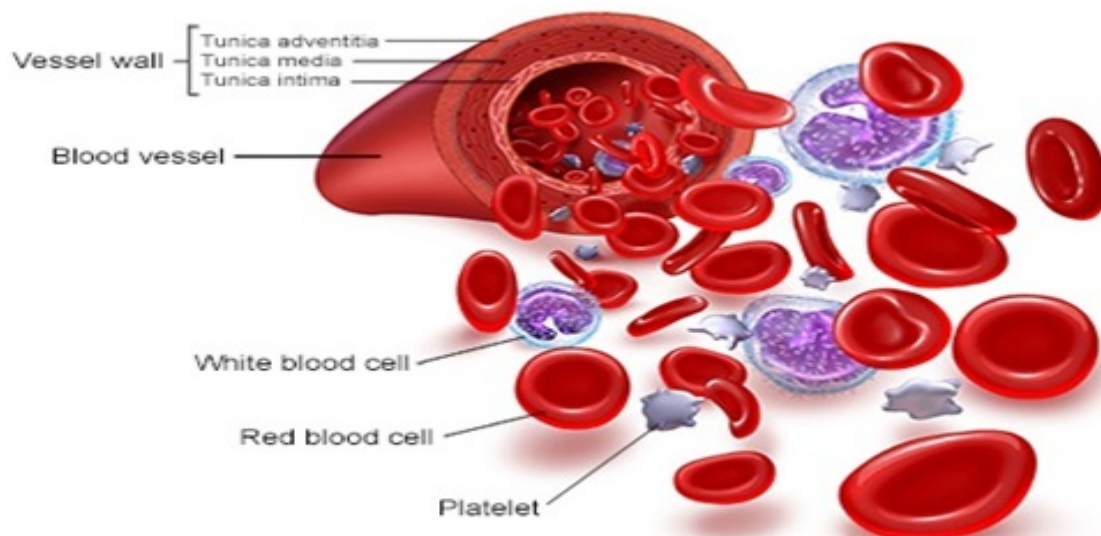
Functions of Blood

Blood has three main functions in the human body. They are:-

- I. Transport of substances from one part of the body to the other like respiratory gases, waste products, enzymes, etc.
- II. Protect against diseases
- III. Regulation of body temperature.

Blood regulates our body temperature. It carries oxygen from lungs to different parts of the body. It carries carbon dioxide from the body cells to the lungs for breathing it out. It carries digested food from the small intestine to all parts of the body. It carries hormones from the endocrine glands to different organs of the body. It carries waste

products like urea from the liver to the kidneys for excretion. It defends against infection. On an average, a healthy man has about 5 litres of blood in the body, while woman has about 500ml less than man. So, total blood is about 60-80 ml/kg of body weight.



Composition and Functions of Blood

Plasma

The fluid or liquid part of blood is called plasma. It is a colorless liquid which contains 90% water, protein and inorganic salts. It also contains some organic substances like glucose, amino-acids, fats, urea, hormones, enzymes, etc. in dissolved form. It carries these dissolved substances from one part of the body to another. The proteins in plasma include antibodies to assist in the body's defence system against disease and infection.

Red Blood Corpuscles (RBC)

Also known as **erythrocytes**, they are disc-shaped cells, concave in the middle and visible under a microscope. RBCs carry oxygen from the lungs to all the cells of the body. They have no nucleus. They contain a pigment called haemoglobin, which is made up of an iron-containing pigment known as haema and a protein called globin. RBCs are produced in the spleen and the bone marrow. They live for about four months because they lack nucleus. So, when we donate blood to save the life of a person, the loss of blood from our body is recovered within a day because red blood cells are made very fast in the bone marrow. Life of an RBC is about 100-120 days. Haemoglobin in RBC picks up oxygen from the lung tissues by forming a chemical compound with it. This oxygen is carried to the tissues, where it is used in the chemical reactions to produce energy. It then combines with carbon dioxide, which is produced in these reactions and returns to the heart, where the cycle starts again.

White Blood Corpuscles (WBC)

WBCs are also known as **leukocytes**. They fight with infection and protect us from diseases because they eat up the germs which cause diseases. That is why they are also known as 'soldiers' of the body's defence system. They are round or irregular, semi-transparent cells, containing a nucleus and visible under a microscope. They are little larger than RBCs. Some white blood cells make chemicals called 'antibodies' to

fight against infection. That is why they provide immunity to our body. WBCs in the blood are much smaller in number than RBCs. WBCs act as a defence system in the body. There are several varieties of WBCs performing specific functions. They are:-

- I. **Neutrophils** (65 to 70% of total WBC count) which attack the invading bacteria and engulf them.
- II. **Lymphocytes** (25% of total WBC count) which produce antibodies to protect the body against foreign antigens and thus provide immunity against infection.
- III. **Basophils**, which secrete an anticoagulant called heparin to prevent the clotting within the blood cells.
- IV. **Eosinophils** and **monocytes, which** assist in defence mechanism of the body by becoming active against specific antigens.

Blood platelets

Blood platelets are also known as **thrombocytes**. They are tiny, circular or oval colorless cells formed in the bone marrow. They lack nucleus and help in the coagulation of blood (clotting of blood) in a cut or wound to stop bleeding. All the blood cells are made in the bone marrow from the cells called stem cells. Blood clotting is a body's defence system to combat bleeding. Plasma contains a soluble protein fibrinogen of the blood, which produces the insoluble protein called fibrin essential for blood coagulation. It is formed in the liver.

Blood Grouping

In 1900-1902, K. Landsteiner classified human blood into four groups namely A, B, AB and O. The cells of these groups contain corresponding antigens namely A, B and AB except O. That is why person with blood group **O** can donate blood to a person of any group and so is known as **universal donor**. Person with **AB** blood group is known as **universal recipient** because he can receive blood from a person with any of blood group namely A, B, AB and O.

Blood Group	Can donate blood to	Can receive blood from
A	A, AB	A and O
B	B, AB	B and O
AB	Only AB	AB, A, B and O
O	AB, A, B and O	Only O

Rh factor

Rh factor is a blood antigen discovered by Landsteiner and A.S Weiner in 1940. It plays an important role during blood transfusion. The Rh factor is an agglutinin found in RBC of most people called Rh+ve. It was initially found in the rhesus monkey and later in man. People who do not have this antigen in their blood are called Rh-ve. The Rh blood does not carry anti-Rh antibodies naturally but could synthesize them if synthesized through blood transfusion of Rh+ve blood. If Rh+ve blood is transfused into an Rh-ve patient, the serum will produce anti-Rh agglutinin. If another dose of Rh+ve blood is given, the anti-Rh agglutinin will cause clumping of RBCs of the donor's blood as soon as it enters the patient receiving it.

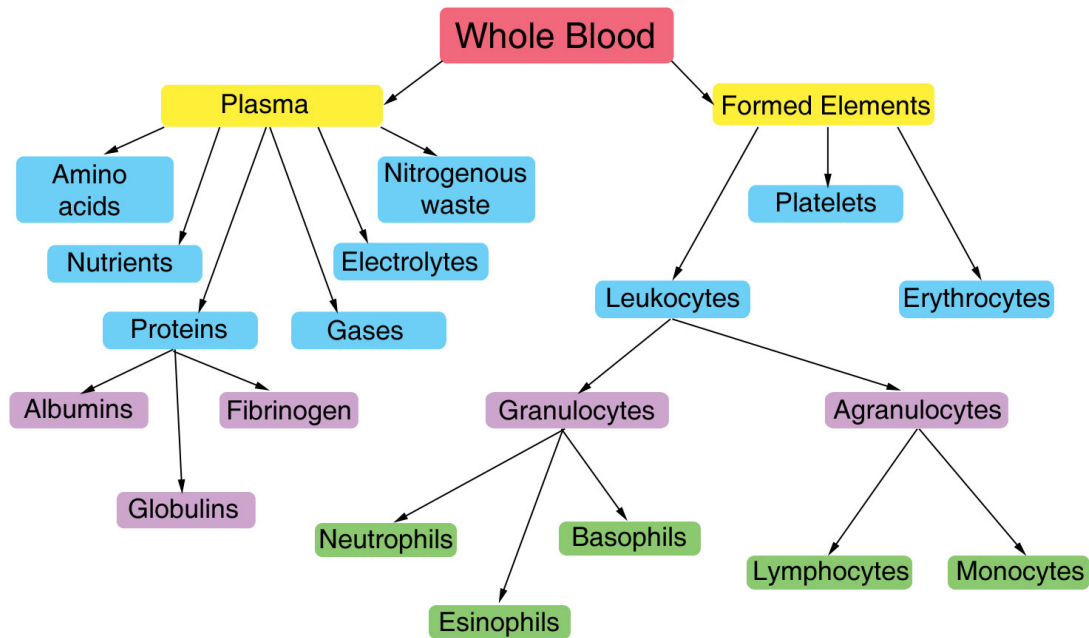
Blood Pressure

Blood pressure is the force exerted by the blood beating against artery walls. The highest point in the pressure range is called systolic pressure (upper reading) and lowest point is called diastolic pressure (lower reading). It is measured by an

instrument called sphygmomanometer. The diastolic pressure is always lower than the systolic pressure. The average systolic pressure of a healthy young man is about 120 mm Hg and the diastolic pressure is about 80 mm Hg. So, **120/80 is the normal blood pressure**. High blood pressure is known as hypertension and low blood pressure is known as hypotension.

Cognitive processing

Now you repeat the information...one of the students would get up and explain the process while the rest of students would participate in discussion. The student will help in creating a concept map of blood and its constituents on blackboard.



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Cognitive stimulation

Practice test should be assigned as homework.
<https://www2.palomar.edu/anthro/practice/bldquiz1.htm>

Comprehensive evaluation

Write the nature and composition of blood.
 Which component of blood acts as defence to the human body against infections?
 Fill in blanks with appropriate terms:
 Oxygen is circulated to the tissues with the help of.....component of blood.
blood group can be donated to any group and so is known as universal donor.
 blood group is known as universal recipient.
 attack the invading bacteria and engulf them.
 Lymphocytes (25% of WBC) producewhich protect the body against foreign antigens and thus provide immunity against infection.
 Basophils secrete an anticoagulant called, which prevents clotting of blood within the blood cells.

Lesson Unit 3: Human Heart Structure and Functions

10th science

Connect to learners

Teacher from his data of students is fully aware of students' health and physiological status. The students with poor vision should be asked to sit on front seats.

Create learning Environment

Children.....So are you ready to learn today?
Do you remember what we discussed yesterday?
Ok tell mewhat you know about human heart? How it works?

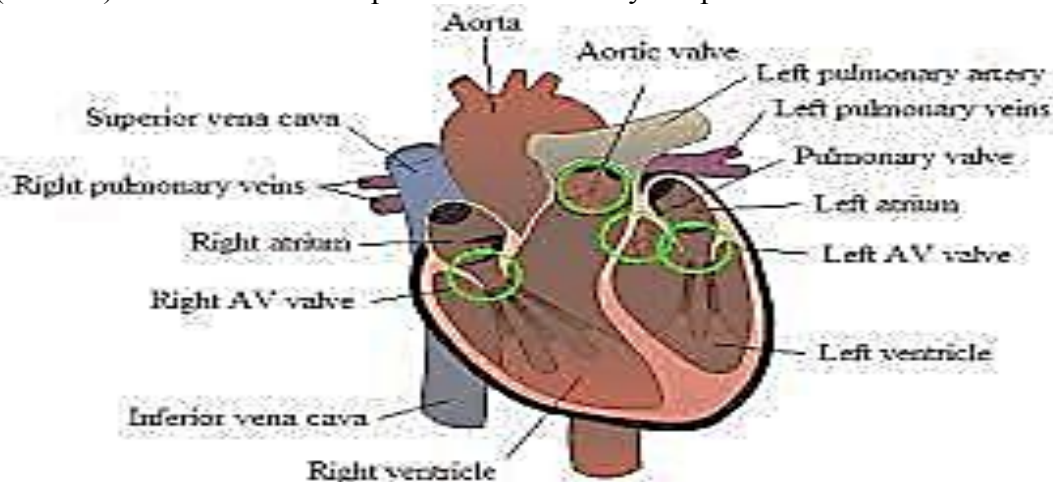
Classify the objectives

Do you know the importance of heart in our life?
Yes...heart is a pump of human body which pumps blood to different regions in body.
It is responsible for the transportation of nutrients, hormones and oxygen in our body.
Today, we will know about the structure and function of human heart in detail.

Communicate the information

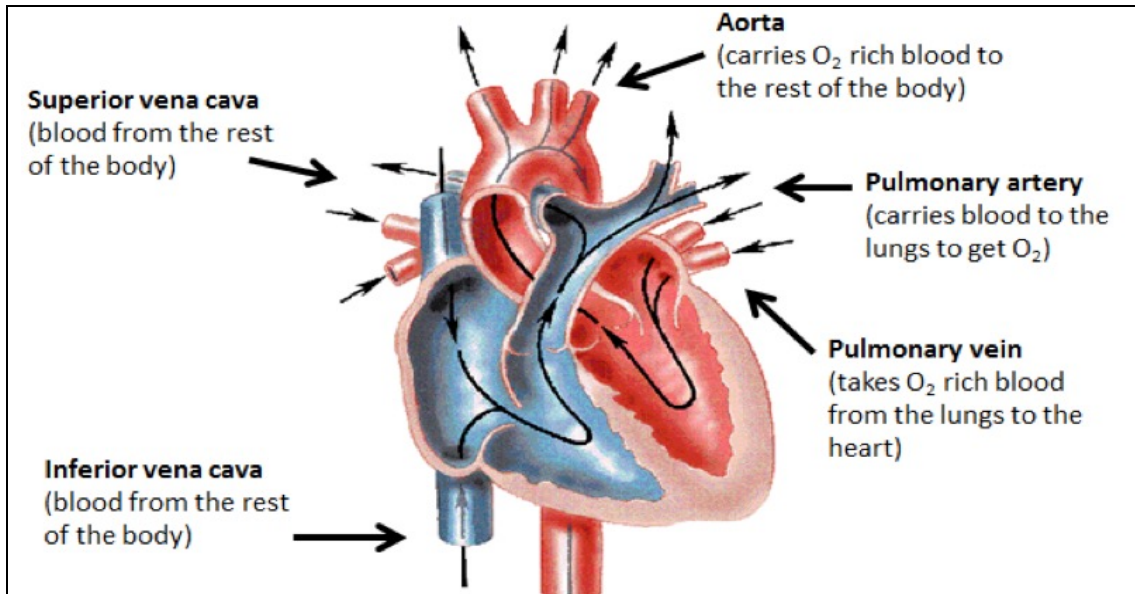
Human Heart

The human heart is about the size of a clenched fist. It contains four chambers: **two atria and two ventricles**. Oxygen-poor blood enters the right atrium through a major vein called the vena cava. The blood passes through the tricuspid valve into the right ventricle. Next, the blood is pumped through the pulmonary artery to the lungs for gaseous exchange. Oxygen-rich blood returns to the left atrium via the pulmonary vein. This oxygen-rich blood flows through the bicuspid (mitral) valve into the left ventricle, from where it is pumped through a major artery, the aorta to remaining parts of the body. Two valves called **semilunar valves** are found in the pulmonary artery and aorta. The ventricles contract about 70 times per minute, which represents a person's pulse rate. **Blood pressure**, in contrast, is the pressure exerted against the walls of the arteries. Blood pressure is measured by noting the height to which a column of mercury can be pushed by the blood pressing against the arterial walls. A normal blood pressure is a height of 120 millimeters of mercury during heart contraction (systole) and a height of 80 millimeters of mercury during heart relaxation (diastole). Normal blood pressure is usually expressed as "120 over 80."

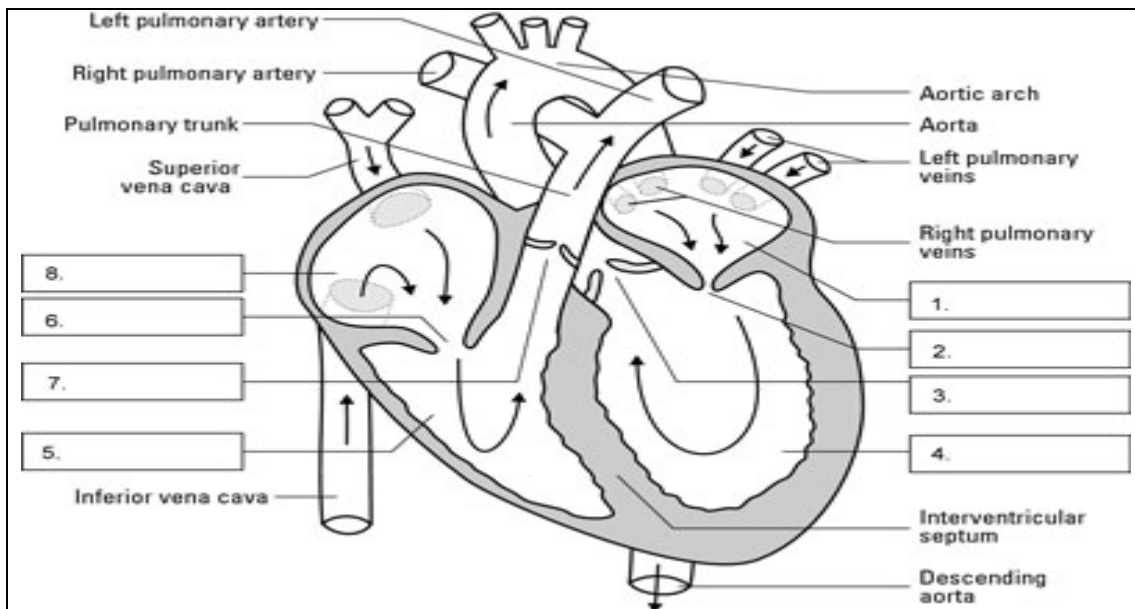


Coronary arteries supply the heart muscles with blood. The heart is controlled by nerves that originate on the right side in the upper region of the atrium at the sino-atrial node. This node is called the **pacemaker**. It generates nerve impulses that spread to the **atrio-ventricular node**, where the impulses are amplified and spread to other regions of the heart by nerves called Purkinje fibers.

Cognitive processing



Cognitive stimulation



Comprehensive evaluation

Draw well labeled diagram of human heart.
 Oxygenated blood is carried to heart by.....
 Blood from heart to lungs is transported through.....artery.
 Right ventricle receives oxygenated blood. T/F
 Average blood pressure of human body is 120/80 mm of Hg. T/F

Lesson Unit 4: Endocrine system

10th science

Connect to learners

Teacher from his data of students is fully aware of students' health and physiological status. The students with poor vision should be asked to sit on front seats.

Create learning Environment

Children.....So are you ready to learn today?
Do you remember what we discussed yesterday?
Ok tell mewhat you know about hormones and enzymes? How do they act?

Classify the objectives

Do you know about endocrine system in human body? How does it affect our body?
Yes...many functions of human body are controlled by hormones that travel in human blood. Endocrine system plays major role in control and coordination in body. Today, we will know about different glands and the hormones that they produce in detail.

Communicate the information

The **endocrine system** regulates vital processes in our body including growth, metabolism and sexual development. This system is comprised of several major endocrine glands. These glands secrete hormones into the blood. Once in the blood, the hormones travel through the cardiovascular system until they reach their target cells. Only cells with specific receptors for a certain hormone will be influenced by that hormone.

Hormones control various cellular activities including growth, development, reproduction, energy use and storage and water and electrolyte balance. Both the endocrine system and the nervous system are responsible for maintaining homeostasis in the body. These systems help to maintain a constant internal environment in response to environmental changes.

The **major glands** of the endocrine system are the pineal gland, pituitary gland, thyroid and parathyroid glands, adrenal glands, pancreas, thymus, ovaries, and testes. There are also other organs in the body that have secondary endocrine functions. These organs include the heart, liver and kidneys. The pituitary gland is a small endocrine organ located in the middle of the base of the brain. It controls a multitude of important functions in the body.

The **pituitary gland** is termed the "**Master Gland**" because it directs other organs and endocrine glands to suppress or induce hormone production.

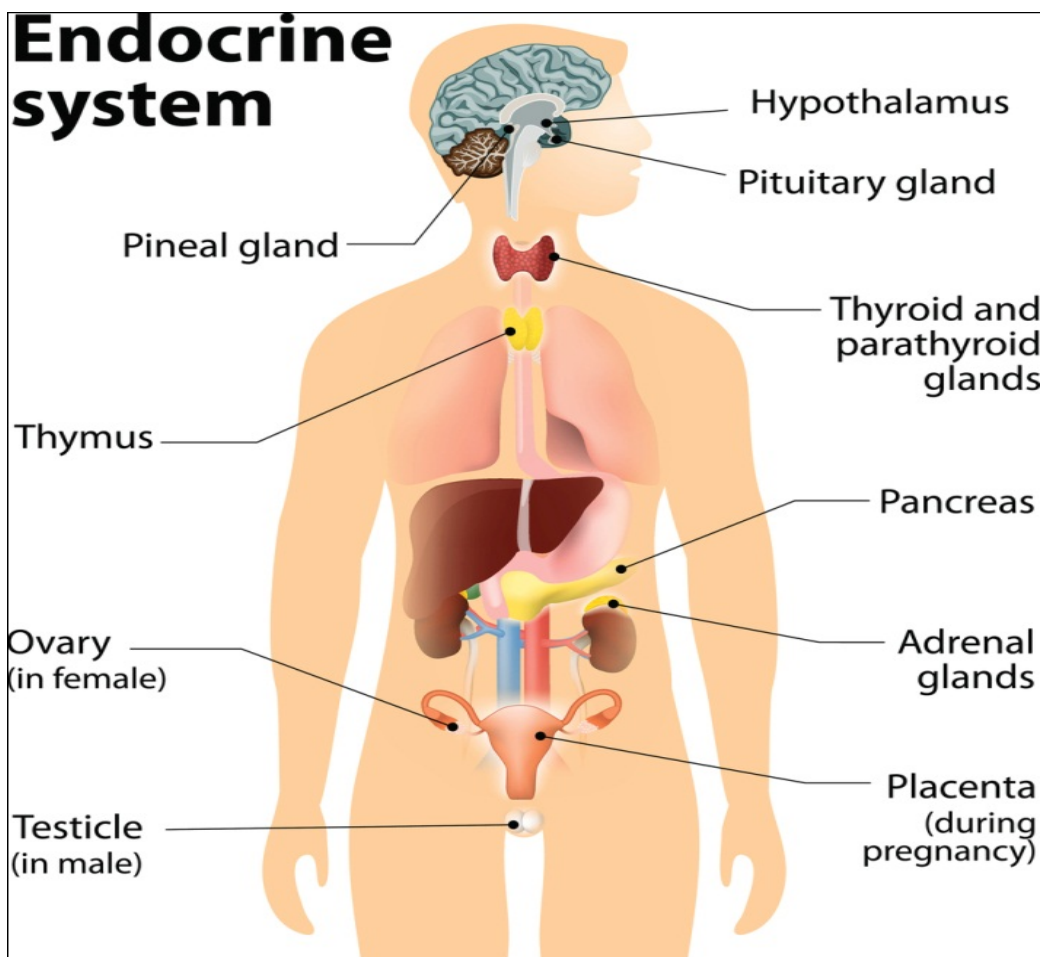
The **thyroid** is a dual lobed gland located in the neck region. It secretes hormones that control metabolism, growth, heart rate, body temperature, and regulate calcium levels. Hormones secreted by the thyroid gland include thyroxin, triiodothyronine, and calcitonin.

There are **two adrenal glands** in the body. One located atop each kidney. The adrenal gland produces hormones in both the inner medulla region and the outer cortex region

of the gland. Hormones produced within the adrenal cortex region are all steroid hormones.

The **pancreas** is a soft organ located near the stomach and small intestines. It is both an exocrine gland and an endocrine gland. The exocrine portion of the pancreas secretes digestive enzymes that are carried by a duct to the small intestines. The endocrine segment of the pancreas consists of small clusters of cells called **islets of Langerhans**. These cells produce the hormones glucagon and insulin. Glucagon raises blood sugar level while insulin lowers blood sugar levels and stimulates the metabolism of glucose, protein and fat. Disorders of the pancreas include diabetes and pancreatitis.

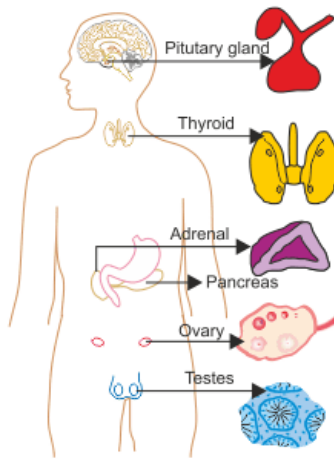
Endocrine system hormones are regulated in several ways. They can be regulated by other hormones, by glands and organs, by peripheral nervous system neurons, and by negative feedback mechanisms. In negative feedback, an initial stimulus provokes a response that works to reduce the stimulus. Once the response eliminates the initial stimulus, the pathway is halted. **Negative feedback** is demonstrated in the regulation of blood calcium. The parathyroid gland secretes parathyroid hormone in response to low blood calcium levels. As parathyroid hormone increases blood calcium levels, calcium levels eventually return to normal. Once this happens, the parathyroid gland detects the change and stops secreting parathyroid hormone.



Cognitive processing

The Endocrine System in Humans

Endocrine glands are ductless glands that **secrete hormones** (chemical messengers) which carry **messages to particular organ or tissue** through the blood stream. These glands control **growth, development, metabolism and reproduction**. Endocrine glands secrete hormones in **response to external and internal stimuli**.



Glands	Hormones	Functions
Pituitary	Growth hormone	<ul style="list-style-type: none"> Regulates growth Controls the functioning of endocrine glands
Thyroid	Thyroxine	<ul style="list-style-type: none"> Controls the metabolism rate It also brings about balanced growth
Parathyroid	Parathormone	Controls calcium balance of the body
Adrenal	Adrenaline	Prepares body for emergency
Pancreas	Insulin	Controls glucose level of the blood
Testes	Testosterone	Controls growth and development of male reproductive system
Ovaries	Oestrogen, progesterone	Controls growth and development of female reproductive system

Cognitive stimulation

Make a chart of different endocrine glands stating the hormones secreted by these glands and their function in the human body.

Comprehensive evaluation

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

7. _____

8. _____

GLANDS where hormones are produced/secreted

Pituitary gland

Thyroid Gland

Adrenal gland

Pancreas

Ovaries

Testes

HORMONES:

Anti diuretic, FSH, AH

Thyroxine

Insulin

Adrenaline

Oestrogen and progesterone

Testosterone

Label the diagram above and write down the names of hormones secreted by these glands.

Lesson Unit 5: Exchange of gases

10th science

Connect to learners

Teacher from his data of students is fully aware of students' health and physiological status. The students with poor vision and attention problem should be asked to sit on front seats.

Create learning Environment

Children.....So you have learnt about blood circulation.
Do you remember what we discussed yesterday?
Ok tell me what you know about blood circulation? How we get oxygen? How carbon dioxide moves out of our body?

Classify the objectives

Do you know the importance of blood circulation in our body?
From where we get oxygen?
How oxygen travels in human body?
Today we are going to learn about exchange of gases in humans in detail and know about the role of human heart and lungs in circulatory system.

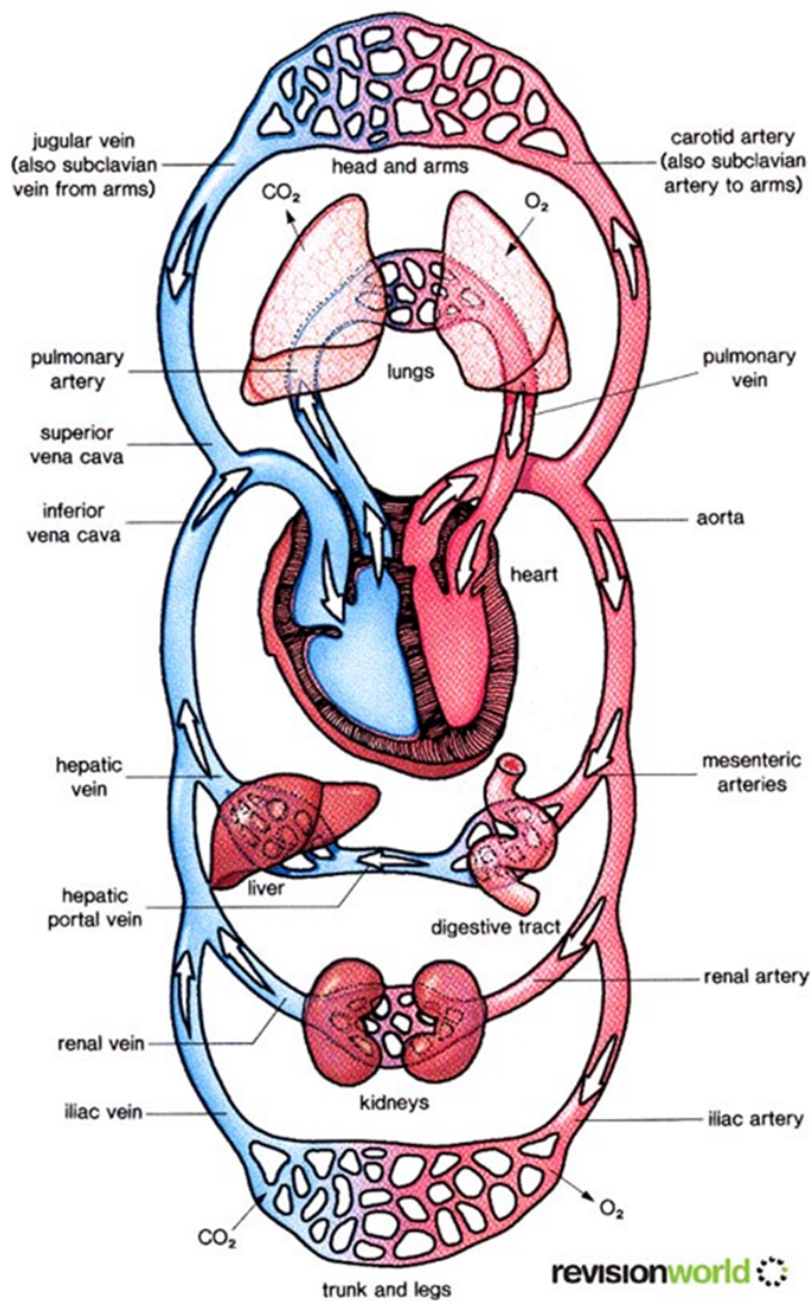
Communicate the information

The circulatory system consists of three independent systems that work together. The heart (cardiovascular), lungs (pulmonary) and arteries, veins, coronary and portal vessels (systemic). The system is responsible for the flow of blood, nutrients, oxygen and other gases as well as hormones to and from cells. The circulatory system is important because it transports blood and other materials throughout the body. Without the circulatory system, the body does not receive oxygen and the heart and lungs fail to work.

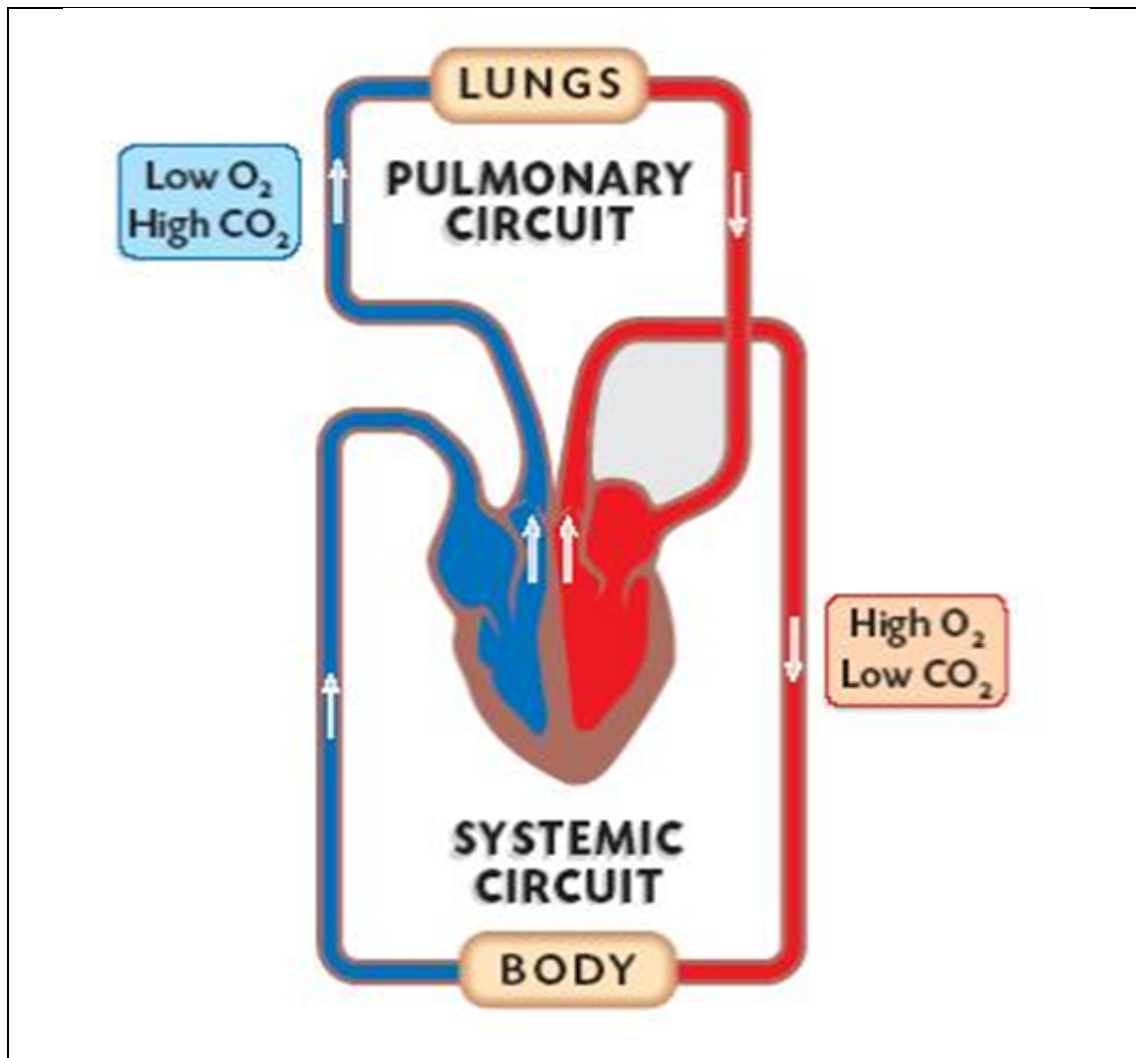
The systemic circulation is a major portion of the circulatory system. The network of veins, arteries and blood vessels transport oxygenated blood from the heart, delivers oxygen and nutrients to the body's cells and then returns deoxygenated blood back to the heart. The pulmonary circulation is the path of circulation between the heart and the lungs. Blood is pumped to the various places of the body. Oxygen depleted blood returns from the body to the right atrium of the heart by two large veins called venacavae.

Electrical impulses produced by cardiac conduction cause the heart to contract. As a result, blood in the right atrium is pumped to the right ventricle. On the next heart beat, the contraction of the right ventricle sends the oxygen-depleted blood to the lungs via the pulmonary artery. This artery branches into left and right pulmonary arteries. In the lungs, carbon dioxide in the blood is exchanged for oxygen at lung alveoli. Alveoli are small air sacs that are coated with a moist film that dissolves air. As a result, gases can diffuse across the thin endothelium of the alveoli sacs. The

oxygen-rich blood is transported back to the heart by the pulmonary veins. The pulmonary circuit is completed when pulmonary veins return blood to the left atrium of the heart. When the heart contracts again, this blood is pumped from the left atrium to the left ventricle and later to systemic circulation. Oxygenated blood travels from the lungs through the pulmonary veins and into the left side of the heart, which pumps the blood to the rest of the body. Oxygen-deficient, carbon dioxide-rich blood returns to the right side of the heart through two large veins, the superior vena cava and the inferior vena cava. Then the blood is pumped through the pulmonary artery to the lungs, where it picks up oxygen and releases carbon dioxide.



Cognitive processing



Cognitive stimulation

Students would be asked to explain the process of circulation.
Prepare an assignment on circulatory system.
Discuss the importance of different subsystems like respiration and blood transportation in humans.

Comprehensive evaluation

Draw the diagram showing exchange of gases among different parts of human body.
Define systemic and pulmonary circuits.
How oxygenated blood travels in human body?
What is the role of pulmonary circulation in human body?

Lesson Unit 6: Respiration and Breathing

10th science

Connect to learners

Teacher from his data of students is fully aware of students' health and physiological status. The students with poor vision and less attention should be asked to sit on front seats.

Create learning Environment

Hello Children...!!

So are you ready to learn today?

How had your previous class gone?

Do you remember what we discussed yesterday?

Ok tell me what you had in breakfast today?

Do you know what happens to the food we eat?

Yes, it gets digested in body.

What happens to the digested food?

It is used to give us energy for doing and maintaining our bodily activities.

Classify the objectives

All living organisms require energy to carry out life processes. This energy comes from food. However, processes carried out in cells cannot use the energy locked in stored food, fats, etc., directly. Cellular processes get usable energy from a process called respiration. Respiration commonly involves the use of oxygen to break down carbohydrates and other organic molecules giving usable energy, carbon dioxide and water in the process.

In today's lesson we will discuss about

- Difference between breathing and respiration.
- Different types of respiration.

Communicate the information

BREATHING	RESPIRATION
It is a physical process involving exchange of oxygen and carbon dioxide.	It is a biochemical process involving oxidation of glucose to carbon dioxide and water.
Energy is not released.	Energy is released.
It takes place outside the cells.	It takes place within the cells.
Enzymes are not involved.	Respiratory enzymes are involved.

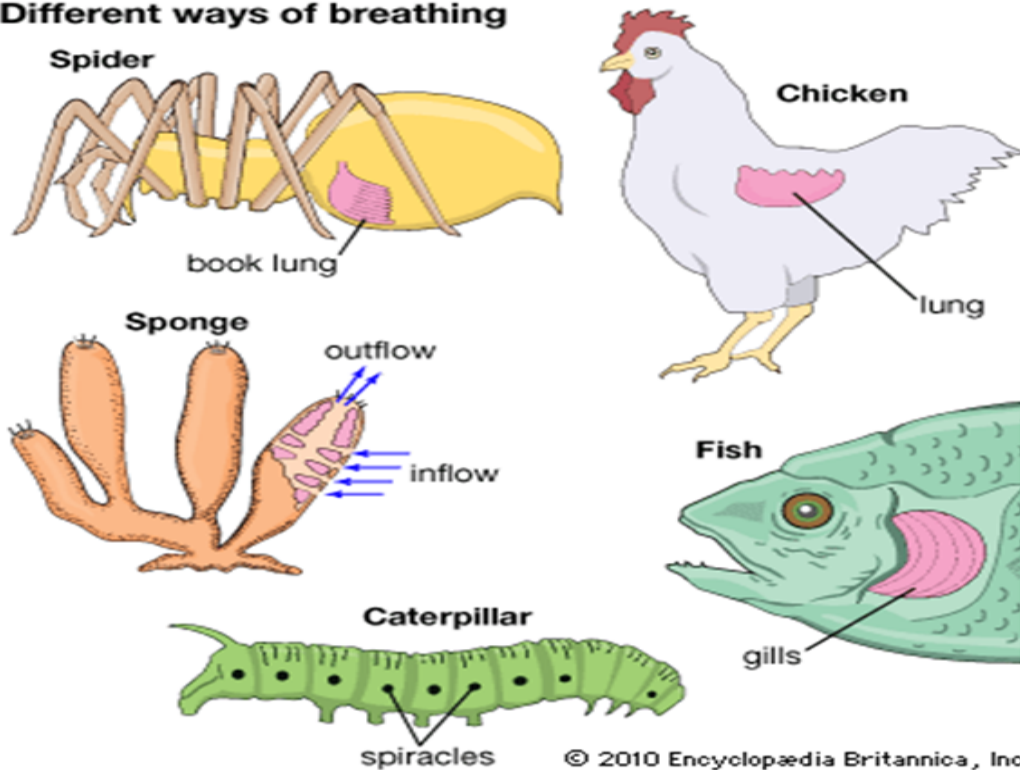
The breathing is a physical process of exhalation and inhalation of gases in human body. The act of breathing has two stages – inhalation and exhalation.

- Inhalation – intake of air into the lungs through expansion of chest volume.
- Exhalation – expulsion of air from the lungs through contraction of chest volume.

Inhalation and exhalation involves the **diaphragm and rib muscles**, which are constantly contracting and relaxing (approximately 16 times per minute), thus causing the chest cavity to increase and decrease.

- **During inhalation – the muscles contract.**
- **During exhalation – the muscles relax.**

Different ways of breathing



Respiration is the process by which cells convert food in energy. The food from which energy is released is mainly glucose. There are 2 **types of respiration**: aerobic and anaerobic respiration. **Aerobic respiration** uses oxygen to get the energy from food. **Anaerobic respiration** does not require oxygen but releases much less energy. Types of respiration present in all living organisms are:

1. **Anaerobic Respiration**
2. **Aerobic Respiration**

Cognitive processing

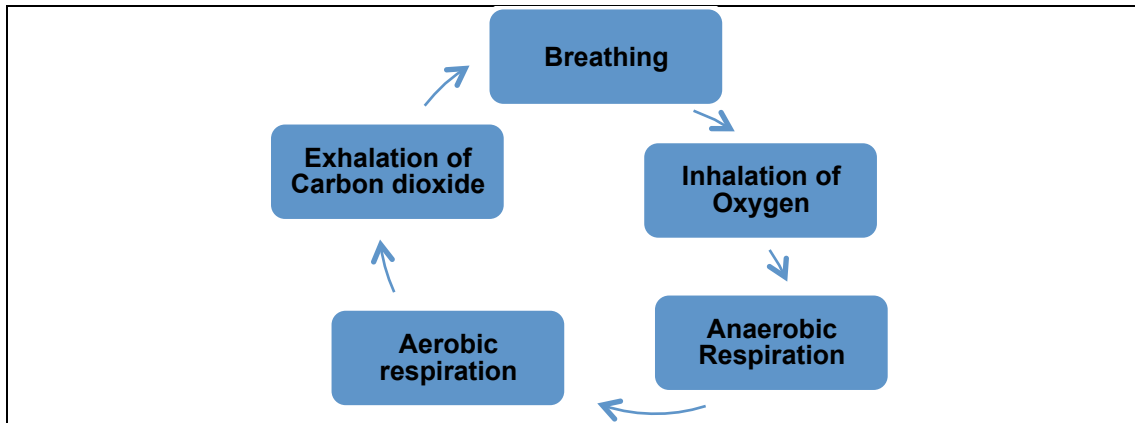
Now you repeat the information...one of the students would get up and explain the types of respiration and rest of students would participate in discussion.

How do different animals breathe in different ways?

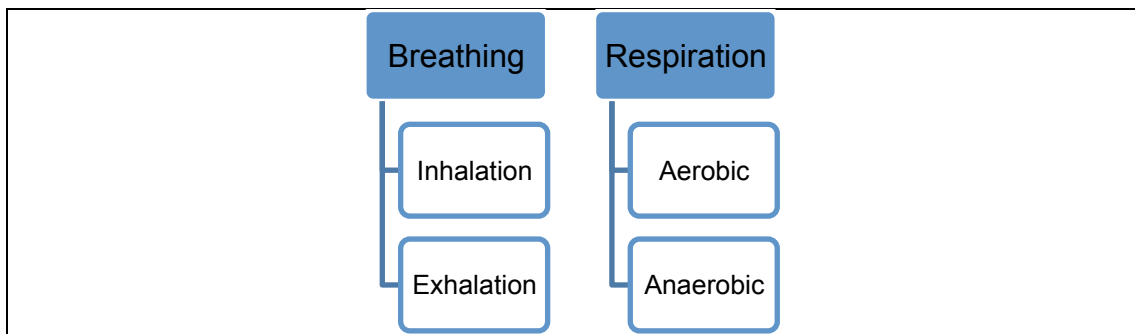
Ok..children, till now we have discussed respiration and its types and how its is different from breathing.

Students would be made to watch this video (7.12 minutes)

<https://www.youtube.com/watch?v=ydX8Lw4q2Mk>



Cognitive stimulation



Now you draw the concept map on your notebooks and prepare a chart showing different animals who breathe through different organs.

Comprehensive evaluation

1. Explain the process of respiration and how it is different from breathing?
2. Differentiate between:
 1. Aerobic and anaerobic respiration.
 2. Breathing and respiration
 3. Inhalation and exhalation

Lesson Unit 7: Human Respiratory System

10th science

Connect to learners

Teacher from his data of student is fully aware of students' health and physiological status. The students with poor vision should be asked to sit on front seats.

Create learning Environment

Hello Children...!!

So are you ready to learn today?

How had your previous class gone?

Do you remember what we discussed yesterday?

Ok tell me what will happen to you if I close your nose with a clip?

Where the air that we breathe in goes into our body?

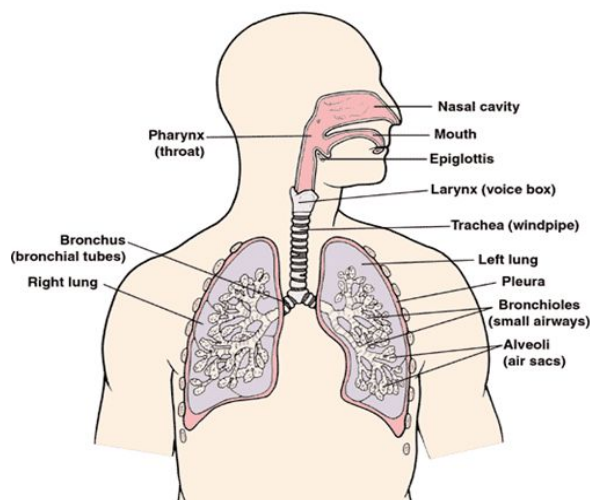
Classify the objectives

Respiration is the process of using oxygen to generate energy in a chemical process. In today's lesson we will discuss the human respiratory system and how breathing occurs in humans.

Communicate the information

Human Respiratory System

Respiratory System



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Our own pathway, in order:

Mouth/Nasal Cavity

Pharynx

Larynx

Trachea

Bronchi

Bronchioles

Alveoli (tiny air sacs)

Human respiratory System: Every living organism requires energy which is extracted through nutritional food. The respiratory system is the system in the human body that enables us to breathe. The act of breathing includes the following steps:-

- ❖ Inhaling and exhaling air in the body
- ❖ The absorption of oxygen from the air in order to produce energy
- ❖ The discharge of carbon dioxide, which is the byproduct of the process.

The respiratory system is divided into two parts:-

1. **Upper respiratory tract:** This includes the nose, mouth, and the beginning of the trachea (the section that takes air in and lets it out).
2. **Lower respiratory tract:** This includes the trachea, the bronchi, bronchioles and the lungs (the act of breathing takes place in this part of the system). The organs of the lower respiratory tract are located in the chest cavity. They are delineated and protected by the ribcage, the chest bone (sternum), and the muscles between the ribs and the diaphragm (that constitute a muscular partition between the chest and the abdominal cavity). **The trachea** – the tube connecting the throat to the bronchi. **The bronchi** – the trachea divides into two bronchi (tubes). One leads to the left lung, the other to the right lung. Inside the lungs each of the bronchi divides into smaller bronchi. **The bronchioles** - the bronchi branches off into smaller tubes called bronchioles which end in the pulmonary alveolus. **Pulmonary alveoli** – tiny sacs (air sacs) delineated by a single-layer membrane with blood capillaries at the other end.

The exchange of gases takes place through the membrane of the pulmonary alveolus, which always contains air: oxygen (O₂) is absorbed from the air into the blood capillaries and the action of the heart circulates it through all the tissues in the body. At the same time, carbon dioxide (CO₂) is transmitted from the blood capillaries into the alveoli and then expelled through the bronchi and the upper respiratory tract. The inner surface of the lungs, where the exchange of gases takes place, is very large due to the structure of the air sacs of the alveoli. **The lungs** – a pair of organs found in all vertebrates. The structure of the lungs includes the bronchial tree – air tubes branching off from the bronchi into smaller and smaller air tubes, each one ending in a pulmonary alveolus.

Measurements of lung function: **Air volume** (in liters) – lung capacity. **Maximum lung volume** is known as **TLC** (total lung capacity). The maximum lung volume of a healthy adult is up to 5-6 liters. In children, the maximum lung volume is up to 2-3 liters, depending on age. In infants it is up to 600-1000 milliliters.

- **Residual volume** (RV) is the volume of air remaining in the lungs after strenuous exhalation when the lungs feel completely empty. Residual volume prevents the bronchioles and the alveoli from sticking together. Residual volume is approximately 1.5 liters (adults).
- The differential between total lung capacity and residual volume is the **maximal volume utilized by the lungs in order to breath. It is known as vital capacity** (VC). In an adult, the VC is between 3.5 and 4.5 liters.
- **Tidal Volume** is the volume of air displaced between normal inspiration and expiration. In a healthy adult the tidal volume is approximately 500 milliliters.

Cognitive processing

Now you repeat the information...one of the students would get up and explain structure of respiratory system.

Students would draw the structure on their notebooks the different terms and their meanings and discuss with each other.

Children would be asked to watch this video. (time 1.43 minutes)

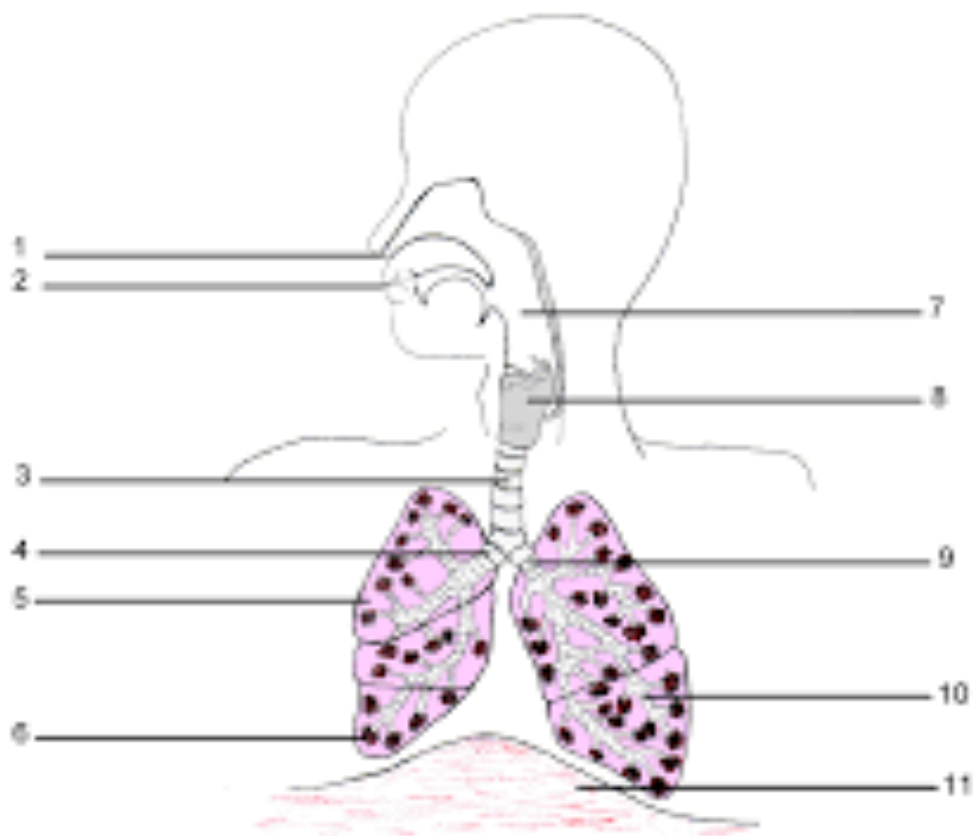
<https://www.youtube.com/watch?v=zRv5tNCMpyY>

Cognitive stimulation

Make a colored chart on human respiratory system. Label it and explain it in writing details of its functions.

Write about lung capacity tidal volume and residual volume.

Comprehensive evaluation



The Human Respiratory System

Students would be asked to explain the process of breathing and what happens when we breathe oxygen and exhale carbon dioxide.

Write a note on the lung capacity.

Lesson Unit 8: Cellular Respiration

10th science

Connect to learners

Teacher from his data of students is fully aware of students' health and physiological status. The students with poor vision should be asked to sit on front seats.

Create learning Environment

Children...

Are you ready to learn today?

Do you remember what we discussed yesterday?

Ok tell mewhat you know about food and energy?

Do you know the importance of respiration in our life?

Why we breathe?

Yes...surely it is important for us to survive and support our life functions.

In fact, we get energy from food through the process of respiration.

In today's lesson, we will know about:

- What is cellular respiration?
- How we get energy from the food we eat?

Classify the objectives

Respiration commonly involves the use of oxygen to break down carbohydrates and other organic molecules, giving usable energy, carbon dioxide and water in the process. In today's lesson, we will discuss about the process of cellular respiration i.e. how energy in the form of ATPs is generated from glucose in the cellular reactions.

Communicate the information

Respiration is the process by which cells convert food in energy. The food from which energy is released is mainly glucose. There are **2 types of respiration**: aerobic and anaerobic respiration. Aerobic respiration uses oxygen to get the energy from food. Anaerobic respiration does not require oxygen but releases much less energy.

Types of respiration present in all living organisms are:

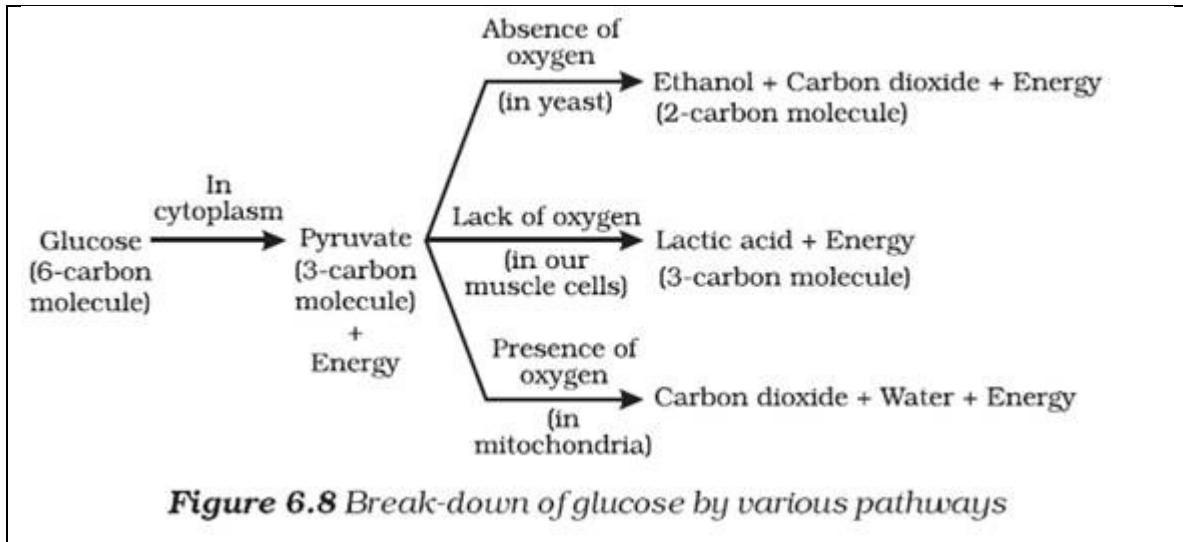
1. Anaerobic Respiration
2. Aerobic Respiration

Every living organism requires energy which is extracted through nutritional food they take. Cellular respiration is a set of metabolic reactions and processes that take place in the cells of organisms to convert biochemical energy from nutrients into adenosine triphosphate (ATP) and release waste products.

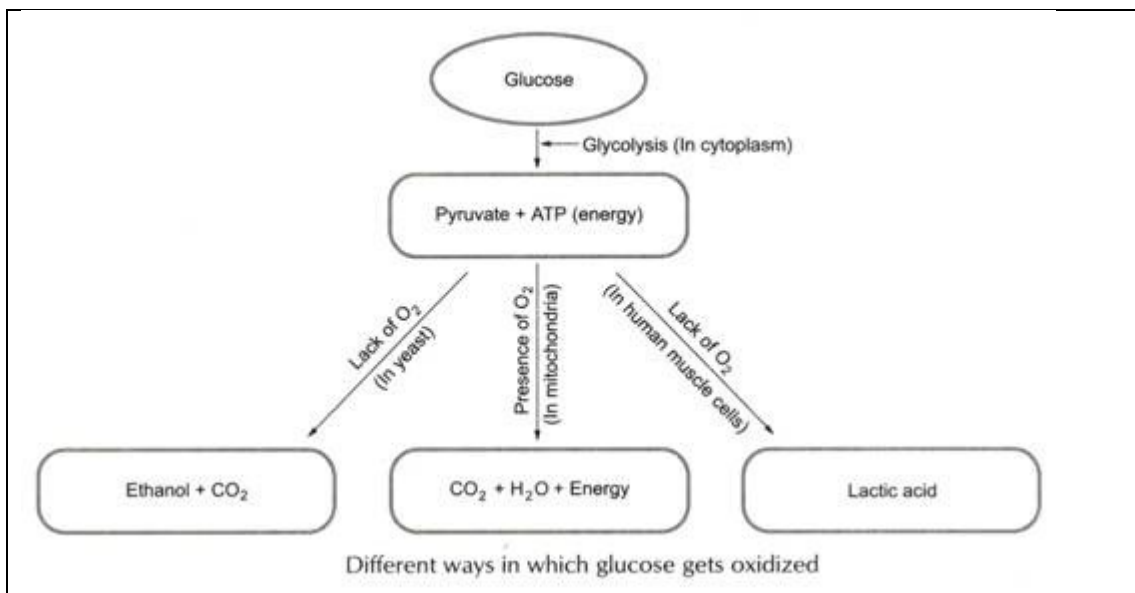
All organisms breathe—a process in which they take in oxygen and give off carbon dioxide. This is called external respiration. Internal respiration, or cellular respiration, takes place inside every living cell. In this process, carbohydrates and other organic molecules are broken down in successive steps to produce energy, which is used to make a compound called adenosine triphosphate (ATP). Cellular processes get energy from ATP. ATP is often called the 'energy currency' of the cell. The amount of ATP in a cell

indicates how energy-rich it is. Where does this energy come from? During photosynthesis, carbon dioxide and water combine with the help of the energy from the sun to form carbohydrates. Energy gets stored in the bonds of the carbohydrates.

- 1. Anaerobic respiration:** Partial oxidation of food in the absence of oxygen, resulting in the release of some amount of energy, is called anaerobic respiration. Anaerobic means without oxygen or in the absence of oxygen, while aerobic means with oxygen or in the presence of oxygen. Glucose has six carbon atoms joined to each other by covalent bonds. Hydrogen and oxygen atoms are also attached to these carbon atoms. In anaerobic respiration of glucose, some hydrogen atoms are removed from it, resulting in its oxidation. (The addition of oxygen or the removal of hydrogen is oxidation.) At the end of a series of reactions, glucose gets converted into two molecules of pyruvate, which contains three carbon atoms. These reactions also produce two molecules of ATP. Glycolysis means 'splitting of sugar'. It takes place in all organisms, in the cytoplasm of the cell. It is the first stage of respiration—both aerobic and anaerobic. After glycolysis, its product (pyruvate) gets converted into different compounds depending on whether further reactions take place in the presence or absence of oxygen. Glycolysis is the last energy-producing stage in case oxygen is absent or in low supply, and in cells that lack mitochondria. After glycolysis, further anaerobic reactions produce different products like lactic acid or ethanol (ethyl alcohol) in different situations. This step completes the anaerobic respiration of glucose. Anaerobic respiration resulting in the formation of these products is also called fermentation. In aerobic respiration, a different path is followed after glycolysis. In the presence of oxygen, in cells that have mitochondria, pyruvate is oxidized further in a number of steps to produce more energy, carbon dioxide and water.
- 2. Aerobic respiration:** The complete oxidation of food yielding carbon dioxide, water and energy in the presence of oxygen is called aerobic respiration. Aerobic respiration takes place inside the mitochondria. After glycolysis, pyruvate enters the mitochondria and is oxidized in a series of reactions. The products of these reactions include ATP, carbon dioxide and water. The number of molecules of ATP formed in aerobic respiration is 38. Hence the energy made available is much greater than in the case of anaerobic respiration. Inside the mitochondria, when an inorganic phosphate group (PO_4^{3-} , represented here as P_i) gets attached to a compound called ADP (adenosine di-phosphate), a molecule of ATP (adenosine triphosphate) is formed. $\text{ADP} + \text{P}_i \rightarrow \text{ATP}$. The bond holding the last (terminal) phosphate group is easily broken when ATP reacts with water. In the process, energy is produced. This energy is used to drive cellular processes that are endothermic (i.e., processes that absorb energy). Processes like protein synthesis, contraction of muscles, etc., get energy from ATP.



Cognitive processing



Cognitive stimulation

Now you draw the concept map on your notebooks.
 Write aerobic and anaerobic respiration and how are they different from each other?
 Make an assignment on different types of cellular respiration with examples paste the pictures, if available.

Comprehensive Evaluation

Write difference between the aerobic and anaerobic respiration.
 _____ molecules of ATP are produced in aerobic respiration.
 Draw the conceptual chart about cellular respiration.
 Explain the process of Glycolysis.
 Which is the major site of anaerobic respiration in cells?
 Glucose is converted into.....which is further converted into.....molecules for generation of energy.

Lesson Unit 9: Types of Nutrition

10th science

Connect to the learner

Teacher from his data of students is fully aware of students' health and physiological status. The students with poor vision should be asked to sit on front seats.

Create learning Environment

Hello children, I hope you are enjoying your learning.

Do you remember what we discussed yesterday?

Ok tell mewhat you had in breakfast today?

Do you know the importance of food in our life?

Why we take food? Yes...surely.

Classify the Objectives

Every living organism requires energy which is extracted through nutritional food they take. Food gives us energy to work and support out life functions. Infact, we get nutrition from the food we eat. In today's lesson we will know about-

- Different types of nutrition in living beings
- Role of nutrition in body

Communicate the Information

Nutrition is of two sub-types:-

Now, what is autotrophic nutrition?

Autotrophic nutrition means a process in which simple inorganic substances are taken in and used to synthesize organic molecules. Energy is needed to achieve this. In photo-**autotrophic nutrition** light is the energy source. In most instances the light source is solar energy, the process being photosynthesis. Soil water and carbon dioxide In the presence of sunlight and chlorophyll through a photochemical reaction produce glucose and oxygen and water. This process is called **photosynthesis**.

Do you know different kinds of nutritional habits of other animals?

Do plants also require nutrition?

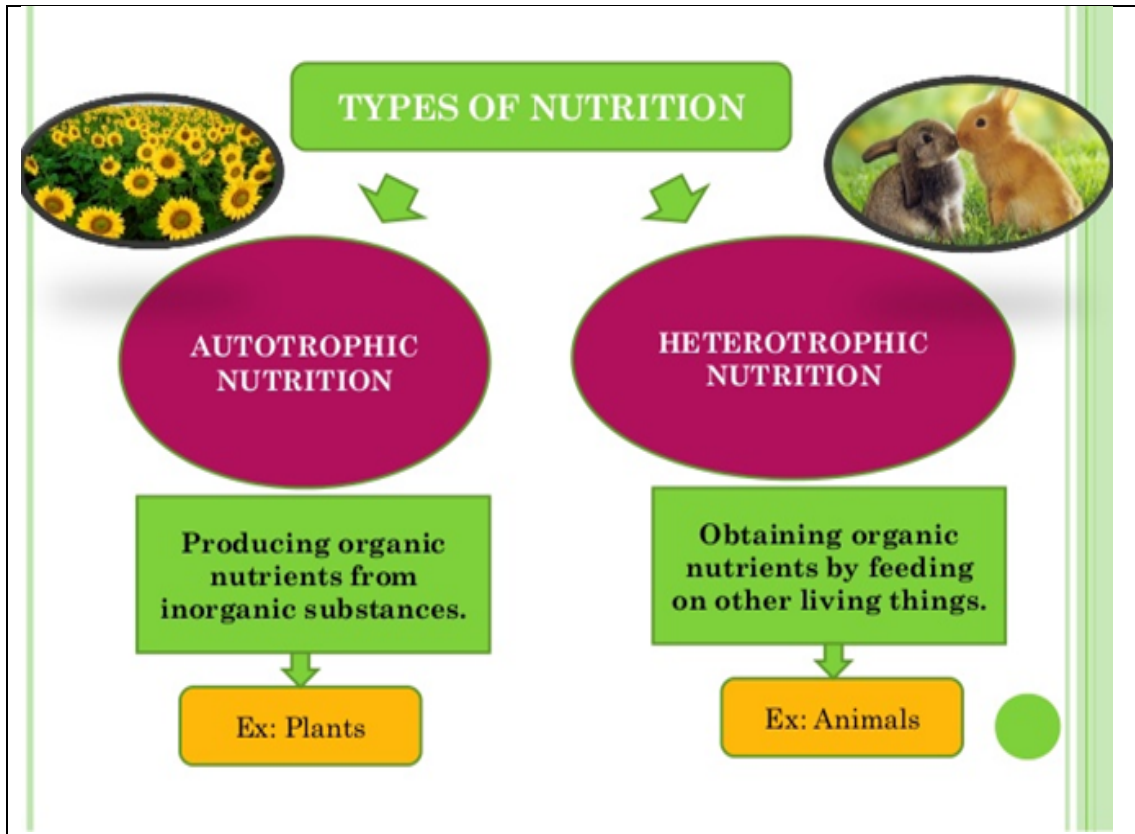
How they get their nutrition.

Ok....

Heterotrophic nutrition is nutrition obtained by digesting organic compounds. Animals, fungi and protists are unable to synthesize organic compounds to use as food. They are known as **heterotrophs**. Heterotrophic organisms have to acquire and take in all the organic substances they need to survive.

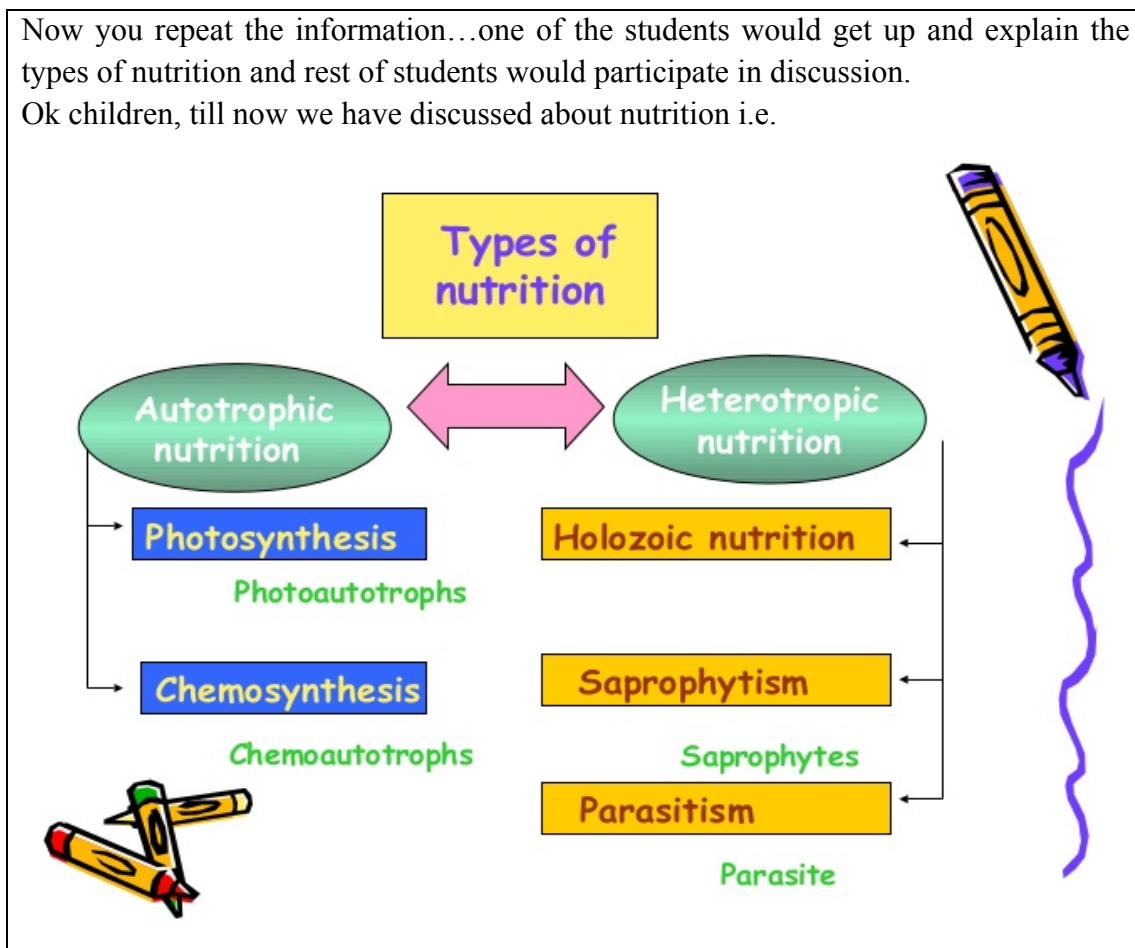
Heterotrophic nutrition is further of three types:-

1. **Saprophytic**
2. **Parasitic**
3. **Holozoic**



Cognitive Processing

Now you repeat the information...one of the students would get up and explain the types of nutrition and rest of students would participate in discussion.
 Ok children, till now we have discussed about nutrition i.e.



Cognitive Stimulation

Now you draw the concept map on your notebooks.

Write autotrophs and heterotrophs how are they different from each other?

Make an assignment on different types of nutrition available with examples. Paste the pictures, if available.

Comprehensive evaluation

Nutrition in which new organic substances are formed from inorganic substances is called.....

Heterotrophic nutrition occurs in.....except.....

Algae has autotrophic nutrition T/F

Photosynthesis is the type of nutrition T/F

Define types of nutrition.

Draw flow chart on different types of nutrition with examples.

Children are asked to complete the question above.

Lesson Unit 10: Photosynthesis

10th Science

Connect to the learner

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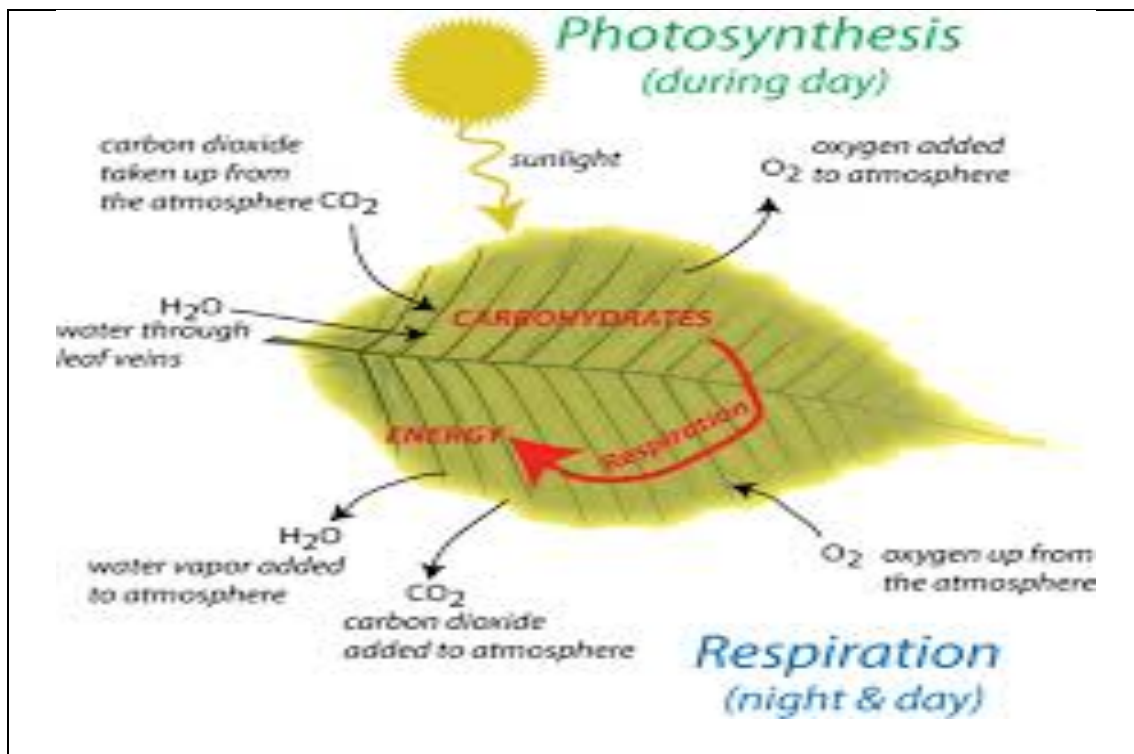
Create learning Environment

Children.....So are you ready to learn today?
Do you remember what we discussed yesterday?
Ok tell meDo you know how plants get their nutrition?

Classify the Objectives

Do you know the importance of food in our life?
From where we get our food?
Yes...main source of our food are plants....plants gets their food from the process called photosynthesis...now today we are going to learn about photosynthesis in detail.
In today's lesson we will know about the process of photosynthesis, chemical changes that happen in photosynthesis.

Communicate the Information

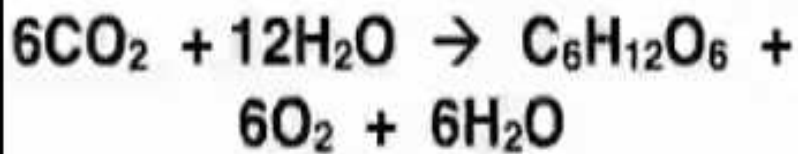


Cognitive Processing

Ok children, we have discussed about nutrition till now. How photosynthesis is related to nutrition?

One of the students would get up and explain the process and rest of students would participate in discussion.

Photosynthesis



Cognitive Stimulation

Draw the concept map of the process of photosynthesis in your notebooks.

Just think how it will affect us if photosynthesis does not occur in plants?

Which of the following are true regarding photosynthesis and cellular respiration?

- A. Both photosynthesis and cellular respiration occur in the chloroplasts of a cell.
- B. Photosynthesis and cellular respiration are performed by all plants and animals
- C. Photosynthesis and cellular respiration are near-opposite processes.
- D. Photosynthesis produces carbon dioxide, and cellular respiration uses carbon dioxide.

Comprehensive Evaluation

Does the process of photosynthesis can occur in night?

Make a chart of the process of photosynthesis.

Explain how photosynthesis is essential for us?

Can we grow plants in dark room? Explain your point of view.

Children are asked to complete the question above.

Lesson unit 11: Human Digestive System

10th Science

Connect to the learner

Teacher has data of students and is aware of students' health and physiological status along with any other health and psychological issues.

The students with poor vision should be asked to sit on front seats and who has poor attention may also be called to shift their seats.

Create learning Environment

Hello children...!! So are you ready?

How had your previous class gone? Do you remember what we discussed yesterday?

Ok tell me what you gained out of our lesson on nutrition?

Do you know whether the food we eat is nutritious or not?

How we get nutrition from the food we eat?

We take different types of food like cereals, fruits, vegetables, milk products, etc.

Every food has different nutrition value based on its constitution.

Classify the Objectives

In our lesson today we will study how food is digested to give us nutrition. Do you have any idea about this? Tell me.....Ok. We eat food and it gets digested in our stomach.

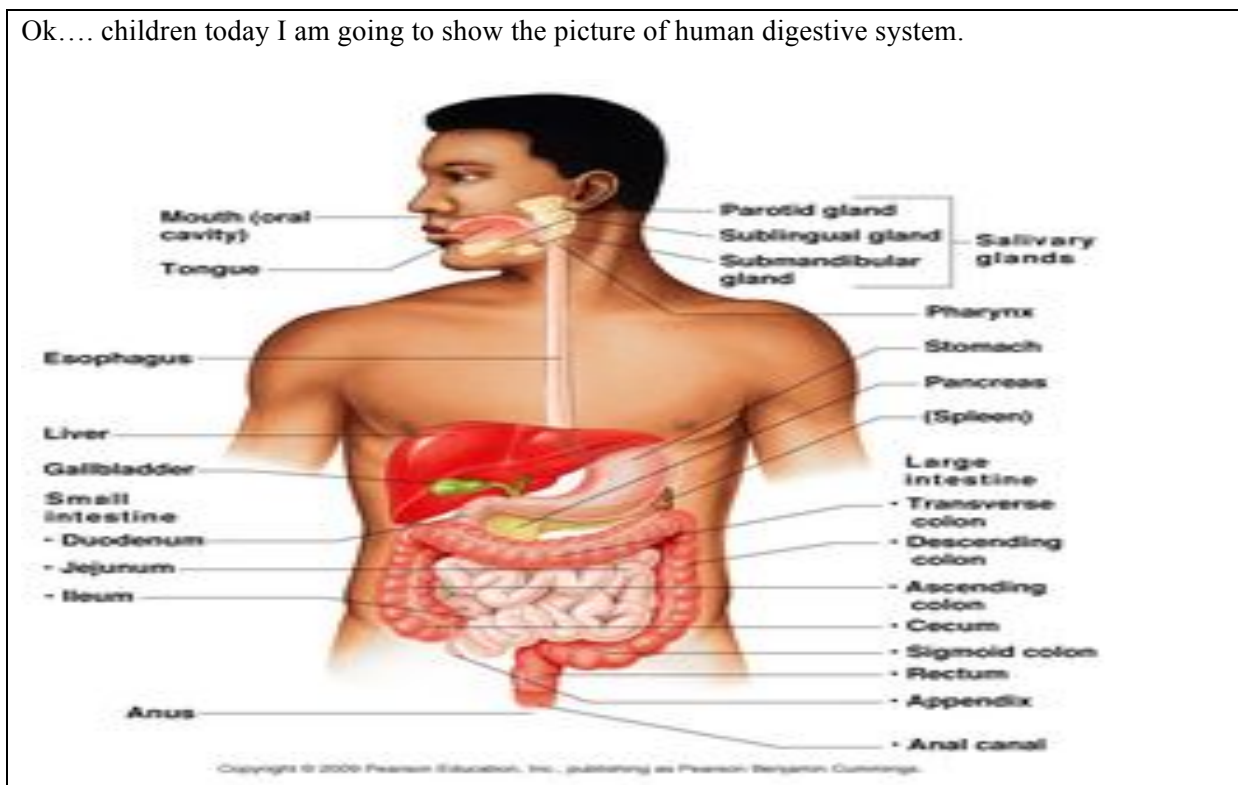
What is the role of digestion and what helps in digesting our food?

What are the different organs of digestive system?

What is the role of different enzymes in digestion?

Communicate the Information

Ok.... children today I am going to show the picture of human digestive system.



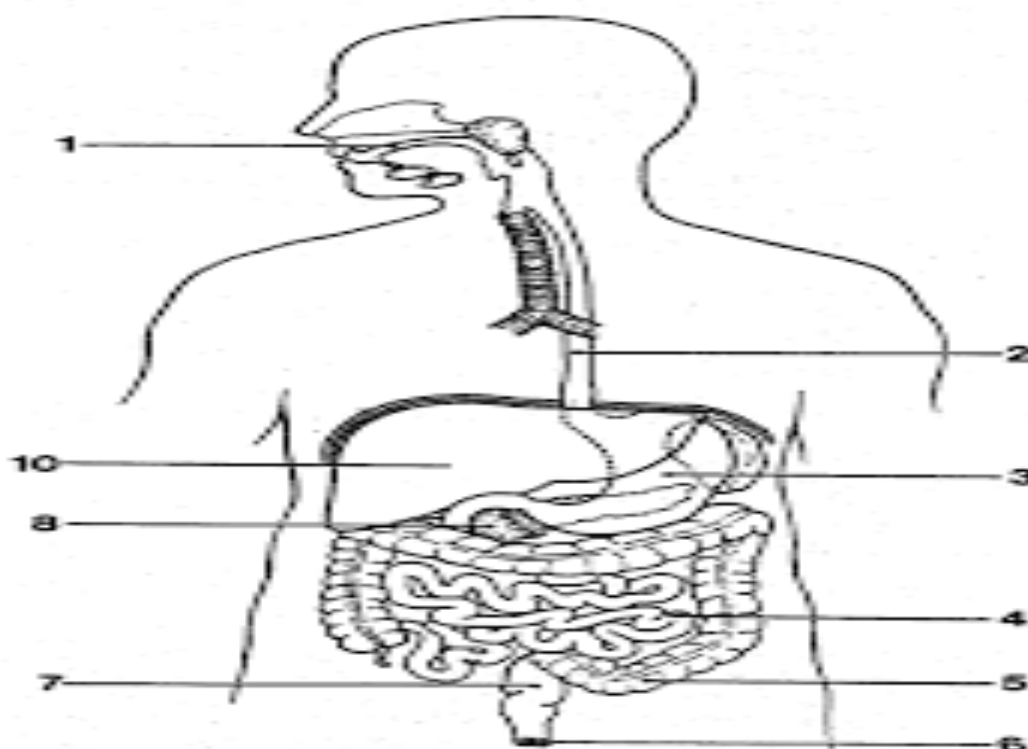
This is the picture of human digestive system. It includes buccal cavity, esophagus stomach, liver, gallbladder, pancreas, small intestine, large intestine, rectum and anus. The food we eat is chewed up in buccal cavity with the help of teeth and it get dissolved with saliva it contain enzyme salivary amylase. Then through esophagus by peristaltic movements food entered in stomach where churning of food occurs and it further get transferred after the act of HCl and other enzymes like pepsin and renin which dissolve complex food particles into small simple molecules. Stomach pushes the food to small intestine where liver enzymes produced by bile and other enzymes do assimilation of food into soluble food particles which are absorbed by blood through villi in small intestine. When food entered into large intestine major part of the food is already digested now rest of food which mainly includes roughage is ejected out of body in semisolid form through anus with the help of rectal muscles of rectum.

Cognitive Processing

Now you repeat the information. One of the students would get up and explain the process rest of students would participate in discussion.

Student will help in creating a concept map of digestion in human body on blackboard.

Ok children, till now we have discussed about nutrition i.e.



Cognitive Stimulation

Now you draw the labelled diagram of human digestive system.

Write down the names of different parts of human digestive system?

Make an assignment on different types of food and their importance in human health.

Comprehensive evaluation

Student would be asked to explain the process of digestion.

Name of different organs involved at different stages of digestion.

Children are asked to complete the question above and draw diagram or make model of human digestive system.

Lesson unit 12: Enzymes in Human digestive system

10th Science

Connect to the learner

Teacher has data of students and is aware of students' health and physiological status along with any other health and psychological issues.

The students with poor vision should be asked to sit on front seats and who have poor attention may also be called to shift their seats.

Create learning Environment

Hello children...!! So are you ready?

How much did you enjoy your previous class?

Ok. Do you remember what we discussed yesterday?

Now tell me what you gained out of yesterday's lesson?

Do you know how digestion occurs in our body?

Do you know the role of enzymes?

What are the functions of different digestive enzymes?

Classify the Objectives

Today we will know how different enzymes act on food we eat and help in digestion.

Communicate the Information

Digestive enzymes:-

Digestive enzymes such as amylase, lipase, pepsin, trypsin, etc. help in the breaking down of complex food particles into simple ones. These simple particles can be easily absorbed by the blood and thus transported to all the cells of the body.

Digestive enzymes are **enzymes** that break down polymeric macromolecules into their smaller building blocks, in order to facilitate their absorption by the body.

Any **enzyme** that breaks down protein into its building blocks, amino acids, is called a protease, which is a general term. Your **digestive** tract produces a number of these **enzymes**, but the three main proteases are pepsin, trypsin and chymotrypsin.

The protein digesting enzyme **pepsin** is activated by exposure to hydrochloric acid inside the stomach. Chief cells, also found within the gastric pits of the stomach, produce two digestive enzymes: **pepsinogen** and gastric lipase.

Pepsinogen is the precursor molecule of the very potent protein-digesting enzyme **pepsin**.

Major Digestive Enzymes			
Enzyme	Produced In	Site of Release	pH Level
Carbohydrate Digestion:			
Salivary amylase	Salivary Glands	Mouth	Neutral
Pancreatic amylase	Pancreas	Small Intestine	Basic
Maltase	Small intestine	Small intestine	Basic
Protein Digestion:			
Pepsin	Gastric glands	Stomach	Acidic
Trypsin	Pancreas	Small intestine	Basic
Peptidases	Small Intestine	Small intestine	Basic
Nucleic Acid Digestion:			
Nuclease	Pancreas	Small intestine	Basic
Nucleosidases	Pancreas	Small intestine	Basic
Fat Digestion:			
Lipase	Pancreas	Small intestine	Basic

Cognitive Processing

Now you repeat the information...one of the students would get up and explain the process rest of students would participate in discussion.
 Student will help in creating a concept map of digestion in human body on blackboard.
 Ok children, we have discussed till now about digestive enzymes that are important in the process of digestion.

Cognitive Stimulation

Now you draw the concept map on your notebooks.
 Write down the name of digestive enzymes, their site of action and their role in digestion?

Comprehensive evaluation:

Student would be asked to explain the process of digestion with the action of enzymes.
 Pepsin act on.....
 Renin is produced in.....
 Trypsin can be converted to.....
 Enzyme present in saliva is
 Liver secretes.....enzyme for digestion of.....
 Names of different enzymes involved in different stages of digestion.
 What is the role of these enzymes in digestion?

Lesson Unit 13: Excretion in plants

10th science

Connect to learners

Teacher from his data of students is fully aware of students' health and physiological status. The students with poor vision and less attention should be asked to sit on front seats.

Create learning Environment

Children.....So are you ready to learn today?
Do you remember what we discussed yesterday?
Till now, you have understood the importance of excretion and its mechanisms in human bodydo you think plants have some excretory mechanisms?

Classify the objectives

In today's lesson, we will discuss different mechanisms of plant excretion in detail.

Communicate the information

Living organisms carry out their life based on certain life processes. These life processes help to regulate their daily activities. Excretion is one among them. The metabolism takes place in the cells of living organisms resulting in both useful and toxic products. The accumulation of toxins may harm the organism. Thus the living organisms remove all these metabolic wastes from their body and this process is called excretion. Different organisms follow different modes of excretion. Let's have a glance at excretion in plants and how excretion in plants is different from that of animals.

Excretion in Plants

Elimination of toxic and waste products from the body is called excretion. Organisms like animals have an advanced and specialized system for excretion. But plants lack a well-developed excretory system like that in animals. They do not have special organs for excretion. Thus excretion in plants is not so complex.

Excretory products

The cellular respiration, photosynthesis, and other metabolic reactions produce a lot of excretory products in plants. Carbon dioxide, excess water produced during respiration and nitrogenous compounds produced during protein metabolism are the major excretory products in plants. Plants produce two gaseous waste products i.e. oxygen during photosynthesis and carbon dioxide during respiration. Excretion of gaseous waste in plants takes place through stomatal pores on leaves. Oxygen released during photosynthesis is used for respiration while carbon dioxide released during respiration is used for photosynthesis.

Excess of water is also excreted from the plant body through the stomatal pores and

from the surfaces of fruits and stems. The process of elimination of water is called transpiration.

Other than gaseous wastes, metabolism in plants also generates organic by-products. These wastes are stored in different forms in different parts. The gums, oils, latex, resins, etc. are some waste products stored in plant parts like barks, stems, leaves, etc. Eventually, plants shed off these parts. The oil produced from orange, eucalyptus, jasmine, latex from the rubber tree, papaya tree, and gums from acacia, are different forms of stored waste products. Sometimes they even excrete into the soil. Excretion in aquatic plants takes place through diffusion.

Excretion is an essential process in all forms of life. For example, in mammals urine is expelled through the urethra, which is part of the excretory system. In unicellular organisms, waste products are discharged directly through the surface of the cell.

During life activities such as cellular respiration, several chemical reactions take place in the body. These are known as metabolism. These chemical reactions produce waste products such as carbon dioxide, water, salts, urea and uric acid. Accumulation of these wastes beyond a level inside the body is harmful to the body. The excretory organs remove these wastes. This process of removal of metabolic waste from the body is known as excretion.

Green plants produce carbon dioxide and water as respiratory products. In green plants, the carbon dioxide released during respiration gets utilized during photosynthesis. Oxygen is a byproduct generated during photosynthesis, and exits through stomata, root cell walls, and other routes. Plants can get rid of excess water by transpiration and guttation. It has been shown that the leaf acts as an 'excretophore' and, in addition to being a primary organ of photosynthesis, is also used as a method of excreting toxic wastes via diffusion.

Other waste materials that are excluded by some plants — resin, saps, latex, etc. are forced from the interior of the plant by hydrostatic pressures inside the plant and by absorptive forces of plant cells. Plants perform photosynthesis which uses CO₂, water, sunlight, and chlorophyll to synthesize food. During photosynthesis, oxygen is given out as a by-product. This oxygen acts as an excretory product and is given out by a process called diffusion.

Certain plants perform a process known as photorespiration where oxygen is taken in and CO₂ is given out as a waste product.

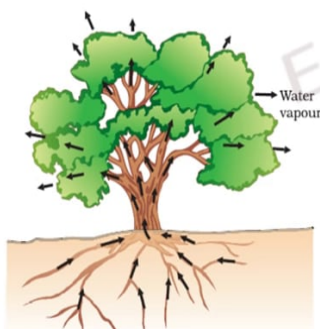
All plants perform transpiration which is the process by which plants transport water from the roots to the aerial parts of the plant for elimination in the form of water droplets or water vapours. This process occurs because the plants take in more water than they need for their biomechanical processes and the excess water is eliminated by transpiration. Transpiration occurs via small pores present on the undersurface of leaves known as stomata.

Cognitive processing

Excretion in Plants

Photosynthesis: $6\text{CO}_2 + 12\text{H}_2\text{O} \longrightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{H}_2\text{O} + 6\text{O}_2\uparrow$

- Oxygen is a waste product which is utilized during respiration
- Water is another waste product which is excreted through transpiration
- Plants also excrete in the form of resins, gums, alkaloids like quinine
- Plants also excrete through leaves or bark which fall off later



Excretion in plants can be summarized as follows:

Transpiration: Gaseous wastes and water are excreted through stomata, lenticels of the stem, and the outer surface of stems, fruits, etc.

Storing: Some organic wastes are stored in plant parts like barks and leaves.

Diffusion: Aquatic plants excrete metabolic wastes through diffusion. Terrestrial plants excrete into the soil. Excretion is a process by which metabolic waste is eliminated from an organism. In vertebrates this is primarily carried out by the lungs, kidneys and skin. This is in contrast with secretion, where the substance may have specific tasks after leaving the cell.

Cognitive stimulation

Students will be shown a video on excretion in plants to reinforce the content and stimulate their thinking.

<https://www.youtube.com/watch?v=Nqfd7EX-y0A>

Comprehensive evaluation

1. Write a note on the different systems excretion in plants.
2. The loss of water in the form of vapour from the aerial parts of a plant is known as...
[A] translocation [B] evaporation
[C] expiration [D] transpiration
3. Plants store excretory waste products...
[A] in food vacuoles [B] as resins and gum
[C] in cellular vacuoles [D] both in cellular vacuoles and as resin and gums

Lesson Unit 14: Human Excretory System

10th science

Connect to learners

Teacher from his data of students is fully aware of students' health and physiological status. The students with poor vision should be asked to sit on front seats.

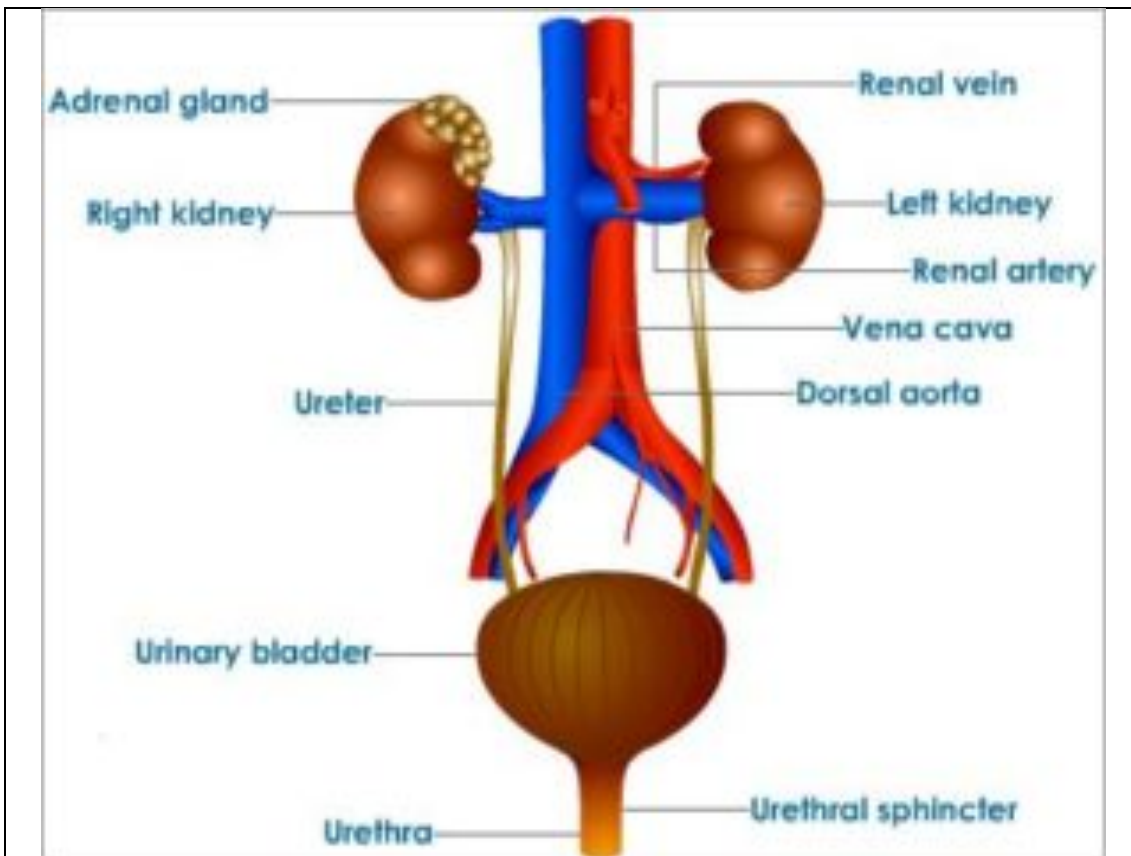
Create learning Environment

Children.....So are you ready to learn today?
Do you remember what we discussed yesterday?
Ok tell mewhat you know about human excretory system? How it works?

Classify the objectives

Do you know the importance of excretion in our life?
Human body excretes waste products from body through excretory system. In today's lesson we will know about the structure and function of human excretory system in detail.

Communicate the information



Human Excretory System

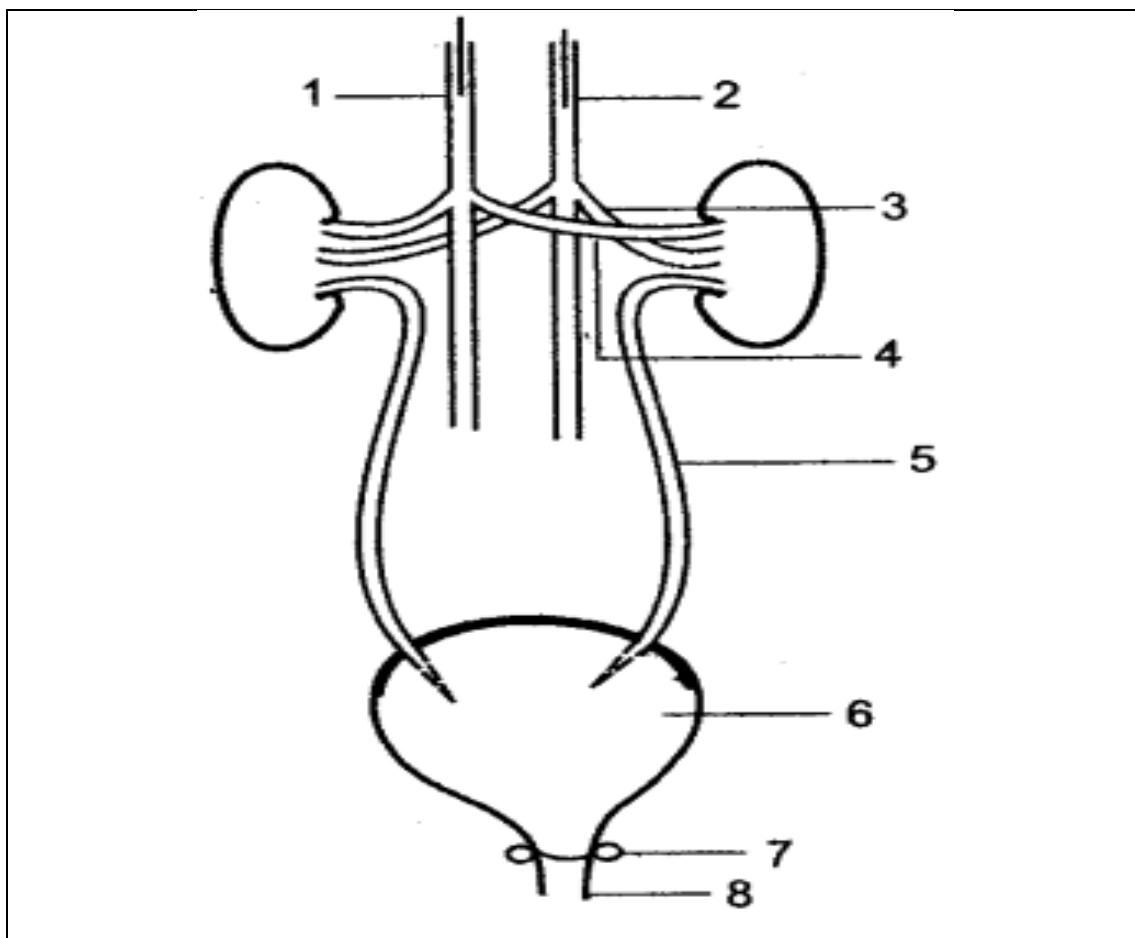
The excretory system is responsible for the elimination of wastes produced by homeostasis. Several parts of the body such as sweat glands, liver, lungs and kidney

are involved in this process. Every man has two kidneys. Each kidney is made up of **three sections:**

1. **the renal cortex**
2. **the renal medulla**
3. **the renal pelvis**

The blood arrives at the kidney via the renal artery, which splits into many afferent arterioles. These arterioles go to the Bowman's Capsules of nephrons, where the wastes are taken out of the blood by pressure filtration. Peritubular capillaries also surround the nephron so substances can be taken in and out of the blood. The renal cortex is the outer layer of the kidney and the medulla is the inner layer of the kidney. The renal pelvis takes urine away from the kidney via the ureter. Both of the ureters lead the urine into the body's only urinary bladder, which expands and sends nerve impulses when full. From there, urine is expelled through the urethra and out of the body.

Cognitive processing



Cognitive stimulation

Make a chart of Human Excretory System
How excretion is necessary for a healthy life?
How much water is filtered through kidneys in a day?

Comprehensive evaluation

Draw well labeled diagram of human Excretory System.

ਵਿਸ਼ਾ: ਵਿਗਿਆਨ

ਸਾਰੇ ਪ੍ਰਸ਼ਨ ਜ਼ਰੂਰੀ ਹਨ।

ਹਰੇਕ ਪ੍ਰਸ਼ਨ ਇੱਕ ਅੰਕ ਦਾ ਹੈ।

ਹਰੇਕ ਪ੍ਰਸ਼ਨ ਦੀਆਂ ਚਾਰ ਵਿਕਲਪ ਹਨ ਇਹਨਾਂ ਵਿੱਚੋਂ ਸਹੀ ਵਿਕਲਪ ਦੀ ਚੋਣ ਕਰਕੇ ਉੱਤਰ ਕਾਪੀ ਵਿੱਚ ਉਸ ਪ੍ਰਸ਼ਨ ਨੰ: ਦੇ ਸਾਮਹਣੇ ਦਿੱਤੇ ਚਾਰ ਵਿਕਲਪਾਂ ਵਿੱਚੋਂ ਸਹੀ ਵਿਕਲਪ ਤੇ () ਸਹੀ ਦਾ ਨਿਸ਼ਾਨ ਲਗਾਉ।

1. ਮਨੁੱਖੀ ਸ਼ਰੀਰ ਵਿੱਚ ਖੂਨ ਦਾ ਕਿਹੜਾ ਅੰਗ ਆਕਸੀਜਨ ਦੀ ਸਪਲਾਈ ਲਈ ਜ਼ਿੰਮੇਵਾਰ ਹੈ।
 - a. ਲਾਲ ਰਕਤਾਣੂ
 - b. ਸਫੇਦ ਰਕਤਾਣੂ
 - c. ਲਸੀਕਾ
 - d. ਪਲਾਜ਼ਮਾ
2. ਖੂਨ ਦੇ ਗਰੁੱਪਾਂ ਦੇ ABO ਸਿਸਟਮ ਵਿੱਚ 'ABO' ਦੇ ਅਰਥ ਕੀ ਹਨ।
 - a. ਤਿੰਨ ਕਿਸਮਾਂ ਦੇ ਬਲੱਡ ਗਰੁੱਪ ਹੁੰਦੇ ਹਨ।
 - b. ਕਿਸੇ ਬਲੱਡ ਗਰੁੱਪ ਨਾਲ ਸਬੰਧਤ ਨਹੀਂ।
 - c. ਚਾਰ ਕਿਸਮਾਂ ਦੇ ਬਲੱਡ ਗਰੁੱਪ ਹੁੰਦੇ ਹਨ।
 - d. ਉਪਰੋਕਤ ਸਾਰੇ।
3. ਮਨੁੱਖ ਵਿੱਚ ਦੂਹਰੀ ਲਹੂ ਗੇੜ ਪ੍ਰਣਾਲੀ ਦਾ ਹਿੱਸਾ ਹਨ
 - a. ਲਿਵਰ ਤੇ ਖੂਨ
 - b. ਫੇਫੜੇ, ਦਿਲ ਤੇ ਖੂਨ
 - c. ਫੇਫੜੇ ਤੇ ਦਿਲ
 - d. ਉਕਤ ਕੋਈ ਨਹੀਂ
4. ਅਣ ਆਕਸੀ ਸਾਹ ਕਿਰਿਆ ਦੌਰਾਨ ਗਲੂਕੋਜ਼ ਦਾ ਇੱਕ ਅਣੂ ਬਣਾਉਂਦਾ ਹੈ:
 - a. 2 ਅਣੂ ਪਾਇਰੂਵੇਟ
 - b. 28 ਅਣੂ ਪਾਇਰੂਵੇਟ
 - c. 2 ਅਣੂ ਗਲਾਇਕੋਜਨ
 - d. ਉਕਤ ਕੋਈ ਨਹੀਂ
5. ਅਣ ਆਕਸੀ ਸਾਹ ਕਿਰਿਆ ਬਾਰੇ ਸਚਾਈ ਇਹ ਹੈ ਕਿ:
 - a. ਇਹ ਸਾਰੇ ਜੀਵਾਂ ਵਿੱਚ ਹੁੰਦੀ ਹੈ
 - b. ਇਹ ਕੇਵਲ ਪੌਦਿਆਂ ਵਿੱਚ ਵਾਪਰਦੀ ਹੈ
 - c. ਇਹ ਮਨੁੱਖਾਂ ਵਿੱਚ ਨਹੀਂ ਵਾਪਰਦੀ
 - d. ਉਕਤ ਕੋਈ ਨਹੀਂ
6. ਗਲਾਇਕੋਲਾਇਸਿਸ ਦੀ ਕਿਰਿਆ ਵਿੱਚ ਭੰਨ ਤੋੜ ਹੁੰਦੀ ਹੈ:
 - a. ਗਲੂਕੋਜ਼ ਤੋਂ ਪਾਇਰੂਵੇਟ
 - b. ਗਲੂਕੋਜ਼ ਤੋਂ ATP
 - c. ਗਲੂਕੋਜ਼ ਤੋਂ ਗਲਾਇਕੋਜਨ
 - d. ਗਲਾਇਕੋਜਨ ਤੋਂ ਪਾਇਰੂਵੇਟ
7. ਸਾਹ ਲੈਣਾ ਅਤੇ ਸਾਹ ਕਿਰਿਆ:
 - a. ਸਾਹ ਲੈਣਾ ਅਤੇ ਸਾਹ ਕਿਰਿਆ ਵਿੱਚ ਕੋਈ ਅੰਤਰ ਨਹੀਂ
 - b. ਸਾਹ ਲੈਣਾ ਅਤੇ ਸਾਹ ਕਿਰਿਆ ਇੱਕ ਦੂਜੇ ਤੋਂ ਭਿੰਨ ਹਨ
 - c. ਸਾਹ ਲੈਣਾ ਅਤੇ ਸਾਹ ਕਿਰਿਆ ਇੱਕ ਦੂਜੇ ਤੇ ਨਿਰਭਰ ਹਨ
 - d. ਉਕਤ ਕੋਈ ਨਹੀਂ
8. ਹੇਠ ਲਿਖੇ ਕਥਨ ਵਿੱਚੋਂ ਤੁਹਾਡੇ ਅਨੁਸਾਰ ਕਿਹੜਾ ਸਹੀ ਹੈ:
 - A. ਗਲੂਕੋਜ਼ ਟੁੱਟ ਕੇ ਪਾਇਰੂਵੇਟ ਵਿੱਚ ਤਬਦੀਲ ਹੁੰਦਾ ਹੈ
 - B. ATP ਉਰਜਾ ਦਾ ਮੁੱਖ ਸਰੋਤ ਹਨ

ਉੱਤਰ:

- a. ਕੇਵਲ A ਸਹੀ ਹੈ
- b. ਕੇਵਲ B ਸਹੀ ਹੈ
- c. ਦੋਵੇਂ A&B ਸਹੀ ਹਨ

- d. A&B ਵਿੱਚੋਂ ਕੋਈ ਸਹੀ ਨਹੀਂ ਹੈ
9. ਹੇਠ ਲਿਖੇ ਕਥਨ ਵਿੱਚੋਂ ਤੁਹਾਡੇ ਅਨੁਸਾਰ ਕਿਹੜਾ ਸਹੀ ਹੈ:
 - A. ਮਨੁੱਖੀ ਦਿਲ ਦੇ ਚਾਰ ਖਾਨੇ ਹਨ
 - B. ਫੇਫੜਾ ਧਮਨੀਆਂ ਦਿਲ ਤੋਂ ਫੇਫੜਿਆਂ ਤੱਕ ਖੂਨ ਲੈ ਕੇ ਜਾਂਦੀਆਂ ਹਨ

ਉੱਤਰ:

- a. ਕੇਵਲ A ਸਹੀ ਹੈ
- b. ਕੇਵਲ B ਸਹੀ ਹੈ
- c. ਦੋਵੇਂ A&B ਸਹੀ ਹਨ
- d. A&B ਵਿੱਚੋਂ ਕੋਈ ਸਹੀ ਨਹੀਂ ਹੈ

10. ਹੇਠ ਲਿਖੇ ਸ਼ਬਦਾਂ ਦਾ ਵਿਸ਼ਲੇਸ਼ਣ ਕਰਦੇ ਹੋਏ ਸਹੀ ਚੁਣਾਵ ਕਰੋ

(A) ਮੇਹਦਾ	(a)hcl
(B) ਲੁਬਾ ਗ੍ਰੰਥੀ	(b)salivary amylase
(C) ਲਾਰ ਗ੍ਰੰਥੀ	(c)bile pigment
(D) ਪੈਨਕਰੀਆਜ਼	(d) lipase

ਉੱਤਰ:

	A	B	C	D
(a)	b	c	d	a
(b)	c	a	c	d
(c)	a	c	b	d
(d)	d	c	a	b

11. ਹੇਠ ਲਿਖੇ ਕਥਨਾਂ ਦਾ ਵਿਸ਼ਲੇਸ਼ਣ ਕਰਦੇ ਹੋਏ ਸਹੀ ਚੁਣਾਵ ਕਰੋ
 - (A)ਭੋਜਨ ਦਾ ਮੁੱਖ ਹਿੱਸਾ ਛੋਟੀ ਅੰਤੜੀ ਵਿੱਚ ਹਾਜ਼ਮ ਹੁੰਦਾ ਹੈ
 - (B)ਛੋਟੀ ਅੰਤੜੀ ਵਿੱਚ ਮੌਜੂਦ ਵਿਲਾਈ ਭੋਜਨ ਜਜ਼ਬ ਕਰਨ ਵਾਲੀ ਸਤਾ ਦਾ ਖੇਤਰ ਵਧਾ ਦਿੰਦੇ ਹਨ।

ਉੱਤਰ:

- a. ਕੇਵਲ A ਸਹੀ ਹੈ
- b. ਕੇਵਲ B ਸਹੀ ਹੈ
- c. ਦੋਵੇਂ A&B ਸਹੀ ਹਨ
- d. A&B ਵਿੱਚੋਂ ਕੋਈ ਸਹੀ ਨਹੀਂ ਹੈ।

12. ਹੇਠ ਲਿਖੇ ਸ਼ਬਦਾਂ ਦਾ ਵਿਸ਼ਲੇਸ਼ਣ ਕਰਦੇ ਹੋਏ ਸਹੀ ਚੁਣਾਵ ਕਰੋ
 - (A) ਮਨੁੱਖੀ ਸ਼ਰੀਰ ਵਿੱਚ ਹਾਰਮੋਨਾਂ ਦੇ ਸੰਚਾਰ ਦਾ ਮਾਧਿਅਮ ਖੂਨ ਹੈ।

(B)ਹਾਰਮੋਨਾਂ ਨੂੰ ਸੰਚਾਰ ਮਾਧਿਅਮ ਦੀ ਲੋੜ ਨਹੀਂ।

ਉੱਤਰ:

- a) ਕੇਵਲ A ਸਹੀ ਹੈ
- b) ਕੇਵਲ B ਸਹੀ ਹੈ
- c) ਦੋਵੇਂ A&B ਸਹੀ ਹਨ
- d) A&B ਵਿੱਚੋਂ ਕੋਈ ਸਹੀ ਨਹੀਂ ਹੈ।

13. ਇਹ ਕਿਹਾ ਜਾਂਦਾ ਹੈ ਕਿ ਰਾਤ ਸਮੇਂ ਦਰਖਤਾਂ ਥੱਲੇ ਨਹੀਂ ਸੌਣਾ ਚਾਹੀਦਾ ਕਿਉਂਕਿ:
 - A)ਪੌਦੇ ਰਾਤ ਨੂੰ ਸਾਹ ਕਿਰਿਆ ਦੌਰਾਨ ਕਾਰਬਨਡਾਇਕਸਾਇਡ ਛੱਡਦੇ ਹਨ

ਵਿਸ਼ਾ: ਵਿਗਿਆਨ

ਸਾਰੇ ਪ੍ਰਸ਼ਨ ਜ਼ਰੂਰੀ ਹਨ।

ਹਰੇਕ ਪ੍ਰਸ਼ਨ ਇੱਕ ਅੰਕ ਦਾ ਹੈ।

ਹਰੇਕ ਪ੍ਰਸ਼ਨ ਦੀਆਂ ਚਾਰ ਵਿਕਲਪ ਹਨ ਇਹਨਾਂ ਵਿੱਚੋਂ ਸਹੀ ਵਿਕਲਪ ਦੀ ਚੋਣ ਕਰਕੇ ਉੱਤਰ ਕਾਪੀ ਵਿੱਚ ਉਸ ਪ੍ਰਸ਼ਨ ਨੰ: ਦੇ ਸਾਮਹਣੇ ਦਿੱਤੇ ਚਾਰ ਵਿਕਲਪਾਂ ਵਿੱਚੋਂ ਸਹੀ ਵਿਕਲਪ ਤੇ () ਸਹੀ ਦਾ ਨਿਸ਼ਾਨ ਲਗਾਉ।

B) ਇਹ ਕੇਵਲ ਭਰਮ ਹੈ ਜਿਸਦਾ ਕੋਈ ਵਿਗਿਆਨਕ ਅਧਾਰ ਨਹੀਂ ਹੈ।

ਉੱਤਰ:

- a. ਦੋਵੇਂ A and B ਸਹੀ ਹਨ।
- ਬ. ਕੇਵਲ A ਸਹੀ
- c. ਕੇਵਲ B ਸਹੀ
- d. ਕੋਈ ਵੀ ਸਹੀ ਨਹੀਂ A and B

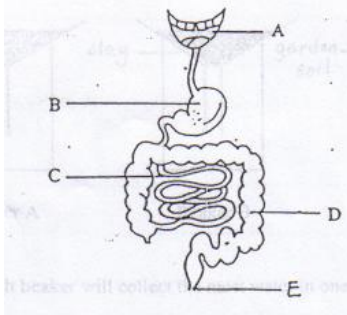
14. ਹਰੇਕ ਅੰਗ ਨੂੰ ਉਸਦੇ ਕੰਮਾਂ ਨਾਲ ਮਿਲਾਣ ਕਰਦੇ ਹੋਏ ਸਹੀ ਚੁਣਾਵ ਕਰੋ

- | | |
|-----------|---------------------|
| (A) ਫੇਫੜੇ | a) ਭੋਜਨ ਦਾ ਹਾਜ਼ਮਾ |
| (B) ਮੋਹਦਾ | b) ਗੈਸਾਂ ਦਾ ਵਟਾਂਦਰਾ |
| (C) ਦਿਲ | c) ਚਰਬੀ ਦਾ ਸੰਸਲੇਸ਼ਣ |
| (D) ਜਿਗਰ | d) ਖੂਨ ਦਾ ਵਹਾਅ |

ਉੱਤਰ:

	A	B	C	D
(a)	B	A	D	c
(b)	C	A	B	d
(c)	A	D	C	b
(d)	D	C	A	b

15. ਤਸਵੀਰ ਦਾ ਵਿਸ਼ਲੇਸ਼ਣ ਕਰਦੇ ਹੋਏ ਸਹੀ ਚੁਣਾਵ ਕਰੋ



- a. ਛੋਟੀ ਅੰਤੜੀ
- b. ਮੂੰਹ
- c. ਮੋਹਦਾ
- d. ਵੱਡੀ ਅੰਤੜੀ
- e. ਰੈਕਟਮ

ਉੱਤਰ:

	A	B	C	D	E
(a)	B	C	A	d	e
(b)	C	A	B	e	d
(c)	B	A	C	d	e
(d)	D	C	A	b	e

16. ਹੇਠ ਲਿਖੇ ਸ਼ਬਦਾਂ ਦਾ ਵਿਸ਼ਲੇਸ਼ਣ ਕਰਦੇ ਹੋਏ ਸਹੀ ਚੁਣਾਵ ਕਰੋ

ਉੱਤਰ:

- | | |
|-------------|----------|
| A) ਐਲਵੀਲਾਈ | a) ਦਿਲ |
| B) ਨੈਫਰੀਡੀਆ | b) ਫੇਫੜੇ |
| C) ਵਿਲਾਈ | c) ਗੁਰਦੇ |
| D) ਆਰੀਕਲ | d) ਅੰਤੜੀ |

ਉੱਤਰ:

	A	B	C	D
(a)	d	c	b	a
(b)	b	c	d	a
(c)	a	d	b	c
(d)	d	c	a	b

17. ਹੇਠ ਲਿਖੇ ਸ਼ਬਦਾਂ ਦਾ ਵਿਸ਼ਲੇਸ਼ਣ ਕਰਦੇ ਹੋਏ ਸਹੀ ਚੁਣਾਵ ਕਰੋ

ਉੱਤਰ:

- | | |
|------------------|-----------------|
| A) ਜ਼ਾਇਲਮ | a) ਪਾਣੀ |
| B) ਨੈਫਰਾਨ | b) ਵਿਅਰਥ ਪਦਾਰਥ |
| C) ਗੁੰਦ ਤੇ ਰੇਜਿਨ | c) ਫਿਲਟਰ ਕਿਰਿਆ |
| D) ਫਲੋਇਮ | d) ਭੋਜਨ ਵਟਾਂਦਰਾ |

ਉੱਤਰ:

	A	B	C	D
(a)	b	c	d	a
(b)	c	a	c	d
(c)	a	c	b	d
(d)	d	c	a	b

18. ਪ੍ਰੋਟੀਨ ਹਜ਼ਮ ਹੋਣ ਉਪਰੰਤ ਕਿਸ ਵਿੱਚ ਤਬਦੀਲ ਹੁੰਦੇ ਹਨ।

- a. ਕਾਰਬੋਹਾਈਡ੍ਰੇਟਸ (Carbohydrates)
- b. ਛੋਟੀ ਰਸਦਾਨੀ (Small globules)
- c. ਅਮੀਨੋ ਤੇਜ਼ਾਬ (Amino acids)
- d. ਸਟਾਰਚ (starch)

19. ਪੌਦਿਆਂ ਵਿੱਚ ਕਾਰਬੋਹਾਈਡ੍ਰੇਟਿਸ ਕਿਸ ਰੂਪ ਵਿੱਚ ਤਬਦੀਲ ਹੁੰਦਾ ਹੈ।

- a. ਗਲਾਈਕੋਜਨ (Glycogen)
- b. ਸਟਾਰਚ (Starch)
- c. ਗਲੂਕੋਜ਼ (Glucose)
- d. ਮਾਲਟੋਜ਼ (Maltose)

20. ਪੌਦਿਆਂ ਤੇ ਮੌਜੂਦ ਛੋਟੇ ਛੋਟੇ ਨੂੰ ਕਹਿੰਦੇ ਹਨ।

- a. ਸਟੋਮੈਟਾ (Stomata)
- b. ਕਲੋਰੋਫਿਲ (Chlorophyll)
- c. ਗਾਰਡ ਸੈਲ (Guard cells)
- d. ਉਕਤ ਕੋਈ ਨਹੀਂ

21. ਹੇਠ ਲਿਖੇ ਕਥਨਾਂ ਦਾ ਵਿਸ਼ਲੇਸ਼ਣ ਕਰਦੇ ਹੋਏ ਸਹੀ ਚੁਣਾਵ ਕਰੋ

- (A) ਹਾਰਮੋਨ ਅਤੇ ਐਨਜ਼ਾਇਮ ਇੱਕ ਦੂਜੇ ਤੋਂ ਭਿੰਨ ਹਨ।
- (B) ਹਾਰਮੋਨ ਅਤੇ ਐਨਜ਼ਾਇਮ ਬਣਤਰ ਵਿੱਚ ਪ੍ਰੋਟੀਨ ਹਨ।

ਵਿਸ਼ਾ: ਵਿਗਿਆਨ

ਸਾਰੇ ਪ੍ਰਸ਼ਨ ਜ਼ਰੂਰੀ ਹਨ।

ਹਰੇਕ ਪ੍ਰਸ਼ਨ ਇੱਕ ਅੰਕ ਦਾ ਹੈ।

ਹਰੇਕ ਪ੍ਰਸ਼ਨ ਦੀਆਂ ਚਾਰ ਵਿਕਲਪ ਹਨ ਇਹਨਾਂ ਵਿੱਚੋਂ ਸਹੀ ਵਿਕਲਪ ਦੀ ਚੋਣ ਕਰਕੇ ਉੱਤਰ ਕਾਪੀ ਵਿੱਚ ਉਸ ਪ੍ਰਸ਼ਨ ਨੰ: ਦੇ ਸਾਮਹਣੇ ਦਿੱਤੇ ਚਾਰ ਵਿਕਲਪਾਂ ਵਿੱਚੋਂ ਸਹੀ ਵਿਕਲਪ ਤੇ () ਸਹੀ ਦਾ ਨਿਸ਼ਾਨ ਲਗਾਉ।

ਉੱਤਰ:

- ਕੇਵਲ A ਸਹੀ ਹੈ
- ਕੇਵਲ B ਸਹੀ ਹੈ
- ਦੋਵੇਂ A&B ਸਹੀ ਹਨ
- A&B ਵਿੱਚੋਂ ਕੋਈ ਸਹੀ ਨਹੀਂ ਹੈ।

22. ਹੇਠ ਲਿਖੇ ਕਥਨਾਂ ਦਾ ਵਿਸ਼ਲੇਸ਼ਣ ਕਰਦੇ ਹੋਏ ਸਹੀ ਚੁਣਾਵ ਕਰੋ

- ਖੂਨ ਨੂੰ ਸਾਫ ਕਰਨ ਦੀ ਪ੍ਰਕ੍ਰਿਆ ਨੂੰ ਡਾਇਲਿਸਿਸ ਕਹਿੰਦੇ ਹਨ।
- ਡਾਇਲਿਸਿਸ ਕੇਵਲ ਗੁਰਦਿਆ ਦੇ ਸਹੀ ਕੰਮ ਨਾ ਕਰਨ ਤੇ ਕੀਤਾ ਜਾਂਦਾ ਹੈ।

ਉੱਤਰ:

- ਕੇਵਲ A ਸਹੀ ਹੈ
- ਕੇਵਲ B ਸਹੀ ਹੈ
- ਦੋਵੇਂ A&B ਸਹੀ ਹਨ
- A&B ਵਿੱਚੋਂ ਕੋਈ ਸਹੀ ਨਹੀਂ ਹੈ।

23. ਪੈਨਕਰੀਆਜ ਵੱਲੋਂ ਭੇਜੇ ਕਿਹੜੇ ਪਾਚਕ ਰਸ ਪ੍ਰੋਟੀਨ ਦੇ ਹਾਜ਼ਮੇ ਵਿੱਚ ਲੋੜੀਂਦੇ ਹਨ।

- ਟਰੀਪਸਿਨ Trypsin
- ਪੈਪਸਿਨ Pepsin
- ਲੁਬਾ ਰਸ Bile juice
- ਦੋਵੇਂ a ਅਤੇ b

24. ਮਨੁੱਖੀ ਸਰੀਰ ਵਿੱਚ ਸਾਹ ਕਿਰਿਆ ਲਈ ਜ਼ਰੂਰੀ ਪਦਾਰਥ ਹੈ: (Respiratory pigment in human body is)

- ਕਲੋਰੋਫਿਲ Chlorophyll
- ਪਾਣੀ (Water)
- ਖੂਨ (Blood)
- ਹੀਮੋਗਲੋਬਿਨ (haemoglobin)

ਵਿਸ਼ਾ: ਵਿਗਿਆਨ

ਸਾਰੇ ਪ੍ਰਸ਼ਨ ਜ਼ਰੂਰੀ ਹਨ।

ਹਰੇਕ ਪ੍ਰਸ਼ਨ ਇੱਕ ਅੰਕ ਦਾ ਹੈ।

ਹਰੇਕ ਪ੍ਰਸ਼ਨ ਦੀਆਂ ਚਾਰ ਵਿਕਲਪ ਹਨ ਇਹਨਾਂ ਵਿੱਚੋਂ ਸਹੀ ਵਿਕਲਪ ਦੀ ਚੋਣ ਕਰਕੇ ਉੱਤਰ ਕਾਪੀ ਵਿੱਚ ਉਸ ਪ੍ਰਸ਼ਨ ਨੰ: ਦੇ ਸਾਮਹਣੇ ਦਿੱਤੇ ਚਾਰ ਵਿਕਲਪਾਂ ਵਿੱਚੋਂ ਸਹੀ ਵਿਕਲਪ ਤੇ () ਸਹੀ ਦਾ ਨਿਸ਼ਾਨ ਲਗਾਉ।

Answer sheet:

Name _____ Roll no. _____ class _____ section _____

ਹਰੇਕ ਪ੍ਰਸ਼ਨ ਦੇ ਸਾਮਹਣੇ ਦਿੱਤੇ ਚਾਰ ਖਾਨਿਆਂ ਵਿੱਚੋਂ ਸਹੀ ਉੱਤਰ ਵਾਲੇ ਖਾਨੇ ਵਿੱਚ ਸਹੀ () ਦਾ ਨਿਸ਼ਾਨ ਲਗਾਉ:

Q no	a	b	c	d
1				
2				
3				
4				
5				
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PARENTAL COGNITIVE STIMULATION SCALE

Answer the following items with most appropriate response you seems fit to your context.

	Items	Strongly agree	Agree	No response	Disagree	Strongly disagree
1.	My parents insist me on having sound sleep at night.					
2.	My parents make me participate in sports.					
3.	My parents make me eat healthy food only.					
4.	My parents make me do exercise to keep me fit.					
5.	My parents ask me to make my decisions myself.					
6.	My parents set a goal for me to complete in specific time.					
7.	My parents make me to participate in various competitions to express my abilities.					
8.	My parents ask me to use library for my educational work.					
9.	My parents allow me to plan and organize group activity.					
10.	My parents encourage me to complete my homework without the help.					
11.	My parents encourage me to participate in social welfare activities at school.					
12.	My parents take me to book fairs or and ask to choose my favorite books					
13.	My parents discuss with me the life histories of great men.					
14.	I have been asked to give my opinion on common family issues by my parents.					
15.	My parents ask me to solve puzzles.					
16.	My Parents discuss informative TV programs with me.					

17.	My parents make me realize my mistake without losing temper.					
18.	My parents take me to recreational family trips.					
19.	When I feel sad, my parents emotionally support me.					
20.	I feel free to discuss my problems with my parents.					
21.	Whenever I am ill my parents spare their time to take care of me.					
22.	My parents discuss with me my routine day activities.					
23.	My parents buy toys for me.					
24.	My parents read bedtime stories for me.					
25.	I got rewarded by my parents on completion of given task.					
26.	Whenever I succeed, my parents celebrate it with family.					
27.	My parents motivate me to achieve my future goals.					
28.	I have been sent to attend preschool by my parents.					
29.	My parents encourage me to participate in debates.					
30.	My parents take care of my self esteem in public.					
31.	My parents buy me toys of my choice.					

Name :

Class:

Age:

Mother's educational qualification:

Father's educational qualification