CONCEPTUAL FRAMEWORK
CHAPTER III
CONCEPTUAL FRAME WORK

3.1. INTRODUCTION
This chapter provides a detailed conceptual framework based on which the study has been undertaken. The two variables: i) Competence in teaching science (Dependent variable) and ii) Cognitive intervention strategies (Independent Variable) are dealt with in this chapter.

3.2. TEACHING – AN OVERVIEW
The term “teaching” as defined by Bhattacharya (1974), reads thus: “Perceiving the Process analytically as constituting a host of activities”. Likewise the term “Competence” defined by Brown (1975) and Gage (1974) if we take in the essence of teaching Profession, refers to the criterion that determines teacher effectiveness. Definition applied to teachers, Competency means the right way of Conveying units of knowledge, application and skill to the students. The right way includes knowledge of Content as well as the processes, methods and means of conveying them in an interesting way involving activities of students. In short, a Competent teacher makes the teaching –learning process a joyous experience for children and to himself/herself.

Teaching is a System of action, which induce learning. John Brubacher defines teaching as an arrangement and manipulation of situation in which there are gaps or obstructions, which an individual will seek to overcome and from which he will learn in the course of doing so.

The term teaching originated from a Latin word ‘Taik Jon’, meaning, “to show how? “ This is what the teacher in the classroom does. He/she has to show the
students what is the curricular materials and how they are organised, how facts becomes Concepts, laws and Principles, how they are associated and dissociated. For this purpose, the teacher has to resort to many materials, tactics and methods.

3.3. TEACHING SCIENCE

Science is a body of Systematic knowledge and it is a system of knowledge. A system consists of a number of things, which are related together in a particular way to serve a particular purpose. The proper understanding and explanation of facts lead to development of Science. There is an inherent urge to know and understand facts, and this is done by relating the facts together. A meaningful relationship between facts is established through rational explanation. Explanation becomes the basic feature of Sciences. The ideal of Science is to achieve systematic inter – connection of facts.

Nature and characteristics of Science

1. Science is a system. It is a system of knowledge where so many facts are related together. It is a system of organized knowledge.

2. Science is empirical in nature. In Science, knowledge is obtained by observation. Verification plays an important role in Science. Verification is based on the facts, which is observed and experiences.

3. Science is based on Critical discrimination. It is objective and impartial,

4. Science deals with the general nature of things and events, and it consists of general explanations and principles.

5. Science is a body of reasoned knowledge. Laws are formulated in science on the basis of reflection and reasoning.
6. Science is self-corrective in nature. Whenever new facts are found, the old Conclusions are revised, if the new facts demand so. It is based on systematic doubt and search for new facts.

7. Science is objective in nature; Science does not depend on subject attitudes like feeling, temperature, bias, etc. Science takes facts as they are in an impartial manner. Science is neutral and free from any prejudice.

8. Science formulates laws; Facts are explained with reference to laws. Laws are explained by constructing theories.

9. Another feature of science is its function of prediction. On the basis of laws, Science can predict the happening of certain events.

3.4. COMPETENCE

The term ‘Competence is a generic word that represents the following three levels of human functioning’ (i) Knowledge (ii) attitude and (iii) Performance Skill. A Program could be based on Competency Statement in one or more of the following components (a) its planning and design (b) its training materials (c) its training procedures and (d) its evaluation. The word Competency is taken in the broad Sense of knowledge, attitudes, Skills and behaviours that facilitate intellectual, Social, emotional and physical growth in children (Weber. 1972)

Competency means the transformation of inborn \ innate qualities and concealed\hidden strength of the individual into application (Utility). A Competent teacher makes the teaching – learning process a joyous experience for children and for himself\ herself.
The term ‘Competency’ is a generic word that represents the following three levels of human functioning.

(a) Knowledge:— that result of Perpetual processes, Such as attending, Selecting, Symbolic rehearsing, decoding, encoding’ reflecting and evaluating responses.

(b) Attitudes:— the products of emotional responses towards specific exert or objects.

(c) Performance skills:— the outcomes of psycho – motor processes that enable an individual to make an overt response, and perhaps, produce a tangible product that can be observed and assessed by some one else.

When a specific knowledge, attitude or performance skill is describe in a series of words, a competency statement has been formulated. If that statement (or a condensed version of it) is incorporated as one of the ingredients (eg. The observable outcome) it becomes a training objectives or learning objective.

The term “Competence” is frequently used when one talks of any profession or work that express one’s quality of being competent, knowledge, qualification or capacity. When one talk about the teacher or his profession, ability at teaching constitutes his competence. Teaching competence is a set of overt teacher (classroom) behaviours that bring about pupil learning

3.5. COMPETENCE-AREAS

Teacher preparation ought to begin with a sound pre – service teacher education programme that may transform an individual into a competent and committed professional functionary, fully equipped with an equally comprehensive professional readiness to perform these tasks with perfection and
satisfaction. The process of teacher training extends much beyond the initial stage and continue to remain significant once the teacher formally joins the process of teaching and learning in an institution. It extends in the form of organizing in-service professional education which may be characterized by orientation, re-orientation and recurrent augmentation of the already acquired skills as well as to generate acquaintance and familiarity with new skills and developments. Along with is the continuing self-directed learning, and capacity, which is gaining more and more currency as the organized in-service components may not be available in sufficient measures and adequate durations.

The self-directed learning in a way enhances the commitments part of the individual along with the upgradation of Competencies. Skills and acquaintance with new educational technologies. Needless to say that preparation and continuing education of teachers and teacher educators, would play an important role in ensuring continuity of the pre-service and in-service education of teachers in schools. The quality of teacher’s education, therefore, not only determines the quality of school education but also bridges the gap between the quality of individual teachers and teacher educators.

It is being increasingly appreciated that before a teacher is assigned the responsibility of teaching in schools, familiarity with basic understanding of sociological, philosophical and psychological principles is a basic pre-requisite. No teacher can be successful in school without a thorough and practical understanding of the specific community, the learners’ needs, and societal expectations and basic objectives of the particular stage of education. Curriculum
development and research in basic of education and teacher education over the years identified the requirement of basic induction training for fresh teachers.

Besides, practically every schoolchild is supposed to acquire certain identified skills and competencies at the level of mastery. This enjoins upon the teacher to develop capacities to identify individual learning difficulties and develop remedial and enrichment strategies to ensure that the deficiencies are met without causing any additional burden on the children. In a broader perspective, these components form new pre-requisites for ensuring social justice and equity, and effective participation of children from various socio-economic backgrounds, ensuring in turn a hear equal contribution of everyone in the process of development which would hopefully bridge the gap between different sections of the learners and the society. Education can contribute effectively only when it is of good quality and is acquired practically by every learner at that level.

The intensive interactions with teachers, teacher educators, curriculum developers, evaluators and experts of different Categories, NCTE has identified the following ten inter-related competencies as essential for making competent teachers:

1. Contextual Competencies
2. Conceptual Competencies
3. Content Competencies
4. Transactional Competencies
5. Competencies related to other educational activities
6. Competencies to develop teaching – learning material
7. Evaluation Competencies
8. Management Competencies

9. Competencies related to working with parents

10. Competencies related to working with community and agencies

Viewed in terms of inter-relationships and continuity, these can be subjected to various permutations and combinations. In fact, all such Competencies have not simply to be acquired by teachers but also to be put into practice practically in every activity on day-to-day basis. Acquisition of these would naturally require a high degree of proficiency. It also indicates that transformation of the teacher’s personality through teacher education has to be achieved to ensure excellence of professionalism in performance of the assigned tasks. Teaching, being not an easy job, requires mental alertness, physical fitness and a deep sense of responsibility and accountability.

Rigour in every activity is, therefore, essential. Enlisting the tasks expected of teachers is a tough task in itself. In case of teachers at elementary stage, it has become still more difficult due to factors like non-enrolment and non-retention of children in primary schools. In addition, there are issues concerning weak children, bright children, school environment, class management, dealing with parents, evaluation of learning attainments, curriculum and material development and eventually ensuring mastery level learning practically by all the children. In the words of prof. R.H. Dave, Teacher education at elementary stage is a process of initial empowerment and continuing re-empowerment of professional practitioners for the purpose of generating competency based teaching at the level of mastery in practically all the children.
by adopting suitable aids, activities, motivational devices and evaluation procedures”.

3.6. TEACHING COMPETENCE

The term “teaching competency” as defined by Flanders and Simon (1969) includes more than mere teacher effectiveness and pupil outcomes. According to Hewkew (1956) and Wilson (1973), it includes knowledge, attitude, skill and other teacher characteristics. Medley and Mit (1963) and Biddle perceive “teacher competence” as teacher behaviour that produces intended effects. Rama (1979) gives a comprehensive definition of the term teaching competence as the ability of a teacher manifested through a set of overt teacher classroom behaviour. In other words it is a set of observable teacher behaviours that bring about pupil learning. Hence for the purpose of this study “teaching competency” would mean effective performance of all observable teacher behaviours that bring about desired pupil outcomes”.

The following are the universally acceptable definitions of teaching Competence.

“Successful teaching is teaching that brings about effective learning. The decisive question is not what methods or procedures are employed, or whether they are old fashioned or modern time tested experimental, Conventional or progressive”.

(James, 1954)

“The Possessions of the teacher, his knowledge, skills, attitude, personality Configuration, and the like are referred to as competencies; they lend the character dimension to teaching”. (Haskew, 1956)
"The competence of teacher is defined as the average success of all his behaviours in achieving their intended effects". (Medley Mitzel, 1963)

"A Competent teacher is one who: (i) has the skill of accurate perception of the classroom situation and the changes that occur within the classroom". (ii) is aware of the teacher's role which are appropriate to different situation and (iii) Possesses the personality skill, which allows him to adapt to changing situations. (Hoyle, 1969)

"Teacher competencies are the resultant of attitudes, understanding, skills and behaviours that facilitator intellectual, social, emotional and physical growth in children. (Copper et. al, 1973)

"Competent teacher is assumed to be made up of a collection of modular skills and a chain of performances on such modules constitutes effective teaching performance". (Travers, 1975)

Kornisar (1966) has pointed out that teaching included so many activities as introducing, demonstrating, citing, hypothesizing, reporting, conjecturing, confirming, contrasting, explaining, questioning, elaborating as constituent skills of teaching. (Stones and Morris, 1972)

3.7. PRE – SERVICE TRAINING AND TEACHER COMPETENCE

The Pre-Service training Programme, aiming at imparting necessary Competencies to teachers, has been found to be inadequate. This weakness has immensely affected the efficiency of the schooling system. Teachers themselves are conscious of these issues. Jangira et.al (1995) surveyed teachers' opinions on pre – service training and found high levels of dissatisfaction among teachers in rural schools in Haryana and Kerala.
Kothari Commission (1964-66) has pointed out that reality and vitality are lacking in the curriculum of teacher education. Of all the factors that influence the quality of education, the quality, Competence and character of teachers are undoubtedly the most significant. These in turn depend on the quality of training and other support provided to them. Yash Pal (1993) has observed that inadequate programme of teacher preparation leads to in school.

The International Commission on Education (1996) has stressed the importance of teacher preparation as follows.

- Improving the quality of education depends on first improving the recruitment, training, social status and conditions of work of teachers; they need the appropriate knowledge and skills, personal characteristics, professional prospects and motivation if they are to meet the expectations placed upon them.

- The demands on teachers’ Competence, professionalism and dedication impose on them an enormous responsibility; Expectations are high and seemingly limitless.

- A rethinking of teacher education is necessary in order to bring out in future teachers precisely those human and intellectual qualities that will facilitate a fresh approach to teaching.

- Reasserting the importance of teachers in basic education and improving teacher’s qualifications are tasks to which all Governments must address themselves.

- One of the main functions of teacher education, both pre – service and in – service is to equip teachers with the ethical, intellectual and
emotional wherewithal to develop the same range of qualities, in their pupils, as society demands.

3.8. CONCEPT OF COMPETENCY – BASED TEACHER EDUCATION

The appeal of Competency- Based Teacher Education is in its emphasis on pragmatism in determining the content of Teacher Education Programmes, its potential for improvement through preparing teacher. The basic Concepts are simple and straightforward. Programme requirements are derived from and based on the practice of effective teacher.

This contrasts sharply with approaches where the content of the behavioural sciences such as Psychology and the structure of academic disciplines such as mathematics are used to determine content and organization of teacher education.

In Competency-Based Teacher Education greater emphasis is placed on performance-based and consequence-based objectives. What teachers know about teaching seems less important than their ability to teach and to bring about changes in their pupils. The fourth type of competency is affective. The affective competencies, which define expected attitudes and values, tend to resist Specificity and are more difficult to assess than the first three types (the prospective teacher values the contribution of all Students in a class discussion). They are typically embedded in other Competency Statement. The fifth type, exploratory competencies do not fit well with the other four types of the competencies. Based on Teacher Education Classification system, activities that promise significant learning’s are Specified. Competency-based Teacher Education programmes may require the learner to work 30 hours in a community
centre, discuss schooling with parents or act as a teacher aide for a few weeks. Such activities are exploratory, they provide opportunities for students to learn about teaching, but the specific nature of such learning is not defined. The idiosyncratic dispositions and experience of the learner and the particular set of experiences in the activity largely influence the outcomes. Exploratory Competencies have also been referred to by educators as experience objectives. Competency - Based Teacher Education Programmes do not depend on exploratory Competencies, but they are employed on experimental basis. However, specific outcomes are yet to be explained.

3.9. CHARACTERISTICS OF A COMPETENT TEACHER

Mike Turner and Leslie Bash (1999) have listed the characteristics of a competent teacher. In their opinion, a competent teacher is one who:

- Is professionally Committed to Promote education and well-being of all children regardless of their cultural, ethnic or religious background
- Knows their special subject or curriculum area well enough to teach it and informs less knowledgeable colleagues on what and how to teach in that subject.
- Can teach the key ideas and content of his subject in a variety of ways which meet the learning styles of the children with different ability and interest groups
- Can manage children in a quiet and ordered manner in and out of the classroom
- Can work equitably with children, colleagues, parents, governors and administrators
• Can encourage the spiritual, moral, social and cultural development of
  children
• Is committed to the ideas of lifetime professional development for the
  sake of their schools and themselves
• Can accept the need for continuous change in order to meet the needs
  of their clients and employers

3.10. CLASSIFICATION OF COMPETENCIES

Regional institute of Education, Mysore (1998) identified a list of 51
essential competencies and classified them under 12 areas

1. Development, preparation and utilization of instructional materials
2. Motivation of children
3. Communication in classroom
4. Methods of instruction
5. Evaluation of learning
6. Diagnosis and remediation
7. Classroom management
8. Co-curricular activities
9. Community Participation
10. Special education
11. Institutional Planning
12. Classroom instruction

The 10 initial teacher preparation Competencies, developed by INTASC,
included the following:
1. Content knowledge and pedagogy
2. Student learning and development
3. Diverse learners and the ability to adapt to diverse learners
4. Instructional Strategies
5. Classroom management and Motivation
6. Communication techniques
7. Curriculum and planning
8. Assessment
9. Reflective practice
10. Professional relationships internal and external to the school

At the individual level, quality education should result in students acquiring necessary competencies as an outcome of their education. Biremballm (1996) suggests that today's student requires four types of competencies:

Cognitive competencies, such as solving problems, thinking critically, formulating questions, searching for relevant information, making informed judgements, making efficient use of information, Conducting observations and investigations, inventing and creating new things, analyzing data, presenting data Communicating effectively both oral and written.

Meta-Cognitive competencies, such as self-reflection or self-evaluation;

Social Competencies, Such as leading discussions and Conversations, persuading, Co-operating and working in groups

Effective dispositions, such as preference, internal motivation, responsibility, self-efficacy, independence and flexibility
These Competencies of Students are also the Competencies required for quality life. Amartya Sen (1995) rightly emphasized the importance of developing human capabilities through education for development. In his scheme of development, quality education plays an important role in quality of life.

Mariappan (1997) listed four competencies in his paper on “Developing teacher competencies in environmental education”. They are teaching competencies, cognitive competencies or cognitive abilities, Social competencies and value based competencies.

District Primary Education Programme (DPEP), Tamil Nadu (Paramasivam, 1997) identified the following teacher competencies after conducting workshop at Vadalur and Krishnagiri. They are

- Planning the lesson
- Managing instruction
- Catering to the needs of slow & gifted children
- Summative evaluation
- Guidance and counselling
- Promoting individual talents
- Innovative methods
- Institutional management
- Establishing inter-School rapport
- Involving Community
- Developing non-Scholastic skills

Studies on Teacher Competencies to handle normal children were collected and reviewed to know the important Competencies, skills
required to perform teaching activities effectively in the regular classroom.

The studies are presented here under.

Ainscow and Muncey (1989) found that the most effective teachers:

- Emphasize the importance of meaning
- Set tasks that are realistic and challenging
- Provide a variety of learning experience
- Give pupils opportunities to choose
- Have high expectations
- Create a positive atmosphere
- Provide a consistent approach
- Recognize the efforts and achievements of their pupils
- Organize resources to facilitate learning
- Encourage pupils to work co-operatively
- Monitor progress and provide regular feedback

3.11. STRATEGIES FOR EVALUATION OF TEACHER COMPETENCIES

- Asks questions
- Responds to the students response
- Responds to students ideas
- Encourages participatory teaching learning
- Conducts activities
- Communicates effectively
- Nurtures creativity
- Keeps the classroom environment lively
• Achieves objectives
• Provokes thinking
• Uses education technology

3.12. COMPETENCIES AT FUNCTIONAL LEVELS

Bloom (1956) developed a taxonomy of Competencies comprising of three major functional levels; Cognitive, affective and Psychomotor. Each level could be divided into many sublevels that are complex. Using a different orientation to the analysis of learning conditions and experiences, Gagne (1965) concentrated on the Cognitive functional level, and applied the process of task analysis to identify a hierarchy of eight types of learning including (a) Signal learning (b) Stimulus – response learning (c) chaining (d) verbal association (e) multiple – discrimination learning (f) Concept learning (g) Principle learning and (h) Problem Solving.

For the sake of precision, three functional levels of competencies (knowledge, attitude and performance skills) noted earlier will be addressed. These are compatible with those used by Bloom and his Colleagues as well as with Gagne’s more detailed analysis of learning tasks within the knowledge level.

Knowledge Competencies entail Processes that stop short of application or solution to problem and Bloom’s cognitive hierarchy knowledge Competencies include only the first two of his levels (recall of factual information and comprehension). His text level (application) is categorized here as a performance that occurs between principle learning and problem solving.
Attitudinal competencies reflect emotional responses to stimuli conditions or event, feelings in interest result from them and are inferred as people's non-verbal communication. Bloom and his colleagues categorized attitudes in the affective level of their taxonomy

3.13. COMPETENCIES IN THE AREAS OF APPLICATION

Wellman (1967) developed competence taxonomy appropriate for actual life situations and learning tasks experienced by career deciders as they work in educational, vocational and social applications.

Block (1978 pp-18) describes area of competency applications that are even more comprehensive than are Wellman's. In attempting to answer the questions, "who is a Competent school leaver?" he synthesized the work of White (1959 pp.297-333) and Inkeles (1966 pp.265-283). According to Block (1978 p. 13) individuals make certain demands of their environment. Competence reflects their capacity to affect these demands. At the same time, the environment makes demands on individuals, requiring them to interact effectively in these kinds of settings each of which is defined by particular adult roles, some of these settings are roles automatically assigned by society, and others are optional. Any role may be selected and aspired to by the individuals themselves. Competent individuals are therefore those who, "possess particular motor, intellectual and emotional competencies to handle the various intra-inter-and or extra-personal demands that each environmental presents" (Block 1978). They understand all these aforementioned functional levels and apply their competencies in all the areas of their careers and lives.
• Individual Capacity
• Educational qualification
• Academic achievement
• Perception
• Practice teaching
• Teacher – Pupil ratio
• Intelligence
• Teacher behaviour
• Personality adjustment
• Classroom Climate

3.14. DEVELOPING COMPETENCY IN TEACHING SCIENCE

A teacher must possess certain qualifications. These qualifications are expected of a teacher of science as well. The teacher of science must possess the following qualifications:

➢ Thorough knowledge of the subject
➢ Good memory and Originality
➢ Knowledge of the methods of Teaching
➢ Able to present the subjects in an interesting manner

Various methods are to be used in accordance with requirements of the Psychology of the students. While teaching the subject, every attempt should be made to employ a method, which is interesting and helpful. Unless the method is interesting and helpful, it shall not be possible to make the students interested in the subject matter.
The Communication theory considers teaching as telling, demonstrating and dispensing information, attitudes or skills, the assumption is that the teacher as a mature adult has access to preferred information, which the student does not process and condition should be specially created for effective communication. Teaching can be considered as a triadic relationship among the teacher, the learner and the subject Content. This triadic relationship is dynamic and changing; changes in the student and changes in a body of knowledge induce changes in the teacher and their inter-relationship.

Successful teaching result in effective learning. Successful teaching makes the content of culture live in the lives of the learners and there by enable them to live more fully, richly, wisely and humanely. The business of successful teaching is to organize situations meaningful as possible. Competent teachers are really communication specialists. They add to their communicative skill, the abilities, to select ready-made instructional materials and use them in the classroom to teach effectively. There has been a quantum jump in the growth of schools and colleges and in student strength at all levels, but a tragic slump in the standards of teaching and learning. Children from varied backgrounds flock to schools and seek instruction. Apart from the ever-increasing class strength, the diversity of student population in the same class poses a challenge to the teacher. Formal and stereotyped teaching will not promote learning among such heterogeneous groups. The training of teachers—both Pre service and In-Service will have to be recast and redesigned to Provide for alternate methods for different levels of children. The teacher may have to bear the heterogeneity of his class pupils constantly in mind to make his teaching purposeful and effective. The
teacher handling so many students with varying capacities should have his pedagogic armory full of classroom devices and strategies, which will make the unfamiliar subjects matter familiar, the abstract concept and theories more concrete.

3.15. COGNITION

"Cognition refers to mental process that transforms the sensory input in various ways, code it, Store it in memory and retrieve it for later use. Perception, imagery, Problem solving, remembering and thinking is all terms which describe hypothetical stage of cognition". (Neisser 1967)

The meanings of ‘cognitive” and cognition are different, but the term usually refers to “mental representation of events” to the process of interpreting, predicting and evaluating the environment as well as to beliefs, thoughts and expectations

Cognition refers to the process whereby an individual obtains knowledge about anything perceiving, remembering, discriminating, intergrading, and abstracting generalizing, evaluating, imaging, thinking, Problem Solving and Creating.

3.16. COGNITIVE PSYCHOLOGY

The new school of contemporary Psychology is the result of intellectualism demonstrating faith in the higher cognitive abilities and capacities of human being for his adaptation to his environment and struggle for perfection. The root of psychology may be discovered in the cognitive outlook of the Gestalists, who advocated overall mental functioning by bringing the idea of
3.17. COGNITIVE PROCESSES

Mental Process hypothesized to occur during sensation, perception, association, memory, learning and thinking. Under the cognitive processes, all the activities are included so that man becomes aware of both the external and internal environment. In order to act one must first perceive or gain knowledge.

The knowledge of the world about a person and of his own body comes to him/her through him/her sense organs. The Process of gaining knowledge of the environment through the Sense Organ is technically called sensation. The perception as a normal knowing Process of the adult where sensation is constantly being modified by various memory images.

Association means the process through which the memory images are related and ordered. From birth, memory is an integral part of the cognitive Process. The activity of combining present sensation and perception with experience and memories makes up what is usually thought of as knowing. Utilizing present perception with memory images and association gives us the process of thinking.

A cognitive process may or may not leave a lasting trace i.e. it may or may not be learned. If it does leave an engram one says that the animal has learned something, or that it has acquired a bit of knowledge. Thus, fleeting cognitive processes such as perceiving a scene, imaging an event, or forming an intention without remembering anything after a while, are cognitive processes and more over, they involve knowledge investments, but they do not enrich the animal's
knowledge. All knowledge is an outcome of a cognitive process involving learning.

The Process of mental growth and development is responsible for the development of an individual’s cognitive process like sensation, perception, reasoning, understanding, interpretation, problem solving, imagination, memory conservation, concept formation, association, thinking, intelligence, and generalization.

Sensation

Sensation means anything, which is experienced through the senses; a general term, which is used to refer to sound, visual experiences, smell, taste, tactile or kinesthetic describe the particular form that the experience will take or has taken.

Perception

The process by which one analyses and makes sense out of incoming sensory information. Perception has been studied extensively by psychologists, and now forms part of cognitive psychology. Perception can be distinguished from sensation, which concern the stimulation of Sensory receptors and may be restricted to the earlier stages of processing incoming information.

Understanding

To grasp a fact, process and situation interact especially in learning through experience. (e.g.) you do not need to understand how computers work to be able to use them.
Imagery

An image is usually a specific object. Mental representation recreates sensory impressions. The study of imagery has been a major area in memory research, as it forms one of the main systems for the encoding and representation of memories.

Memory

Memory is the general term given to the storage and subsequent retrieval of information. Memory has been intensively studied by psychologists throughout the history of psychology and consequently involves an extensive range of theoretical approaches and fields of enquiry. These include the study of episodic memory, everyday memory, levels of processing, encoding and representation and physiological correlates of memory.

Conservation

In Piagetian theory towards the end of the pre-operational stage, the ability to recognize the volume, number or mass do not change when the physical appearance of the way that they are presented.

More recent studies (e.g. Donaldson) however have demonstrated that the language used by the child, and the social situation of the experiments may have produced the result, and children may be able to conserve at a much earlier age than Piaget suspected.

Concept formation

Concept formation is the name given to the process by which an individual comes to develop mental categories, which will allow objects and events to be
classified and grouped together. A cognitive development has emphasized concept formation.

**Association**

The linking of one thing with another is sequence. Associative learning is learning which has been acquired as a result of the connection of a stimulus with response. During the period when Psychology was attempting to account for all behaviours as stimulus – response connections, association was seen as the central Psychological process.

**Problem Solving**

The study of the various strategies used by people, to achieve solution, usually of highly specified puzzles. By having the problem clearly specified it is hoped that the detailed cognitive process involved in problem solving will become apparent. It is, however, not clear, whether the findings from such researches have application to more complex human problem, such as how to pass an exam or pay the mortgage.

**Thinking**

Thinking is a general term, which can be defined in several ways: (1) the use of symbolic process by brain. (2) any chain or series of ideas: (3) ideation the sequence of producing ideas concerned with the solving of specific problems or incongruities in models of reality. Thinking is usually taken to mean conscious cognitions; most psychological investigations of thinking have concentrated on problem solving or Concept formation.
Intelligence

Intelligence refers to the ability of an individual to understand the world and work out appropriate courses of action. With in psychology these is no more precise definition that is generally accepted, through the old claim that “intelligence is what intelligence test measure” is uncomfortably acute.

Interpretation

The activity of making sense of information and identifying essential meaning is called interpretation. In psychotherapy, the activity of the therapist in pointing out underlying meaning in the patient’s activities or cognitions.

Generalization

Generalization is the process by which a learned response is derived in more situations than those in which it was first learned; it will also be applied to similar situations.

3.18. COGNITIVE PROCESS IN THE CLASSROOM

Cognitive processes are unobservable mental actions used to manipulate information. Like other kinds of processes, cognitive processes produce outcomes, or cognitive products. Cognitive products may be processed again, or they may manifest during performance. For example, a student may rehearse (cognitive process) the spelling of an irregular word over and over to learn (cognitive product) to spell it correctly in a test (performance).
The foregoing paragraphs deal with present trend of research on student's cognitive processing in the classroom.

Before beginning this transposition, two general principles characterizing both areas of research warrant explanation immediately. Because these principles are consistently descriptive of cognitive processing in diverse situations, they help justify translating findings from research not done in classrooms to classroom settings. In addition, these principles give rise to several key issues that need to be addressed when considering relations among student's cognitive processing, curriculum, teaching and learning.

The first principle is that cognitive processing can be applied to any kind of information. Information can include visual forms like the patterned lines that form letters of the alphabet, organized verbal data like stories, motivational events like student's evaluations of their performance on arithmetic problems, and plans for accomplishing tasks like composing an essay. The significance of this principle is that students' cognitive systems have the potential to process not only various kinds of information found in educational curricula, but also information...
FIGURE 3
A COGNITIVE PROCESS IN THE CLASSROOM TEACHING

Classroom environment

Curriculum
- Chunks
- Sequence

Instruction
- Goal - relevant cues
- Plan - adapting cues

Student tasks
- Learning curriculum
  - Using Instructional cues

Cognitive processing system

Sensory system
- Memory system
  - Working memory (STM)
  - Permanent memory
- Content
  - Concepts
  - Prepositions
  - Schema

Response system
- Processing system
  - Content
  - Goals
  - Plans
  - Rehearsing
  - Associating
  - Monitoring
  - Coding
  - Attending
that acts of teaching provide to students to help them achieve educational objectives. Thus, a single unified model can be used to analyze how students learn concepts, create and use cognitive strategies, and acquire and demonstrate motivation.

The second principle is that cognitive processing is neither just a response to events in a student’s environment, nor is it a complete internal determinant of a student’s performance. Cognition is both an effect caused by previous events, including cognitive ones, and a cause of future events. The relation between cognitive processing and events in the instructional environment is reciprocal. Over time, each shapes the other. The Principle of reciprocity has two important implications. First, students can not be passive recipients of teaching. They participate in creating what teaching means to them, even if it appears that all they do is listening. Second, the principle of reciprocity makes it improper to declare teacher behaviours as the sole cause of student’s achievement. Since student’s cognitive processing creates cognitive products that they manifest as learning, cognitive events like rehearing as learning, concept are among the causes of learning. This cognition may have to be stimulated by the teacher’s utterance, “That’s important for tomorrow’s quiz.” In turn, the teacher’s behaviour may be triggered by a student’s prior question that reflected earlier cognitive processing, and so on. Units of interaction within the dynamic ‘How’ of classroom events, what one labels as cause and as effect vary. The more general characterization is on of reciprocity.

Three major additions to this representation of a student’s cognitive processing system are needed to create a model relevant to classroom teaching.
The first is a conceptualization of curriculum that is compatible with the student's cognitive processing system. When a curriculum is delivered to students in classrooms, instruction is taking place. Describing instruction in terms of its reciprocal interactions with a student's cognitive processing system is a second addition. Finally, because it is students who work at learning from instruction, a characterization of student tasks will summarize how students learn from teaching according to a cognitive processing framework. Before building a model of the student's cognitive processing system that integrates curriculum, instruction, and the way these culminate in student tasks, a rationale for considering student's cognitive processing in the classroom is presented.

3.19. PRINCIPLES OF COGNITIVE PROCESS

The first principle is that cognitive processing can be applied to any kind of information. Information can include sensory information like vision and audition. Motivational events like setting the goal, Testing unknown and giving life oriented examples, and plans for accomplishing task like size, colour, shape, Intensity, contrast, Organisation, Time, Repetition and Sensory training of content. The Significance of this principle is that student's cognitive system have the potential to process not only the various kinds of information found in educational curricula, but also information that acts of teaching provide to students to help them achieve educational objectives. Thus, a single unified model can be used to analyze how students learn concepts, create and use cognitive strategies and acquire and demonstrate motivation.
The second principle is that cognitive processing is neither just a response to events in a student's environment like seating arrangement, proper lighting, blackboard visibility nor is it a complete internal determinant of a student's performance. Cognition is both an effect caused by previous events, including cognitive ones, and a cause of future events. The relation between cognitive processing and events in the instructional environment is reciprocal. The principle of reciprocity makes it improper to declare teacher behaviours like Tone modulation, using A.V.aids, Questioning and Gesture age as the sole cause of student achievement. Since student's cognitive processing creates cognitive products that they manifest as learning, attending, loading, Rehearsing, Associating, Monitoring, Mental assimilation, Registration and Recalling of concept are among the causes of learning.

To describe student's cognitive processing during teaching, it will be useful to develop a model. The model presented here synthesizes main stream research from cognitive and instructional psychology with very recent research on teaching. The central part of this model, the student's cognitive processing system, can be described in terms of three major facets. The first facet represents static aspects of the system, where cognitive processing works on different forms of information. The second facet reflects dynamic features of the system, namely the cognitive processes and their functions. The third facet, called parameters, describes the boundaries of the cognitive system.
FIGURE: 4
PRINCIPLES OF COGNITIVE PROCESS IN CLASSROOM TEACHING

**Principle: 1**

I. **Input**
   - Information
     - Sensory Information
       - Vision
       - Audition
       - Goal setting
     - Test previous knowledge
     - Link known with unknown
     - Life oriented examples
   - Size
   - Colour
   - Shape
   - Intensity
   - Contrast
   - Organisation
   - Time
   - Reception
   - Sensory training

II. **Motivational events**
   - Seating arrangement
   - Proper lighting
   - Block board visibility
   - Tone modulation
   - Audio-Visual aids
   - Questioning
   - Gesture

III. **Accomplishing Task**
   - Cognitive Events
     - Attending
     - Coding
     - Rehearsing
     - Associating
     - Monitoring
     - Mental assimilation
     - Registration
     - Recalling
   - Cognitive Product
     - Learning
     - Output
3.20. COGNITIVE LEARNING

Cognition refers to the processing of information about the environment that is received through the sense. Cognitive process involves:

- Selection of information
- Making of alteration in the selected information
- Association of items of information with each other
- Elaboration of information in thought
- Storage of information in memory and when needed
- Retrieval of stored information

A change in the way information is processed because of experience a person or animal has had. In other words, due to experience, the significance and meaning of events have been changed, new associations have been formed, and these changes have been stored in memory for future use.

Cognition includes such process as perceiving, recognizing, conceiving, judging and reasoning, specifically, the cognitive processes include a number of human functions which are important regardless of the type or level is the degree to which the various cognitive process are involved in learning.

Cognitive learning contrasts with the S.R approach in assuming that the organism learns the meaning of various objects and events rather than a series of movements. Learned responses are not regarded as habits but rather as acts made by the organism in terms of the meaning of stimuli.
FIGURE 5
COGNITIVE LEARNING PROCESS

Selection of Information → Information

Making of alteration in the selected information

Association of items of information with each other

Elaboration of information is thought

Storage of information is memory and when needed

Retrieval of stored information

STM

LTM
3.21. COGNITIVE ELEMENTS OF TEACHING BEHAVIOUR

On careful reading of books, the researcher observed that material relevant to cognitive elements of teaching behaviour was scarce until 1963. This edition of the Handbook of Research on Teaching (Gage, 1963), deals with non-cognitive variables in research on teaching, social interaction in the classroom, and the social background of teachers. But enough focus is not given to cognitive element. Since 1963, however, research on cognitive elements of teaching behaviour has begun to appear. Several distinct orientations may be discerned in the research literature, of which the following three may be specially mentioned:

- The first constitutes the interest of psychologists concerned with the nature of intelligence and with the identification of intellectual skills and abilities.

- The second is logic-based, interested in the extent to which classroom behaviour is logical.

- The third is that of the linguist who seeks understanding of classroom behaviour by studying the words and word sequences of communication among the teacher and the pupils.

3.22. GENERAL EDUCATIONAL IMPLICATION OF PIAGET'S COGNITIVE THEORY DEVELOPMENT

1. It provides a broad development perspective to the educator for building a curriculum for the children

2. The description of developmental stages and - qualitative aspects of intellectual growth is very useful in providing suitable educational practices
3. The cognitive theory, states that the child is to be actively involved in teaching-learning process for his intellectual growth.

4. The pre-school-child is at the pre-operational level, the educational programme at this stage should provide concrete operations.

5. Piaget-based curriculum requires that children should not skip any stage.

6. Educational programme should enable the child to integrate the information.

7. A child should be helped to develop internal consistency of the system.

8. Most of the activities of the piaget type require simple equipment and material.

9. Drilling in skill should be avoided.

10. Teaching learning situation should be geared to a point where the child is neither too familiar nor too unfamiliar with the objects and ideas.

11. Variety of cognitive activities like story telling, rhymes, singing, etc. are included in the programme in a systematic manner. There is a deliberate attention of developing cognitive growth.

12. A child's development is retarded if he is not allowed a fairly wide sensory and motor experience in his early years.

13. Real events and concrete objects play an important role in learning.

14. In Science and mathematics, learning from physical environment is more important than what is learnt from people, books or television.

15. A teacher should arouse curiosity of the child through planned activities.
16. Children like to find out by themselves by their own spontaneous activity

17. Children learn speedily if we provide concrete material to them

3.23. EDUCATIONAL IMPLICATION AT THE PRE-SCHOOL AND PRIMARY STAGE

1. The teacher should familiarize himself with the theoretical and practical aspects of Piaget’s theory of cognitive developments

2. The teacher should try to assess the level and types of thinking of each child in his class

3. Each child may be asked to perform some of the experiments as suggested by Piaget

4. The teacher should spend a lot of time in listening to each child’s reaction to the experiments

5. Plenty of equipment materials and opportunities should be given to children to learn on their own

6. For Social interaction, group situations may be arranged so that children learn from each other

7. Learning experiences should be so arranged as they take into account the level of thinking of mental development attained by an individual or group

8. It should be kept in mind by the teachers that the children may be influenced by egocentric speech or thought

3.24. STRATEGY

In general, a strategy is a tool, plan or method used for accomplishing a task. Other terms associated with strategy instruction are given below:
A strategy is composed of “Cognitive operation over and above the processes that are natural consequences of carrying out the task, ranging from one such operation to a sequence of interdependent operation”. Strategies achieve cognitive purpose. (e.g. Comprehending, memorizing).

3.25. COGNITIVE STRATEGIES

Celiger (1982) defined strategy as a set of abstract cognitive functions, which are used to acquire knowledge, which are biologically determined independent and constant.

- Chunking
- Spatial learning
- Concept mapping
- Advance Organizer.
- Metaphor
- Rehearsal
- Imagery
- Mnemonics

A strategy or group of strategies or procedures that the learner uses to perform academic tasks or to improve social skills

- Visualization
- Verbalization
- Making association
- Chunking
- Questioning
- Scanning
- Accessing cues
- Using mnemonics
- Sounding out words
- Self-checking and monitoring
Cognitive Strategies are intellectual “Waldoes”. The “Waldoes” is a machine which magnifies strength and increase dexterity. So named by Robert Heinlein in “The Roads must roll” after the fictional character who invented them. The name has been carried over from science fiction to robotics, Heinlein thought of the “Woldoe” as an extension of the hand and arm. The intellectual waldoe, extend mind.

Cognitive strategies are specific to distinct learning activities and would include using steps in learning. They involve interacting with the materials to be learned, manipulating the material mentally or physically or applying a specific technique to a learning task. (O’ Malley et al, 1985)

- Repetition
- Grouping
- Note taking
- Deduction
- Imagery
- Substitution
- Elaboration
- Summarization
- Translation
- Transfer
- Inference
- Auditory representation
- Recombination

Cognitive strategies operate directly on incoming information manipulating it in ways that enhance learning. Weinstein and Mayer (1986) Suggest that these categories can be subsumed less than three broad grouping,
### Figure 6: Classification and Categories of Cognitive Strategies

<table>
<thead>
<tr>
<th>Cognitive Strategies</th>
<th>Categories</th>
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<tbody>
<tr>
<td>1. Chunking</td>
<td>• Clustering</td>
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<tr>
<td></td>
<td>• Organizing</td>
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<tr>
<td></td>
<td>• Structuring</td>
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<td></td>
<td>• Sorting</td>
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<td></td>
<td>• Grouping</td>
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<tr>
<td></td>
<td>• Classifying</td>
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<tr>
<td></td>
<td>• Categorizing</td>
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<td></td>
<td>• Making Association</td>
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<tr>
<td></td>
<td>• Arrangement</td>
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<tr>
<td>2. Spatial Learning</td>
<td>• Transfer knowledge</td>
</tr>
<tr>
<td>(Spatial strategies)</td>
<td>• Comparision</td>
</tr>
<tr>
<td></td>
<td>• Relationship</td>
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<tr>
<td>3. Concept Mapping</td>
<td>• Summarization</td>
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<td></td>
<td>• Substitution</td>
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<td></td>
<td>• Recombination</td>
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<td></td>
<td>• Inference</td>
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<tr>
<td>4. Advance organizer</td>
<td>• Prior knowledge</td>
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<tr>
<td></td>
<td>• Repetition</td>
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<td></td>
<td>• Retouring</td>
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<tr>
<td>5. Metaphor</td>
<td>• Comparision</td>
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<tr>
<td></td>
<td>• Meta Cognition</td>
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<td></td>
<td>• Transfer</td>
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<td></td>
<td>• Translation</td>
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<tr>
<td>6. Rehearsal</td>
<td>• Repetition</td>
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<td></td>
<td>• Questioning</td>
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<td></td>
<td>• Note taking</td>
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<td></td>
<td>• Retrieval</td>
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<td></td>
<td>• Reinforcing</td>
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<tr>
<td>7. Imagery</td>
<td>• Modeling</td>
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<td></td>
<td>• Prompting</td>
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<tr>
<td>8. Mnemonics</td>
<td>• Naming strategies</td>
</tr>
<tr>
<td></td>
<td>• Key words</td>
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<tr>
<td></td>
<td>• Visualization</td>
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<tr>
<td></td>
<td>• Verbalization</td>
</tr>
<tr>
<td></td>
<td>• Symbolic words</td>
</tr>
</tbody>
</table>
3.26. FAMILIES OF COGNITIVE STRATEGIES

- Rehearsal
- Organisation
- Elaboration processes

3.26. FAMILIES OF COGNITIVE STRATEGIES

- Chunking simply means grouping, organizing information according to time, space, logical reasoning, types, taxonomies, cause and effects, similarities and differences is the crucial points in this strategy.

- Spatial strategies provide a visual display of substantial amount of information. In type-I grid-like form is used. But in type-II student have to record the information. They should be intellectually capable of forming the logical operations involved and systematically recalling information.

- Bridging strategies such as helping the students move from known to unknown, the advanced organizer is like a bridge, which can be constructed and used with material presented in written and oral form. It introduces a unit of instruction before the main body of presentation. It is based on student’s previous knowledge. It should be brief and abstract.

3.27. MEMORY STRATEGIES

Memory strategies have been defined as mental or behavioural activities that achieve cognitive purposes and are effort consuming, potentially conscious and controllable. (Flavell, 1985)

Role of strategic processing in Determining Memory

- Rehearsal strategies
- Organization and Reorganization strategies
- Elaboration strategies
3.28. STRATEGY INSTRUCTION

Using strategy instruction students with learning disabilities could be assisted in learning. Students can be taught how and when to use strategies, helping them identify personally effective strategies, and by encouraging them to make strategic behaviours part of their learning schema. Terms associated with strategy instruction are then defined, including cognitive strategies, cues, independent, strategic learner, learning strategy, meta-cognition and self-regulating, mnemonic, and learning schema. The effectiveness of strategy instruction and student outcomes when they become strategic are discussed. The digest then identifies the most essential performance: computation and problem solving; memory; productivity; reading accuracy and fluency; reading comprehension; and writing. The basic steps in teaching strategy use are provided, including: (1) describe the strategy; (2) model its use; (3) provide ample assisted practice time and provide feedback; (4) promote student self-monitoring and evaluation of personal strategy use; and (5) encourage continued use and generalization of strategy.
Teaching students about strategies, teaching them how and when to use strategies, helping students identify personally effective strategies, and encouraging them to make strategic behaviours part of their learning schema.

**Learning Schema**

The sets, or mixes, of strategies that the individual learner uses automatically to perform, produce, communicate, or learn. It can take years to develop a personal learning schema.

What has been learned about the effectiveness of strategy instruction?

Student’s ability to learn has been increased through the deliberate teaching of cognitive and meta-cognitive strategies. This is especially true for students with significant learning problems – strategy instruction is crucial for them. It has been demonstrated that when struggling, student’s are taught strategies and are given ample encouragement, feedback, and opportunities to use. Those, students improve in their ability to process information, which, in turn, leads to improved learning. Because not all students will find it easy to imbibe strategy use in their learning schema, differentiation of strategic instruction is required, with some students needing more-scaffolding and individualized, intensive instruction than others.

Why is it important to teach children to be strategic?

The Individuals with Disabilities Education Act (IDEA) of 1997 and the No Child Left Behind (NCLB) Act of 2001 focus on improved achievement by all Students. IDEA mandates that all students access and progress in the general education curriculum. This includes students with disabilities, English language
learners, and gifted students. NCLB has established performance goals that drive the efforts of public schools.

What happens to students when they become strategic?

The following outcomes can be expected:

- Students trust their minds
- Students know there’s more than one right way to do things
- They acknowledge their mistakes and try to rectify them. They evaluate their products and behaviour
- Memories are enhanced
- Learning the content increases
- Self – esteem increases
- Students feel a sense of Power
- Work Completion and accuracy improve
- Students develop and use a personal study process
- They know how to “try”
- On – task time increases; students are more “engaged”

3.29. COGNITIVE STRATEGIES-THEORETICAL PERSPECTIVE

“Children develop cognitive strategies and effort based beliefs about intelligence – the habits of mind associated with higher – order learning – when they continuously face challenges to find solutions that are not immediately apparent, to explain concepts, justify their reasoning and seek information. When we do not hold children accountable for this kind of intelligent behaviour, they take it as a signal that we do not think they are smart and they often come to accept this judgment”. (Resnick and Hall)
Project based learning and other school reform effort seek to engage students through altering them the change to develop and apply content area skills in the context of complex and meaningful real world problems. Student class work often looks like real world work, students learn about the whole concept in addition to its parts and cooperative learning, a norm in many workplaces, is emphasized in class.

Assessment tasks require students synthesize and apply new information to create a product. These strategies for teaching students are supported by research-based theory about how learners develop knowledge.

**Piaget and Constructivism**

Piaget theorized that people construct their understanding as opposed to merely reflecting what they hear or are told. Following a “constructivist” explanation, each learner reconciles new information with past beliefs and ideas to reach understanding. Knowing something requires building mental representations that place order on experiences and information. The process of learning involves active reasoning. Individuals get new information, interpret and make inferences and ultimately reach a point where they can express what they know in their own terms. To facilitate this kind of learning, teachers provide students with opportunities to speak, write, or physically construct something as a means of processing new information. As learners become more competent, they are able to manage their own cognitive process through self – monitoring and meta-cognition. (Resnick article, P.8)

“Knowledge Based Constructivism”: Combining skill development will contextual application of skills:
Resnick and her colleagues build on Piaget's work by demonstrating the importance of the learner's knowledge in the individual's ability to perform complex tasks. Researchers examined student's ability in problem solving and found that correct knowledge is essential to learning. For example knowing the angles in the game of billiards, or the possible moves in the game of chess is what makes a great player. The discovery and inventing aspects of learning need to be incorporated with disciplined efforts to include information, facts and processes of reasoning and logic. Research has demonstrated that if children are systematically taught the principles and / or skill of a discipline they can use their own cognitive resources to infer and puzzle out the rest.

**Standard Educational Approaches can Harm Low performing Students**

Many teachers still use the more traditional "associationist" educational approaches rooted in hierarchical mastery of tasks. Teachers drill students on sequenced basic skill in which they must demonstrate proficiency before moving on to higher order thinking skills. This approach can put students who are below grade level at further disadvantage if it fails to engage them in learning. Strategies in which learners are given a combination of problem solving, inquiring and skill based content offer all students a chance to Utilize and develop their higher order thinking skills as well as the opportunity to increase their own sense of themselves as learners and thinkers.

**3.29.1. GOAL ACHIEVEMENT AND MOTIVATION TO LEARN**

Resnick (1982) describes a new theory of aptitude that implies that people can learn to be intelligent. The ability to learn easily is a habit of mind that derives from an individual's belief about the relationship between effort and
ability. People’s approach to this topic relates closely to the amount of effort they put forth in learning or problem solving situations. (Cites from summer Beginning – Dweck). People are either performance oriented or learning Oriented.

Individuals who have learning oriented goals seeking aptitude as something that changes through effort and is developed through embracing learning and mastery opportunities. They associate ability with an inventory of skills that are expandable through individual effort. People with performance goals often associate high effort levels with low achievement in contrast to individuals with learning goals who will often apply more effort to increase their ability.

3.30. BIOLOGY OF COGNITION

Viewed biologically, cognition is any specific function discharged by certain plastic subsystems of the higher vertebrate brain. Different brain subsystems specialize in different cognitive tasks. (This explains why certain local damages cause acalculia but nor agraphia, and soon.) However the converse is false: certain cognitive tasks, even if specialized, may recruit number of subsystems, perhaps as support systems. Indeed, the monitoring of blood flow in the various regions of the cerebral cortex shows that, when a subject engages in hard intellectual work, all of the regions consume about the same amount of blood.

The fact that certain cognitive tasks engage the entire cortex or nearly so does not prove that the complex mental activities are distributed rather than localized. It only shows that the activity of the specific "Center" radiates to other and enlists their supports, as well as that of systems other than the cortex. Among
the latter the limbic system stands out. In particular, the perceptual and conceptual cortex interacts with the thalamus and hypothalamus via the amygdala.

Fig-7

Interaction between cognition and emotion

Perceptual and conceptual area

Hypothalamus and basal forebrain

Amygdala

Medial and midline thalamus

This anatomical connection between the organs of cognition and those of affect explains why perceptions, memories, and expectations can arouse emotions, and why the latter can elicit, distort, or even inhibit some cognitive processes. In sum, though different and localized in different brain regions, cognition and emotion interact. It is mistaken therefore to study them in isolation from one another. Hence, it is wrong to set aside the cognitive science as if it has no connection into psychology department.

A cognitive process may or may not leave a lasting trace (i.e, it may or may not be learned). A cognitive process such as perceiving a scene, imagining an event, or forming an intention, without remembering anything after a while, are
cognitive processes and, moreover, they involve knowledge investments, but they do not enrich the animals knowledge. All knowledge is an outcome of a cognitive process involving learning. (Bunge; 1983)

Any biologist knows that all living beings metabolize, and that the movement metabolic processes stop, the organism dies. So if we record certain vital signs of an organism, we can be sure that it is alive, even without having measured its metabolism. Likewise, all neurobiologists know that all normally performing humans have brains. They can gather both indirect and direct evidence for the hypothesis that a particular human being has in mind. They can watch a subject's behaviour and make use of a battery of behavioural indicators or they can monitor and even elicit, deviate, or stop some of a subject's mental processes with the help of sophisticated electrophysiological and neurophysiologic techniques.

The remainder of this section will be devoted to a jumble of problems about cognition: Pattern seeking, preconception, model making, and problem solving and intelligence. The first problem: The human being seems to be, both perceptually and conceptually, a pattern seeker and maker. We are forever seeking regularities or constancies, whether associations or causal connections, be they natural (law) or artificial (rules).

For example, young children, innocent of standard grammars, partly make up their own grammatical rules as they acquire a language; in particular, they regularize all irregular verbs. (Language acquisition is thus a combination of learning and invention).
In other words, we tend to overlook irregularities, imperfections, and even coincidences and exceptions. This propensity is so strong that most people find it hard to believe that anything accidental might happen. In particular, the psychoanalyst Jung made much of “Synchronicity” or coincidence, and there might not be magic or parapsychology without such resistance to belief in coincidence or accident.

3.31. PHYSIOLOGICAL PSYCHOLOGY

3.31.1. PHYSIOLOGY OF BRAIN

The human brain—it has been called the last frontier in the history of scientific inquiry. One of the greatest challenges that we face today is to understand how the brain works and, in doing so, understand ourselves as well. As long as the brain is mystery, it has been said, the universe, the reflection of the ironically, we will be successful only to the extent that our own brains are up to this awesome task.

It is nearly impossible to overestimate the importance of the brain our everyday lives. Every gesture we make, every feeling, every experience we have of our surroundings every insight or memory, is a result of a complex, beautifully modulated pattern of activity among specialized cells that number about 85 billion. We owe our entire cognitive universe, all of what we are (or think we are), to the functioning of these cells.

Physiological psychology is a branch of psychology that concerns itself with the relationship between the nervous system and behaviour. Whenever we seek answers about the physiological basis for our perceptions of the world, our movements, our needs and desires, our knowledge of the past or our ability to
learn, then we are dealing in the province of physiological psychology. In this area of research, the focus of attention is on the functions (hence the physiology) of the brain and spinal cord, sense organs, muscles, and glands.

Because of technological breakthrough, combined with new concepts of brain functioning, it has now been possible in the last decade to understand and successfully treat a range of nervous system disorders that afflict millions of people. We presently have the means for brain imaging that enables us to examine brain tissue without the hazards of neurosurgery and to trace the activity of chemicals inside the brain while an individual is alive and functioning. We have a greater understanding than ever before of the brain chemistry that underlies Schizophrenia, depression, and anxiety, as well as Parkinson's disease and Alzheimer's disease. The savings in terms of health care dollars have been enormous, and the benefits that have resulted from the ability to relieve the suffering of many mentally and physically ill patients are beyond calculation. With all these advances, we can serve advances; we can serve not only important needs of society but also address a fundamental issue that is thousand of years old: what is the relationship between the brain and the mind?

Where is the Mind?

It is hard to imagine someone proposing that an organ of the body other than the brain might be responsible for the way we think and feel. If we were to speak today of the "seat of the mind", few of us would look beyond the brain. Yet, it is clear that several civilizations and cultures at one time or another have thought otherwise. The Pacific islanders of Melanesia, for example, considered memories to be stored in the stomach, probably on the assumption that a
repository of food would hold ideas as well. Likewise, the larynx was thought to be the seat of the intellect, since it was associated so closely with the production of speech. The Predominant view among the ancient Hebrews, Chinese, and Hindus was that the heart was the seat of the mind. The ancient Egyptians so venerated the heart learning from it that special containers held them next to the bodies of their pharaohs to secure the passage of their souls to life everlasting. The brain was casually thrown away (Broad, 1978; Doty, 1965).

We seem determined to hang on to a cardio centric (heart – centered) view of the mind when we choose words to express our private thoughts and feelings. We have a “change of heart” when we charge our minds, offer our “heartfelt thanks” when we wish to indicate our sincerity, and are “broken hearted” when a romance fails. The brain does not figure conspicuously on St. Valentine’s Day in the message of affection, we do not send, nor do we often leave our brains in San Francisco. It is obvious that we carry the baggage of an earlier time.

We have Aristotle (384 – 322 B.C) essentially to blame for our obsession with hearts and minds. Aristotle believed in the heart over the head as the Center of life, and his writings influenced practically the entire spectrum of intellectual thought for well over a thousand years. From these observations, the peculiar rhythmic contraction of the heart possessed the essence of life, while the brain could be touched and probed with no response at all. Aristotle concluded that the brain served only to cool off the hot gases of the body, anatomy students of the university of Padua were being taught Aristotelian dogma that the heart was not only the origin of arteries and veins but of nerves as well (Clarke and O’Malley, 1968)
Around 400 A.D., Bishop Nemesius of Emesa (now Syria), adopting the ventricular orientation of Galen, saw the ventricles as chambers and form this postulated three “Psychic calls” in the brain. The first cell was the “Senses communis”, responsible for sensations. The Second cell was the “imaginative”, a Seat of reasoning and judgment. The third cell was the “memorativa”, where memories were stored and bodily movement initiated. Strangely, the “cell doctrine” lasted for more than a thousand years as the standard model of how the mind arose from the workings of the brain. A philosopher and mystic, Robert Fludd, Proposed in 1619 a cosmic relationship between three cells in the brain and the constellation in the sky.

The growing empirical orientation of the Renaissance eventually cast the cell doctrine into oblivion. Leonardo de Vinci in 1506, was able to visualize brain Ventrices by the ingenious technique of injecting hot wax into the Ventrices of an ox and then waiting for the wax to harden. The brain matter was then still considered, (Broad, 1978) Unit Thomas Willis in 1664 began to theorize to theorize that mental functions were results of brash matter itself.

Phrenology is a good example of how a basically sound premise (the possibility of behavioural functions localized in a specific region of the brain) could lead to a wrong conclusion (the bulging of the skull). Making matters worse, Chronological principles were developed in a hopelessly unsystematic fashion. Gall had noticed, for example, some skill prominences in local pickpockets and later labeled the spot as indicating the inclination towards “personal acquisitiveness”. Despite its obvious failings, however, phrenology encouraged others to seek a more rational basis for relating behavioural functions
to the brain. One of those who believed in a scientifically based concept of brain localization was a remarkable French physician and Surgeon named Paul Broca (1824 – 1880).

3.31.2. NEUROSCIENCE - BRAIN TRANSPLANTATION

The idea of transplanting something into scene from a Frankenstein movie. Yet, the reality is that researchers have successfully accomplished the engrafting of cells into specific areas of the brain, on an experimental basis. These accomplishments look promising enough to predict that brain tissue transplantation may be a future treatment for neurological disorders ranging from the loss motor control in Parkinson’s disease and cognitive deterioration in Alzheimer’s disease to blindness and spinal cord injury.

While Successful brain tissue transplants in general date back to as early as 1903, the recent efforts have focused upon regions of the brain that are known to be responsible for specific functions. For example, Parkinson’s disease is presently understood to be consequence of a degeneration of brain cells that produce the neurochemical dopamine. In 1979, a term of American and Swedish researchers transplanted normal dopamine- producing cells from fetal rat brains into the brains of adult rats that had been injected with a dopamine – destroying substance and had acquired many of the symptoms characteristic of Parkinson’s disease. Many of the motor deficits in these rats were reduced. (Perlow et al., 1979)

Later studies showed that dopamine producing cells in adrenal glands could also be effective as grafting material to reduce the Parkinson – type behaviours in experimental animals (Freed et al., 1981), the brain, attempted
since 1982 in Sweden with human parkinson’s disease patients, have achieved only transient improvement (Olson et al., 1985). Surgeons in Mexico reported in 1987), but attempts to repeat their success in the United states have been disappointing (Sladek and shoulson, 1988). The right combination of factors to ensure successful transplantation for parkinson’s disease still remain to be found.

Transplant studies aimed at reducing the deficits of Alzheimer’s disease are at present still at the stage of animal investigations. Since this disorder involves a loss of cells that produce the neurochemical acetylcholine, the focus of the experiments has been to transplant acetylcholine – producing cells into brain regions known to have responsibility for memory formation. In one study, rats with brain lesions that made them unable to learn a simple maze showed improved performance after receiving transplantation of acetylcholine – producing cells (Bjorklund and Gage, 1985).

The brain evidently has an astonishing ability to direct the growth of nerve cell fibers to the appropriate destination. McLoon, Lund and McCloon (1982) showed dramatically that when retinas from fetal rats were transplanted into the brains of adult rats, the retinal nerves grew methodically toward the regions of the brain concerned with vision. How this amazing choreography is achieved remains a great mystery. Many neuroscientists believe that there are growths, enhancing chemicals that serve to steer the nerve fibers in specific directions, but the nature of such chemicals is presently unknown. It may be these substances that ultimately hold the key to successful brain tissue transplantation. In the meantime, the fact that progress can even be made in such a complex area of study
is a testament to the growing sophistication of neuroscience research. It appears likely that transplantation surgery will someday have a major impact on clinical neurology.

3.31.3. PHYSIOLOGICAL PSYCHOLOGY AND NEUROSCIENCE

In the early 1970s, the history of physiological psychology entered a new era. Anatomists, physiologists, psychiatrists, pharmacologists, endocrinologists, immunologists, biochemists, and others began to combing their efforts and, in effect, created a team approach toward the difficult problems inherent in brain research. This new collaborative endeavour, referred to as neuroscience, has brought about a revolution in establishing the critical linkages between brain functioning and behaviour.

Physiological psychologists, often referred to as behavioural neuroscientists, and others in, the neuroscience community have made tremendous advances in understanding the nature of mental disturbance in terms of biochemical processes in the brain. Neuroscientists, for example, have discovered the existence of brain-produced opiates and are beginning to understand their important role in the control of pain and in drug addiction, as well as our emotional well-being. This is only one of several areas in which a clearer picture of how we think and feel has emerged from a biochemical analysis of brain functioning.

The brain remains a complex puzzle, as if it is defying the brains of thousands of neuroscientists around the world who are trying to unravel its mysteries. Yet, the progress in undeniable. The adventure of the neuroscience revolution continues at an increasingly rapid pace. New discoveries and insights
gives us optimism that solutions will soon be found to many of the complex challenges that face us in physiological psychology and neuroscience in general.

The essential feature of the nervous system is its ability to process information. It brings information in from the outside environment, interprets that information, remembers some of it, and in turn controls a body that must respond to that environment, change its response if the circumstances warrant, and in short service.

The nervous system handles all these tasks through the operation of specialized, mutually communicating cells called neurons. Within the brain, there are billions of such neurons, making the brain not only the most complex organ of the body but also the most complex known entity in the universe. Fortunately, however, the basic unit within this staggering complexity – the view on itself – can be understood in relatively simple terms. One common approach is parallel between the brain and a computer.

3.31.4. THE NEURAL BASIS OF COGNITION

A broad band of fibers, called the corpus callosum, connects the right and left halves of the brain. The corpus callosum has been surgically severed in some patients to prevent epileptic seizures. The operation is typically successful and patients seem to function as well as people who have not had such operations. However, careful psychological research has found difference between such patients and subjects who have not had this surgery. In one experiment, the word key was flashed on the left side of the screen the subject was looking at. When asked what was presented on the screen the subject was not able to say. However,
the subject’s left hand (but not the right) was able to pick out a key from a set of objects hidden from view.

This experiment, the background of which we will discuss in more detail later, illustrates the obvious point that the brain underlies cognition, and that physical operations on the brain affect cognition. Perhaps more interesting than the problems these patients experienced is the fact that they did not have more serious cognitive deficits after such a major serious procedure.

We are just beginning to understand the role of the brain in cognition. Usually, the more primitive the cognitive function, the more we understand about how the nervous system achieves it. We have a much greater degree of understanding of the role of the nervous system in simple sensation, motor control and autonomic regulation than of its role in memory, problem solving and language. However, we are slowly acquiring understanding in all area of cognition. In some cases, this understanding takes the form of basic descriptive statements (for instance, such-and-language). In other cases, this understanding takes the form of quite speculative proposals; for instance, we will discuss some of the neural mechanisms that may underly learning.

3.31.5. THE NERVOUS SYSTEM

The nervous system refers to more than just the brain. It refers to the various sensory systems that gather information from parts of the body and the motor system that controls movement. In some case information processing that takes place outside the brain is considerable. From information processing point of view, the most important component of the nervous system are the neurons. The human brain itself contains roughly 100 billion neurons, each of which may
FIGURE: 8
NEURAL PATHWAYS IN VOLUNTARY MOVEMENT
have roughly the processing capability of a medium-sized computer. A considerable fraction of the 100 billion neurons are active simultaneously and do much of their information processing through interactions with one another. Imagine the information-processing power in 100 billion interacting computers. According to this view of the brain, there is more computational power in one – 3 – 16 brain than in all the computers in the world. Lest become overwhelmed by the brain, we note that it is not good at doing some things the computer does well. There are many tasks, like finding square roots, at which a hand calculator can outperform all 100 billion neurons. Understanding the strengths and weaknesses of the human nervous system is a major goal in understanding the nature of human cognition.

3.31.6. THE NEURON

Neurons come in all shapes and sizes, depending on their exact location and function. There is however, a generally accepted notion of what the prototypical neuron is like, and individual neurons match up with this prototype to greater or lesser degrees. The main body of the neuron is called the soma. Extending from the soma are a set of short branches called dendrites. Also attached to the soma is a long tube called the axon.

Axons provide the fixed paths by which neurons communicate with each other. The axon of one neuron extends towards the dendrites of others. At its end, the axon branches into a large number of terminal arborizations. Each arborization ends in terminal buttons that almost make contact with the dendrite of the other neuron. This near contact between axon and dendrite is called a synapse. The most typical means of communication between neurons is that the axon
terminal on one side of the synapse release chemicals, called neurotransmitters that act on the membrane of the receptor dendrite to change its polarization, or electrical potential. The inside of the membrane covering the entire neuron tends to be 70 millivolts more negative than the outside due to the greater concentration of negative chloride ions inside and positive sodium and potassium ions outside. Depending on the nature of the neurotransmitter, the potential difference can decrease or increase. Synaptic connections that decrease the potential differences are called excitatory and synapses that increase the difference are called inhibitory.

In a mature adult, the synaptic connections among neurons have all grown in, and new synapses are not formed among neurons. The average soma and dendrite have about 1000 synapses form other neurons and the average axon synapses to about 1000 neurons. The changes in electrical potential due to any one synapse are rather small, but the individual excitatory effects positive in the summation and the inhibitory effects negative). If there is enough net excitatory input, the potential difference in the soma can drop sharply. It the reduction in potential is large enough, a depolarization will occur at the axon billock, where the axon joins the soma. The inside of the neuron momentarily becomes more positive than the outside. This sudden change referred to as an action potential, will propagate down the axon. When the nerve impulse reaches the end of the axon, it will cause neurotransmitters to be released from the terminal buttons, thus completing the cycle.

To review, potential changes accumulate on a cell body, reach threshold, and cause an action potential to propagate down an axon. This pulse in turn
causes neurotransmitters to be transmitted from the axon terminal to the body of a new neuron, causing changes in its membrane potential. It should be emphasized that this sequence is almost all there is to neural information processing, yet intelligence arises from this simple system of interactions.

The time for this neural communication to complete the path from one neuron to another is roughly 10 sec—definitely more than 1 sec, and definitely less than 100; the exact speeds on the characteristics of the neurons involved. This is much slower than the millions of operations that can be performed in 1 sec by a computer. There are, however, billions of these activities occurring simultaneously throughout the brain.

3.31.7. NEURAL REPRESENTATION OF INFORMATION

Information in the brain is represented in terms of continuously varying quantities. There are two such quantities. First, the membrane potential can range more or less negative. Second, the axon can vary in terms of the number of nerve impulses it transmits per second. This is referred to as its rate of firing. It is number, not the pattern, of impulses along a single axon that is important. There can be hundreds of nerve impulses along a single axon that is important. There can be hundreds of nerve impulses per second, the greater the rate of firing, the more effect the axon will have on the cells to which it synapses. Information representation in the brain is to be contrasted with information representation in a computer, where individual memory cells or "bits" can have just one of two values—off and on, or 0 and 1.

There is a general way to conceptualize the interactions among neurons that captures the many specific variations on information transfer in the nervous
FIGURE 9
CONDUCTION OF NERVE IMPULSE

Sense Organ
Nervous System
Motor System
Brain
Motor Neuron
Sensory Neuron
Gather information from parts of the body

Sensory System

Sensory Receptor

CNS (Brain/Spinal Cord)

Muscles & Gland

Environment (Body)

Sensory Neurons (Afferent neurons)

Association Neurons (efferent neurons)

Motor Neurons

Activate the muscle
system. This is to think of a neuron as having an “activation level” that corresponds roughly to its firing rate on the axon or to the degree of depolarization on the dendrite and soma. Neurons interact by driving up the activation level of other neurons (excitation) or driving down their activation level (inhibition). All neural information processing takes place in terms of these excitatory and inhibitory effects; they are what underlies human cognition.

There are serious problems in understanding how this basic process really produces cognitive phenomena. Cognition resides in pattern of the primitive elements of computers. Similarly, we can be sure that human cognition is achieved through large patterns of neural activity.

We do not really know how the brain encodes cognition in neural patterns, but the evidence is strong that it does. There are computational arguments that this is the only way to achieve cognitive function (Hinton and Anderson, 1981). There is also a fair amount of evidence suggesting that human knowledge is not localized in any single neuron, but is distributed over the brain in large patterns of neurons. Damage to any small area of the brain generally does not result in the loss of specific memories. On the other hand, massive damage to large areas of the brain will result in temporary or permanent loss of a large set of memories.
CONDUCTION OF IMPULSE THROUGH SYNAPSE

Nerve impulse coming from axon

Synaptic knob

Release of acetylcholine

Acetylcholine diffuses through Synaptic cleft

Acetylcholine combines with chemoreceptor of the post synaptic membrane

Permeability of post-synaptic membrane is increased

Depolarization of post synaptic membrane

Impulse moves in the post synaptic neurons

Acetylcholine esterase Acetate

Acetic acid + Choline
CONDUCTION OF IMPULSE THROUGH NEUROMUSCULAR JUNCTION

- Nerve impulse coming from axon

- Depolarization of sole foot

- Release of acetylcholine

- Acetylcholine receptor complex

- Increased permeability of Sarcolemma

- Depolarization of Sarcolemma

- Transmission of Impulse from Sarcolemma to muscle fiber

Coding of Permanent Memories

The patterns of neural activation are transitory. The brain does not maintain the same pattern for minutes, let alone days. This means that these patterns cannot encode our permanent knowledge about the world. The frequent belief, for which there is some evidence (Eccles, 1979), is that memories are encoded by changes in the synaptic connections among neurons. There is little evidence for growth of new synapses in the adult, but change in their effectiveness in response to experience. That is neuron (A) can become more effective in
exciting or inhibiting neuron B. If neuron A must stimulate neuron (B) to retrieve some memory pattern, this can be achieved by making the synaptic connection between (A) and (B) more effective. The next time (A) is activated, it will activate (B) and the memory pattern will be retrieved.

3.3.1.8. ORGANIZATION OF THE BRAIN

Having reviewed some of the basic principles of neural information processing, we will look at the overall structure of the central nervous system and then focus on the nature of information processing in the visual system. The central nervous system consists of the brain and the spinal cord. The major function of the spinal cord is to carry neural messages from the brain to the muscles and sensory messages from the body back to the brain.

A cross section of the brain with some of the more prominent neural structures labeled. The lower parts of the brain are evolutionary more primitive. The higher portions of the brain are only well developed in the higher species. Correspondingly, it appears that the lower portions of the brain are responsible for more basic functions. The medulla controls breathing, swallowing, digestion, and heartbeat. The cerebellum plays an important role in motor coordination and voluntary movement. The thalamus serves primarily as a relay station for motor and sensory information from lower areas to the cortex. The hypothalamus regulates expression of basic drives.

The cerebral cortex, or neocortex, is the most recently evolved portion of the brain. The amount of folds and wrinkles on the cortex is one of the striking physical differences between the human brain and those of lower mammals.
Evidence for such cortical localization of function is regarded as important in cognitive psychology. It is argued functions means that distinct cognitive principles underlie the functions. Evidence for special localization of language function is used to support the portion that language is distinct in its processing from that of other higher level cognitive functions. Such evidence is certainly suggestive, but we can argue against the inference from distinct cortical localization to distinct principles of operation.

We have surveyed some of what is known about the structure of the nervous system and how it processes information. An interesting question concerns what implications neural information processing has for the issues of cognitive psychology.

There has been surge of interest in the computational character of neural processing. A recent series of paper edited by Hinton and Anderson (1981) provides a good discussion of this material.

3.31.9. THE BRAIN: ITS STRUCTURE AND FUNCTIONS

The brain and the central nervous system mediate all human behaviour. The behaviour of learning is one of the most important activities of the brain. From a neurological perspective, Learning disabilities represent a subtle malfunction in this most complex element of the human body.

3.31.10. THE CEREBRAL HEMISPHERES

The human brain is composed of two halves, the right hemisphere and the left hemisphere, which appear on causal inspection to be almost identical in construction and metabolism. Each Cerebral hemisphere contains a frontal lobe, a temporal lobe, an occipital lobe, a parietal lobe and a motor area. The motor area
of each hemisphere controls the muscular activities of the opposite side of the body. Thus, the movements of the right hand and foot originate in the motor area of the left hemisphere. Both eyes and both ears are represented in each hemisphere (Goaddes, 1985).

3.31.11. CEREBRAL DOMINANCE

Orton, one of the early investigators of reading and language difficulties, theorized that the reversal of letters and words (which he called strephosymbolia, twisted symbols) was symptomatic of a failure to establish cerebral dominance in the left hemisphere, the location of the language area (Orton, 1937). According to Orton’s theory, the left hemisphere should be the dominant or controlling hemisphere, and the interference of the right hemisphere during language activities causes language confusion. Current findings carry Orton’s theory further. Usually, the left hemisphere does specialize in the language function and the right hemisphere controls nonverbal functions. However, the two hemispheres of the brain do not work altogether independently; there are many interrelating elements and functions. The learning process depends on both hemispheres and their interrelating functions (Cotman and Lynch, 1988; Hiscock and Kinsbourne, 1987; Gaddes, 1985). Inefficient functioning of either hemisphere reduces the total effectiveness of individuals and affects their acquisition and use of language (Hiscock and Kinsbourne, 1987; Duane, 1986).

3.31.12. LATERAL PREFERENCE

The issue of lateral preference is the subject of a related controversial theory, which proposes a relationship between learning disorders and a tendency to use either the right or left side of the body or a preference for the right or left
hand, foot, eye, or ear. The term consistent laterality refers to the tendency to perform all functions with one side of the body. Mixed laterality is a tendency to mix the right and left preference in the use of hands, feet, eyes and ears. A student's laterality may be tested through simple behaviours—such as throwing a ball, kicking a stick, seeing through a tube, and listening to a watch—and through more sophisticated means used in neuropsychology (Biegler, 1987; Obrzut and Boliek, 1991; Gaddes, 1985). The research on lateral preference presents mixed findings about differences in reading ability between students with Consistent laterality and mixed laterality.

3.31.13. RECENT BRAIN RESEARCH

Research on the brain and its relationship to behaviour and learning has accumulated slowly, in part because the technologies for studying the structure and function of the brain have only recently become available. Today neuroscientists can vastly extend their studies of the structure and functions of the brain because of technological advancements. These advancements create opportunities for better understanding of the relationship of the brain and learning
disabilities.

3.31.14. LEFT AND RIGHT HEMISPHERE FUNCTIONS

Although the two halves of the brain appear almost identical in structure, they differ in function, and these differences appear very early in life (Hiscock and
Kinsbourne, 1987).

The left hemisphere reacts to and controls language—related activities. For more than 90 percent of adults, language function originates in the left hemisphere, regardless of whether the individual is left—handed, right—handed
or a combination of the two. Language is located in the left hemisphere in 98 percent of right-handed people and in about 71 percent of left-handed people.

The right hemisphere deals with nonverbal stimuli. Spatial perception, mathematics, music, directional orientation, time sequences, and body awareness appear to be located in the right brain.

Thus, even though visual and auditory nerve impulses are carried to both cerebral hemispheres simultaneously, it is the left hemisphere that reacts to linguistic stimuli, such as words, symbols and thought. Consequently, adult stroke patients with brain injury in the left hemisphere often suffer language loss in addition to an impairment in the motor function of the right half of the body.

This duality of the brain has led to speculation that some people tend to approach the environment in a "left-brained" fashion, whereas others use a "right-brained" approach. These differences in brain function warrant further discussion, because the concept may provide some insight into differences in learning styles.
FUNCTIONS OF LEFT AND RIGHT HEMISPHERE OF THE BRAIN

**LEFT HEMISPHERE**
- Analytical Processing
- Language
- Right hand
- Right body side
- Time sequencing
- Right visual field
- Maths
- Science
- Writing
- Logic
- Verbal Memory
- Word Parts
- Syllable recognition
- Speech of sound
- Motor activity (speech and action)
- Comprehensive
- Aggressive behaviour

**RIGHT HEMISPHERE**
- Global, Holistic Processing
- Recognizing Faces
- Tone of voice
- Visuospatial skills
- Left hand
- Musical ability
- Emotion
- Humor \ Metaphor
- Left visual field
- Dance
- Sculpture
- Art Appreciation
- Music Appreciation
- Perception
- Non – Verbal
- Concrete
- Creative
- Analogy
- Aesthetic
- Model making
- Geometric designs and graphs
- Spatial movement
- Gestation
3.31.15. MECHANISMS UNDERLYING TEMPORAL INFORMATION PROCESSING

Pharmacopsychology as a basic science used drugs as research tools for elucidating the neurobiological basis of behavioural process [Janke, 1983] the ultimate aim of the pharmacopsychological approach is to discover the neurochemical systems in the brain that mediate specific human behaviours.

Manipulation of a single neurotransmitter system may also cause significant changes in the levels of activity of other neurotransmitter systems (De Simony, Dal Toro, Fodritto, Sokola 1991; Trulson and Jacobs, 1997). By attempting to discover how different neurotransmitter systems in the brain contribute to the specific behaviour under investigation, the single – behaviour – multiple – brain – systems strategy facilitates inferences from a single behaviour to the underlying neurobiological processes (Solomon, 1986). In the field of psychology of time a distraction should be made between estimation of time and perception of time (Fraisse, 1984; Rammsayer, 1992). Estimation of time refers to the processing of time intervals in terms of seconds, minutes or more, whereas perception of time refers to the temporal processing of extremely brief duration. Time estimation has been shown to be cognitively mediated but time perception supposedly is of a highly perceptual nature, fast, parallel and not accessible to cognitive control (Michon, 1985, P.40). Studies on time estimation indicate that subjects' judgements of durations were a function of the amount of mental content (Frankenhaeuser, 1959), Complexity of information (Ornsterin, 1969), processing effort (Burnside, 1971) and experience of change (Block and Reed, 1978). However the processing of time intervals in terms of seconds or more, the
processing of brief durations ranging from approximately 50 to 100 sec., appears to be beyond Cognitive control. Therefore, performance on time perception and temporal discrimination of brief intervals in humans (Allan and Danner, 1977) as well as time related behaviour in animals (Cheuch, 1984; Meck, 1983) if often interpreted by the assumption of a hypothetical interval clock. According to their perspective, the internal clock mechanism is basically characterized by a manual pacemaker and an accumulator. The pacemaker generates pulses and the number of pulses relating to a physical time interval is recorded by the accumulator, thus the number of pulses counted during a given time interval is the internal representation of this interval. Hence the higher the clock rate the finer the temporal resolution of the internal clock will be which is equivalent to greater accuracy and higher performance on time perception tasks.

Based on Church (1984) and Meck (1983) results with they suggested that the speed of the internal clock depends on the effective level of brain dopamine (DA). According to this hypothesis, dopamine agonists such as methamphetamine increase clock speed, whereas DA antagonists such as haloperidol decrease the mean rate of the pacemaker of the internal clock.

Haloperidol is a DA receptor blocker that exhibits its DA antagonistic effect by blocking post synaptic D1 and D2 receptors, but with a for higher affinity to D2 receptors (Peroutka and Snyder 1980).

The speed of the internal of clock underlying time perception decreases under the DA antagonistic influence of haloperidol according to the prediction based on animal studies by church (1984) and Meck (1983) whereas the slight increase in performance lender the 5 – HT2 Receptor blocker retransferring may
be due to serotonergic – dopaminergic interactions in the central nervous system. Ritanerin enhance dopaminergic activity by blocking serotonergic inhibition as suggested by Ugedo, Grenhoff and Svensson (1989). Such an interpretation would be in agreement with the hypothesis that temporal processing of brief intervals can be considered a function of the effective level of brain DA as proposed by Church (1984).

Midazolam has deteriorating effect on speed and integrity of information processing – temporal processing of brief intervals is largely independent of the present level of cortical arousal.

Rammsayer and Vogel (1992) studied the effect of the DA antagonist alpha- methyl – para – tyrosine (AMPT), an inhibitor of tyrosine hydroxylase, on processing of temporal information in terms of milliseconds. Unlike the DA receptor blocker haloperidol, AMPT exerts its DA antagonistic effect by blocking the biosynthesis of DA. Unlike haloperidol, remoxipride is a substituted benzamide derivative that selectively blocks central D2 receptors (Ogren et. al, 1984).

It is important to note, however, that the impairing effect of remoxipride on cognitive functions underlying time estimation appears to be less than the effect of haloperidol.

3.31.16. SUB CORTICAL MODULATION OF ATTENTION

Diverse brain areas and systems appear to be involved in the control of attentional processes. In general, Variations in rhythmic forebrain activity that have been found to accompany different modes of information processing in the
brain (as reflected by electroencephalographic activity) are presumed to represent thalamic activity, which in turn is under the control of modulator neurotransmitters from the brain stem and basal forebrain. The reticular nucleus of the thalamus receives cholinergic inputs from both brain stem and basal forebrain nuclei as well as noradrenergic inputs from the locus ceruleus (McCormick, 1989). In addition to norepinephrine (NE) or noradrenaline (NA) and acetylcholine (ACH), dopamine (DA), has also been implicated in the control of attentional processes.

Bloom (1979) speculated that one of the functions of the DNAB (dorsal noradrenergic bundle) is to prolong the impact of environmental stimuli, converting phasic events into longer term tonic influences, thereby enhancing the response of target cells. Thus the ceruleocortical NAergic system may play an important role in selective attention – enhanced activity in the system at terminal regions reduces the effects of stimuli that lack salience, thereby enabling the Organism to Process certain events while ignoring others (Mason and Iversen, 1979). Jacobs (1986) noted that, across species, the repetitive presentation of auditory or visual stimuli produced a decrement in the phasic response of LC – NE neurons. (LC – Locus ceruleus the largest nucleus in the mammalian brain, which is located in the brain stem reticular formation (BSRF) in the floor of the fourth ventricle. The LC, which is very small area containing almost exclusively NE cells, has both ascending and descending projections to areas as diverse as the neocortex, hippocampus, hypothalamus, cerebellum and the spinal cord.
3.32. SOCIOLOGY OF COGNITION

Social Cognition

Thus far, we have been discussing mainly how children understand nonsocial objects, and events in their world. We will now turn to the development of social cognition, that is, how children come to understand the viewpoints, emotions, thoughts, and intentions of themselves and of others, and how they think about social relations and institutions. It has been suggested that a central process in the development of social cognition, particularly in infancy, is differentiation – differentiation of the self from the oneself, of humans from inanimate objects, and of one human object from another (Flavell, 1985, Olson, 1981).

In many ways, the changes in social cognition and the processes underlying them are parallel to those in nonsocial cognition. Children come to recognize that social objects have a permanence and existence of their own and that certain attributes of people are invariant. The children become less egocentric and more able to understand the viewpoints, feelings, and thoughts of others, they more from viewing people in terms of immediately observable attributes to more abstract characteristics involving motives, intentions, and emotions of others. They are able to view the multiple aspects of people and hypothesize about the complexities of their relationships to their environments, past experience, and future expectations. In addition, they become increasingly aware of the psychological processes associated with their own and other people’s feelings, motives, emotions, values, problems, and cognitions. They speculate about what others think of them and examine their own thinking about themselves and others
Perhaps the most distinctive differences between people and inanimate objects that children come to recognize are, first, that people have feelings, thoughts, expectations and intentions that may not be obvious and that may make their behavior difficult to predict, and second, that social relationships involve a series of contingent interactions in which the partners interpret social information and coordinate their activities and responses with each other (Damon, 1981).

Even young infants seem to expect different responses from people than from objects. If someone faces a two-month-old infant without moving or speaking, the infant becomes distressed (Gelman and Spelke, 1981). Infants also learn to expect different kinds of responses from people and to use these responses to guide their own behavior. (Klinnert, Campos, Sorce, Emds, and Svejda, 1983) The concept of Socially Shared cognition plays an important in our efforts to create and sustain model systems of educational activity. “Sharing” is a Janus-headed concept (Cole, 1991, P. 398) on the other hand it refers to receiving, Using and experiencing in common with others. On the other hand sharing also means to divide or distribute something between oneself and others. Both of these aspects of sharing with respect to socially shared cognition are relevant.

First in the design of the system of activities themselves, we are acting from our assumption that cognition is distributed among such important elements as the participated among such important elements as the participants, the artifacts they use and the social – institution within which they are hosed. Second, as a research collective, we share some beliefs and practices, such as an intellectual affinity for the ideas of John Dewey, Lev Vygotsky and George Herbert Mead.
agreed to incorporate qualitative and quantitative methodologies into the work of the collective. At the same time, we divide the work between and among members who are on implementation and \ or evaluation teams, located at Institutions of higher learning that have different populations, priorities, missions and locations.

No two people can ever entirely experience a situation or use a tool in exactly the same way even as they are cognizant of the fact (which they may communicate to each other) that there are aspects of their experience, which can be said to be shared in the sense of, held in common.

3.32.1. SCHEMAS AND PROTOTYPES

Social cognition involves the processes through which we notice, interpret, remember, and latter use information about the social world. Schemas are mental frameworks containing information relevant to specific traits, situations, or events. They are formed through experience and, once developed, exact strong effects on many aspects of social cognition, including attention, encoding, and retrieval of social information. Prototypes are the typical qualities of members of some group or category. They, too, exert strong effects on social cognition once formed. Moreover, recent findings indicate that individuals are more likely to engage in various high – risk behaviours such as smoking or unprotected sex, if they hold favorable prototypes of persons who engage in such actions or perceive themselves as similar to these prototypes.

Heuristics

Mental shortcuts in social cognition because we have limited capacity to process social information, we often use mental shortcuts. Heuristics are mental
rules of thumb that permit us to make rapid decisions or judgments about complex social stimuli. According to the representativeness heuristic, the more similar an individual is to typical members of a given group, the more likely she or he is to belong to that group. Another important heuristic is availability, according to which the more readily information can important frequent it is judged to be.

3.32.2. AFFECTIVE STATE AND COGNITION

Sharply contrasting views of the nature of emotions have been proposed. The Cannon-bard theory suggests that emotion provoking stimuli both physiological reactions and subjective emotional states. In contrast, the James-Lange theory suggests that emotional experiences stem primarily from our recognition of changes on our bodily states. Schachter’s two-factor theory proposes; that it is the cognitive label we attach to physiological arousal that is crucial

Affective states have been found to influence memory, creativity and many forms of social judgment; including evaluation of job applicants, recent evidence indicates that changes in mood are often reflected in changes in social judgments. Also, cognition often influences affect. The emotions we experience are determined, at least in part, by the labels we attach to arousing events, and our emotional reactions to provocative actions by others depend in part on our interpretation of the causes behind these actions. If we expect to like or dislike some stimulus or event, our affective reactions to it will usually be consistent with such expectations.

The affect infusion model explains how our affective states influence cognition. According to this model, such effects occur because effect primes
related associations, memories and thoughts, and because we use our affective states as a basis for inferring our judgments about social stimuli. The model also predicts that affect will have a stronger impact upon cognition at times when we engage in careful substantive thought.

3.3.2.3. SOCIAL INFLUENCES ON COGNITIVE DEVELOPMENT

Traditionally, cognitive development in its several guises has been treated as if it were an individual event, dependent only on the stimulation, which the individual child receives from its environment. But more recently the evidence has been accumulating that what is involved is much more than simply environmental stimuli. Increasingly, attention has focused on the importance of social influences and social interactions in the child’s cognitive development.

In the 1960s, research into what were considered personality traits, such as the need for achievement showed that the expectation of parents seemed to be exerting a considerable influence on the way in which this trait developed in children. Research into language acquisition too developed from the two extreme nature – nature positions represented respectively by Chomsky and Skinner, to an emphasis on the importance of language as a mean of social communication (Vygotsky, 1962), and on the need for social interaction while the child is acquiring language (Villiers and de Villers, 1978).

In terms of the formal theory of cognitive development developed by Piaget, recent evidence shows that many of the outcomes of traditional Piagetian tasks came about because of the social demands of the situation: rather than being cognitively incapable of doing anything as difficult as solving the tasks which were presented to them, children were actually applying a sophisticated social
awareness to the situation and presenting the adult experimenters with the answers which they believed the experimenters wanted (Rose and Blank, 1974).

The recent interest in the child's theory of mind also shows that the child's understanding of other people is very much more highly developed than a strict interpretation of the Piagetian model of cognitive competence might allow. And research into moral development too has come increasingly to emphasis the importance of social interaction.

The picture, which is emerging from all this is congruent with that which emerges when we look at the young infant: a child whose prime focus is on social interaction and social adoption. The human infant is born predisposed to interact with people, and to learn from that interaction. In addition, this predisposition forms the basis for the child's cognitive development as well.

3.32.4. SOCIAL COMPETENCIES

Social Cognition Theory

Social cognition theory is a set of principles that has yet to be integrated into a single overarching theory. The focus of these theories is how cognitive factors may help to account for the acquisition, maintenance, developmental changes, and control or prevention of aggression and violence. Cognitive factors are hypothesized to: be acquired through learning, contribute to proactive exposure and interpretation of social experiences, mediate aggressive responses to particular social experiences, account for individual consistencies and continuities in patterns of aggression, victimization, and bystander support for violence, and be amenable to change (Pepler and Slaby, 1994). Thus, the theory argues that certain cognitive components, such as attributions, attitudes, and beliefs, mediate
the effects of strong emotional arousal on the violent behavioural responses of the aggressor, and because these cognitive components are learned, they are changeable.

3.33. IMPLICATIONS FOR THE PEDAGOGY OF SCIENCE

The consideration of basic results of cognitive science could radically change the way science is taught. Today teaching is still done in most cases like a process of pouring information in the heads of the students and waiting that they integrate this information on their own. If they do that, we say that they are ‘good’ for science; if they fail, we say that they are not ‘talented’ it is essentially an empirical, hit and miss process. The efficiency of this system is given mainly by the power of motivating the students to work on their own.

The process of teaching science should take in consideration the complex mechanism of the creation of abstract concepts and of the associations that link a specific problem to previously assimilated concepts. Teachers should be as familiar to the cognitive bases of science as to the science they teach. The power of multimedia and of the computers should be extensively used in teaching, but in a context appropriate to the cognitive in real situations.

A main implication of the cognitive models presented is that the solving of a problem does not necessarily imply that the student really did it using the right cognitive mechanisms that would be also used in a real world problem. The fact that someone has good marks means that he or she may be quite smart, but not necessarily that he or she will be as effective in solving a problem in a real world setting as for a school problem. In physics, the ‘correct’ way in solving a problem is to internally stimulate the domain of the problem, then to apply on this domain
a suitable grouping, identify the abstract correspondent of objects in the domain, project the known structure between these abstract concepts to the domain for solving the problem, eventually via a mathematical formalization. This is also the mechanism used in a real world problem, where we have to choose the right model to apply on a certain domain. However, there are classes of problem that can be solved using other cognitive models; for example, given the available quantities in the text of a problem, the student may apply randomly formulas learned by rote that involve these quantities. While these mechanisms would work for a certain class of problems, they won’t work for all problems; the children won’t understand why they don’t arrive at solving the new problems, resulting in a failure. An interesting study that shows the importance of internal simulations was done by van Heuvelen (1991). The results can be improved with up to 20% if the teacher insists that the solving of problems should follow a procedure that involves sketches of the domains and then of the abstract concepts.

3.34. A MODEL TO DEVELOP COMPETENCE IN TEACHING SCIENCE THROUGH COGNITIVE INTERVENTION STRATEGIES

Based upon the above conceptual frame work a final model was evolved to develop the competence in teaching science through cognitive intervention strategies. The following steps:

I. COGNITIVE PROCESSES

Cognitive processes are highly mental processes hypothesized to occur during sensation, perception, association, memory, learning and thinking.

a) Motivation

Any teaching and learning process needs motivation on the part of the teachers and learners.
FIGURE 12
RAJKUMAR’S MODEL ON ENHANCING TEACHING COMPETENCY THROUGH COGNITIVE INTERVENTION STRATEGIES

Cognitive Processes → Cognitive Strategy → Strategy Processes

- Motivation
- Attention
- Knowledge
- Sensation
- Perception
- Association
- Conceptualization

Cognitive Strategies
- Chunking
- Spatial Learning
- Concept Mapping
- Advance organizers
- Metaphor
- Rehearsal
- Imagery
- Mnemonics

CNS
- Medulla
- Pons
- RAS
- Thalamus
- Cerebral Cortex

Teaching Competence
- Knowledge of Subject matter
- Situational Evaluation
- Classroom Management
- Reinforcement
- Audio-Visual Support
- Responding Behaviour
- Questioning strategies
- Motivation
- Communication
- Instructional techniques
- Set Induction
- Planning

Frontal lobe
- Emotional behaviour
- Healthy Personality
- Paying attention
- Making decision
- Executing Plan
- Thinking
- Searching
- Storing information

Partial lobe
- Sensory information
- Cognitive functions

Temporal lobe
- Auditory perception

Occipital lobe
- Visual Perception

Teaching Competence
- Recalling
- Registering
- Mental Assimilation
- Sensory Memory
b) Attention

Attention is usually considered the core of information. Processing model. James (1890) describes attention as the “focalization, concentration, of consciousness”.

c) Gaining Knowledge

Under the cognitive processes, include all the activities through which man becomes aware of both the external and internal environment. In order to act one must first perceive or gain knowledge.

d) Sensation

The process of gaining knowledge of the environment through the sense organ is technically called sensation.

e) Perception

The process by which we analyse and make sense out of incoming sensory information.

f) Association

Association means the process through which the memory images are related and ordered. It is an integral part of the cognitive process. The activity of combining present sensation and perception with past experience and memories makes up what we usually think of knowing.

e) Conceptualization

The name given to the process by which an individual comes to develop mental categories, which will allow objects and events to be classified and grouped together. A cognitive process has emphasized concept formation.
These cognitive processes are evolved the strategies called cognitive strategies.

II. COGNITIVE INTERVENTION STRATEGIES

Enhancing competence in teaching science through cognitive intervention strategies are as follows.

1. Chunking

   It is easier to remembering grouped information than isolated bits of information. It is unit of working memory, and through chunking new material is reorganized into already existing memory units.

2. Spatial Learning

   A spatial approach of creating insights that connect a bigger picture by extracting concepts from information and developing relationships among them.

3. Concept Mapping

   Information is processed into long-term memory.

4. Advance Organizer

   Linkage between known and unknown. This strategy establishes a mindset for the learner, relating new material to previously learned material.

5. Metaphor

   Emotional connection from context and experience.

6. Rehearsal

   It is repeating the information. It slows the forgetting process and helps in transferring the information to long-term memory.
7. Imagery

A mental representation depicting an object or event, rather than describing the object or event. Generally, images have a strong subjective resemblance to perceptual experiences and so visual images are described as being similar to actual pictures.

8. Mnemonics

These strategies designed to improve memory. These techniques seek to improve memory accuracy and to make learning easier; in general, these strategies seek in one fashion or another to help memory by imposing an organization on the to-be learned materials.

CENTRAL NERVOUS SYSTEM

These cognitive strategies and strategy process stored and retrieved into cerebral cortex. This cerebral cortex consists of four lobes like frontal lobe, partial lobe, temporal lobe and occipital lobe.

The main function of frontal lobes are emotional behaviour, paying attention, decision making, executing plan, thinking, searching and storing information. The partial lobes are responsible for sensory information, cognitive function like attending, perceiving and analyzing. The main functions of temporal lobes are auditory perception and occipital lobes are visual perception.

These mental processes are entering into sensory memory and to pass registering and recalling of information.

Teaching Competence

According to Good, (1954) teaching competence is that skill, concepts and attitudes needed by teachers for the act of instruction in an educational institution.
From this mode, some of the identified competencies are enhanced by cognitive intervention strategies. Such as planning, set induction, instructional techniques, communication, motivation, questioning strategies, responding behaviour, audio-visual support, reinforcement, classroom management, situational evaluation and knowledge of subject matter.

The next chapter explains in detail the methodology adopted in implementation of the model, sample selection, tool etc.