Chapter – I

Introduction
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“Sensation is unorganized stimulus, perception is organized sensation,
conception is organized perception, science is organized knowledge and wisdom
is organized life: each is a greater degree of order and sequence and unity.”
-German Idealism

1.0 INTRODUCTION

Contemporary information processing theory studies the process of learning
as a system of brain functions (Reed, 2006). Students' primary contact with the
information and knowledge they are expected to learn is through their sense
receptors (Henson and Eller, 1999). Sense receptors are defined as those sense
organs that allow us to make contact with our environment (Santrock, 1997).
Students listen to their teachers (ears), read texts (eyes), smell food in the school
cafeteria (nose), taste their after-school snack (tongue), and write or model with
clay (hands) (Henson and Eller, 1999). Stimuli from the environment are
bombarding our sensory receptors constantly. The sensory register, sometimes
also referred to as sensory memory or the sensory information store holds all of
these sensations, but only for a brief time.

The sensory register has a large capacity and probably can hold everything
the body is capable of seeing, hearing or sensing (Ormrod, 1998). The fMRI
results show that the predicted sensory brain regions were activated by perceptual
semantic retrieval across the five sensory modalities. The modality examined in
each decision was specifically associated with increased activation of the respective sensory brain regions (Charles A. Perfetti, 2007). With the understanding that the brain uses the five basic senses to obtain insight on the world, it is unsurprising that utilizing multiple senses increases the probability of knowledge absorption (Christie, 2000). Using neuroimaging methods, researches shows that semantic decisions that index tactile, gustatory, auditory and visual knowledge specifically activate brain regions associated with encoding these sensory experiences. (Robert F. Goldberg, 2006).

Multi-sensory learning, as the name implies, is the process of learning a new subject matter through the use of two or more senses. This may include combining visual, auditory, tactile or kinaesthetic, olfactory and gustatory sensation (Scott, 1993). By activating brain regions associated with touch, flavour, audition and vision, they indicate a direct relationship between perceptual knowledge and sensory brain mechanisms (Barsalou, 1999).

1.1 SCIENCE LEARNING

Science education is designed to share scientific data and events with students who are not part of the scientific community but have to benefit from scientific understanding. It is a way to make students scientifically literate about general concepts that pertain to scientific discovery. Science education usually includes the subject areas of physical, life, earth and space sciences (Martin, 2009). Construction of deep scientific knowledge results by actively practicing
science in structured learning environments (Abele and Lederman, 2007). The aim of teaching any school subject must always be directed towards achieving the aims of education in general. The teaching of science as a subject must, therefore contribute to the all-round development of the child so that he comes out as socially useful and efficient citizen of the modern scientific world. According to the Kothari Commission (1964-66) “The destiny of the country is being shaped in class rooms”. To achieve the designed goals and to meet the situation in a suitable way the teacher has to play a very vital role in educational institution and come into the lime light. Teaching is considered both an art and a science.

Successful and effective teaching requires two basic things. The teacher should be competent to teach the subject allotted to him/her and at the same time he/she should follow new techniques of teaching to make the learning fruitful and interesting. Teaching and learning process forms an integral part of education. The effectiveness of teaching and learning could be measured in terms of the level of achievement of students in the subject of study and the effectiveness of teaching and learning depends upon both the teacher and the student. To increase the level of achievement in any subject, the teacher and the students need to have knowledge of cognitive process and the cognitive strategies to be employed. The effectiveness of learning depends upon the memory of student.
1.2 CURRICULUM OF SCIENCE

The New Educational Policy (1986) suggested measures to redesign the science curriculum so as to make it related to life. Attempts to improve the quality and effectiveness of teaching and learning in schools must look into what teachers and students do in classrooms. Compulsory teaching of science, as a part of general education up to Class X, had been in practice in most of the states and UTs even before the introduction of a uniform pattern of school education in 1975s. During this period the subject was usually taught as general science in most of the states. However, at the secondary stage science was an optional subject, which was offered either as a combination of physical science and biology or as physics, chemistry and biology. The syllabus of science and textbooks were prescribed by the respective state agencies. The content and process of science teaching in schools, therefore, varied from one state to another. The general objectives of science teaching identified for Classes I–VIII during the 1960s have been basic to the evolution of science education in the country, particularly at the elementary stage.

The major objectives identified were:

- to acquire knowledge of biological, physical and material environments including forces of nature and simple natural phenomena, and
- to develop scientific attitudes such as objective outlook, spirit of enquiry, truthfulness and integrity, inventiveness, accuracy and
precision, avoiding hasty conclusions on insufficient data and respect for the opinions of others.

At the secondary stage, the beginning made at the earlier stage to introduce science as a discipline is to be further strengthened without emphasis on formal rigour. Concepts, principles and laws of science may now appear in the curriculum appropriately but stress should be on comprehension and not on mere formal definitions. The organization of science content around different themes as being practiced seems appropriate at the secondary stage, but the curricular load needs to be substantially reduced to make room for the additional elements of design and technology, other co-curricular and extra-curricular activities. At the secondary school stage, concepts that are beyond direct experience come to occupy an important place in the science curriculum. Since not all phenomena are directly observable, science also relies on inference and interpretation. For example, we use inference to establish the existence and properties of atoms, or the mechanism of evolution. By this time, however, students should have developed the critical ability to evaluate the epistemological status of facts that they encounter in science. Experimentation, often involving quantitative measurement, as a tool to discover/verify theoretical principles should be an important part of the curriculum at this stage.

The technological modules introduced at this stage should be more advanced than at the upper primary stage. The modules should involve design, implementation using the school workshop, if possible, and testing the efficacy of
the modules by qualitative and quantitative parameters. Experiments (and, as far as feasible, the technological modules) should be part of the content of the secondary stage textbook, to avoid their marginalization or neglect. However, this part of the textbook should be only the subject to internal assessment. The theoretical test at this stage including that for the Class X external Board examination should have some questions based on the experiments/technological modules included in the textbook. Participation in co-curricular activities must be regarded as equally important at this stage. These may involve taking up projects (in consultation with teachers) that bear on local issues and involve the problem-solving approach using science and technology. The various components of the science curriculum indicated above should be integrated imaginatively. The entire upper primary and secondary school curricula should have horizontal integration and vertical continuity.

1.3 LEARNING CHEMISTRY

Chemistry is one of the most important branches of science; it enables learners to understand what happened around them. Because chemistry topics are generally related to or based on the structure of matter, chemistry proves a difficult subject for many students. Chemistry curricula commonly incorporate many abstract concepts, which are central to further learning in both chemistry and other sciences (Taber, 2002). These abstract concepts are important because further chemistry/science concepts or theories cannot be easily understood if these
underpinning concepts are not sufficiently grasped by the student (Zoller, 1990; Nakhleh, 1992; Ayas & Demirbaş, 1997; Coll & Treagust, 2001a; Nicoll, 2001). The abstract nature of chemistry along with other content learning difficulties (e.g. the mathematical nature of much chemistry) means that chemistry classes require a high-level skill set (Fensham, 1988; Zoller, 1990; Taber, 2002). Chemistry is often regarded as a difficult subject, an observation that sometimes repels learners from continuing with studies in chemistry. One of the essential characteristics of chemistry is the constant interplay between the macroscopic and microscopic levels of thought, and it is this aspect of chemistry (and physics) learning that represents a significant challenge to novices (Bradley & Brand, 1985). In his early study, Johnstone (1974) reported that the problem areas in the subject, from the pupils' point of view, the most difficult topics being the mole, chemical formulae and equations, and, in organic chemistry, condensations and hydrolysis. Over a number of years, many of the above difficult areas was subjected to systematic study to try to identify the point of difficulty and to seek common factors among the nature of these difficulties (Johnstone et al., 1977; Duncan & Johnstone, 1973; Kellett & Johnstone, 1974; Garforth et al., 1976). Johnstone and El-Banna (1986) suggested a predictive model that enabled them to raise and test an important hypothesis, which was then applied to chemistry learning as well as to learning in other science disciplines.
1.4 LEARNING DIFFICULTIES IN CHEMISTRY

Chemistry, as a subject, is concerned with the properties and reactions of substances. Substances are often understood in terms of aggregations of particles, and the nature of the bonding between those particles is used to explain many of the chemical and the physical properties of the substance including such aspects as whether the substance is a solid, liquid or gas at a given temperature and pressure.

"Many students say that chemistry is difficult. These perceived difficulties are part of the context in which these students develop chemical concepts and problem-solving skills" (Carter & Brickhouse, 1989). Chemical concepts are very abstract and students find it difficult to explain chemical phenomena by using these concepts (Gabel, 1996). Science inquiry has been highly advocated to be implemented in middle and high school science since the last century. Some common constraints to implement inquiry in Chemistry include inadequate Chemistry knowledge and nature of science, lack of pedagogical skills, inadequate access to appropriate curriculum materials and teachers teaching outside their fields of expertise (Roehrig and Luft, 2004).

The major difficulties in learning chemistry are:

(a) Overload of Students' Working Memory Space

The working memory space is of limited capacity (Baddeley, 1999). This limited shared space is a link between, what has to be held in conscious memory, the processing activities required to handle it, transform it, manipulate it and get it ready for storage in long-term memory. When students are faced with learning
situations where there is too much to handle in the limited working space, they have difficulty in selecting the important information from the other less important information. The latter situation has been described as “noise”, the students are having difficulty in separating the signal from the noise (Johnstone and Letton, 1991). Faced with new and often conceptually complex material, the chemistry student needs to develop skills to organise the ideas so that the working space is not overloaded. Without the organising structures available to the experienced teacher, the student frequently has to resort to rote learning, which does not guarantee for understanding. To solve this type of problem, Johnstone (1999) has argued that teachers have to look more closely at what is known about human learning and also look at the nature of the discipline of chemistry and its intellectual structure in an effort to harmonise them. The ability to develop strategies to cope with information overload depends heavily on the conceptual framework already established in the long-term memory. Working space cannot be expanded but it can be used more efficiently. However, this depends upon some recognisable conceptual framework that enables student to draw on old or systematise new material. Miller (1956) suggested the idea of "chunking" (the ability to use some strategy to bring together several items into one meaningful unit, thus reducing working space demands). Difficulties in conceptual understanding have been related to working memory space and the idea of chunking (Johnstone and Kellett, 1980; Johnstone, 1980). Salvaratnam and Frazer (1982) discuss the use of summary frameworks while Johnstone outlines ways by
which extraneous excess information ("noise") can be reduced (Johnstone, 1980; Johnstone and Wham, 1982).

(b) Lack of Attention to Incoming Information

Learners have to focus on a specific task within a ‘noisy’ environment (irrelevant material), but also, within the task, they have to select specific information that is relevant (meaningful) for them. Teachers can only find out whether learners are attending by ascertaining what they are learning (Ausubel, 1968). Learners need to know when and where to pay attention and to what to pay attention. Fox (1993) claimed that attention is affected by the complexity of the task and the motivation of the individual. The focus of the learners’ attention determines what information has to be processed. Learners can attend to only a very limited number demands that compete for their attention. Johnstone and Percival (1976) found that attention breaks exist and occur generally throughout lectures. The observer can detect such breaks relatively easily and those attention breaks appear as genuine loss of learning in subsequent diagnostic tests. A learner’s ability to select the important attention has been shown to underlie learner’s rate of learning. Preparing the mind of the learner is one way to help students to focus their attention on the new information by linking it to their previous knowledge (the knowledge they already know and understand). This is discussed in more detail in Sirhan et al. (1999) where the use of pre-lectures is shown to be powerfully effective as a way to prepare the minds of learners, with
special emphasis on those whose background knowledge and experience is less than adequate. Students who know more about a topic find it easier to identify and focus on important information. For this reason, carefully choosing the delivered material may greatly facilitate learning. This has been explored in detail in Sirhan (2000) and is outlined in Sirhan and Reid (2001, 2002).

(c) Recalling Previous Knowledge

To make the material easier for recall, learners actively need to construct, organise, and structure internal connections that hold the information together. The systematic organisation of knowledge, which may be considered to be the ordering of the component knowledge items in a logical, coherent, concise and principle-based manner, is of fundamental importance for the effective learning, recall, manipulation and use of knowledge. Salvaratnam (1993) found that effectiveness of knowledge organisation is increased if the:

(i) Knowledge stored in memory is principle/concept based, coherent, systematic and concise, and

(ii) Organisation is around the minimum amount of essential knowledge (number of principles and concepts).

of late this latter point that has been confirmed (Otis, 2001). It was found that the concept maps generated by medical students at various stages in their learning shows that many students move from a simple, but inadequate, concept maps at early stages of learning through increasingly complex maps until they move back to much simpler but more adequate maps when concepts have been grasped much
more fully. It is, therefore, important that unnecessary principles, concepts, definitions and terms be excluded as concepts are built up in the minds of learners. Salvaratnam (1993) also listed five aspects, which would aid the learning, understanding, recalling and application of knowledge:

1. Use the underlying principles and concepts as the sole basis for knowledge organisation;
2. Exclude unnecessary laws, concepts, definitions and terms;
3. Use systematic and meaningful terms and definitions;
4. Link the component items of knowledge sharply and coherently; and
5. Store knowledge concisely.

These ways could help to reduce memory overload, aid learning and understanding and avoid mistakes. With this kind of complexity and because knowledge construction is not easy, students often are tempted to engage in rote learning rather than meaningful learning. The teachers’ task is to try to find ways to increase meaningful learning, possibly by actively involving students in the process of knowledge construction (Novak and Gowin, 1984). It has been suggested that it is useful to empower students to become responsible for their own learning. Learners need to decide on the level of complexity at which they will process new information. For example, a student can take notes and either writes them as key words or makes connections between this information and the previous knowledge. The more elaborative, or complex, the learner’s processing of the information, the more he tries to make meaningful the new information, the
more likely he is to remember it. This could be done by giving different examples on the same problem and making interconnections between it and the learners’ knowledge to facilitate memorisation.

1.5 INTRODUCTION TO MEMORY

“Memory is the process of maintaining information over time.” (Matlin, 2005). “Memory is the means by which we draw on our past experiences in order to use this information in the present’ (Sternberg, 1999). Memory is our ability to encode, store and retain subsequently recall information and past experiences in the human brain (Saul McLeod, 2007). It can be thought of in general terms as the use of past experience to affect or influence current behaviour. Memory is the sum totals of what we remember, and gives us the capability to learn and adapt from previous experiences as well as to build relationships. It is the ability to remember past experiences, and the power or process of recalling to mind previously learned facts, experiences, impressions, skills and habits. It is the store of things learned and retained from our activity or experience, as evidenced by modification of structure or behaviour, or by recall and recognition. In more physiological or neurological terms, memory at its simplest form is a set of encoded neural connections in the brain.

In learning process, neurons that fire together to produce a particular experience are altered so that they have a tendency to fire together again. For example, we learn a new language by studying it; we then speak it by using our
memory to retrieve the words that we have learned. Thus, memory depends on learning because it lets us store and retrieve learned information. But learning also depends to some extent on memory, in that the knowledge stored in our memory provides the framework to which new knowledge is linked by association and inference. This human ability to call on past memories in order to imagine the future and to plan future courses of action is hugely an advantageous attribute in our survival and development as a species.

1.6 PROCESS OF MEMORY

As common experience based on facts that memory proceeds from learning. Therefore, memory has certain psychological basis involving the following processes:

(1) Encoding or Learning (2) Storage or Retention (3) Recall or Retrieval

1.6.1 Memory Encoding

Encoding is the first crucial step in creating a new memory (Matlin, Margeret W. 2005). It allows the perceived item of interest to be converted into a construct that can be stored within the brain, and recalled later from short-term or long-term memory. Encoding is a biological event beginning with perception through the senses. The process of laying down a memory begins with attention (regulated by the thalamus and the frontal lobe), in which a memorable event causes neurons to fire more frequently, making the experience more intense and increasing the likelihood that the event is encoded as a
memory. Emotion tends to increase attention, and the emotional element of an event is processed on an unconscious pathway in the brain leading to the amygdala. Only then are the actual sensations derived from an event processed. The perceived sensations are decoded in the various sensory areas of the cortex, and then combined in the brain’s hippocampus into one single experience. The hippocampus is then responsible for analyzing these inputs and ultimately deciding if they will be committed to long-term memory. It acts as a kind of sorting centre where the new sensations are compared and associated with previously recorded ones. The various threads of information are then stored in various different parts of the brain, although the exact way in which these pieces are identified and recalled later remains largely unknown.

The key role that the hippocampus plays in memory encoding has been highlighted by examples of individuals who have had their hippocampus damaged or removed and can no longer create new memories. It is also one of the few areas of the brain where completely new neurons can grow. Although the exact mechanism is not completely understood, encoding occurs on different levels, the first step being the formation of short-term memory from the ultra-short term sensory memory, followed by the conversion to a long-term memory by a process of memory consolidation. The process begins with the creation of a memory trace or engram in response to the external stimuli. An engram is a hypothetical biophysical or biochemical change in the neurons of the brain, hypothetical in the respect that no-one has ever actually seen, or even proved the
existence of, such a construct. An organ called the hippocampus, deep within the medial temporal lobe of the brain, receives connections from the primary sensory areas of the cortex, as well as from associative areas and the rhinal and entorhinal cortices. While these anterograde connections converge at the hippocampus, other retrograde pathways emerge from it, returning to the primary cortices. A neural network of cortical synapses effectively records the various associations which are linked to the individual memory.

There are four main types of encoding:

- **Acoustic encoding** is the processing and encoding of sound, words and other auditory input for storage and later retrieval. This is aided by the concept of the phonological loop, which allows input within our echoic memory to be sub-vocally rehearsed in order to facilitate remembering.

- **Visual encoding** is the process of encoding images and visual sensory information. Visual sensory information is temporarily stored within the iconic memory before being encoded into long-term storage. The amygdala (within the medial temporal lobe of the brain which has a primary role in the processing of emotional reactions) fulfils an important role in visual encoding, as it accepts visual input in addition to input from other systems and encodes the positive or negative values of conditioned stimuli.

- **Tactile encoding** is the encoding of something felt, normally through the sense of touch. Physiologically, neurons in the primary somatosensory
cortex of the brain react to vibro tactile stimuli caused by the feel of an object.

Semantic encoding is the process of encoding sensory input that has particular meaning or can be applied to a particular context, rather than deriving from a particular sense.

It is believed that, in general, encoding for short-term memory storage in the brain relies primarily on acoustic encoding, while encoding for long-term storage is more reliant (although not exclusively) on semantic encoding.

1.6.2 Memory Retention

Storage is a passive process of retaining information in the brain, whether in the sensory memory, the short-term memory or the more permanent long-term memory. Each of these different stages of human memory function as a sort of filter that helps us to protect from the flood of information that confront us on a daily basis, avoiding an overload of information and helping to keep us sane. The more the information is repeated or used, the more likely it is to be retained in long-term memory (which is why, for example, studying helps people to perform better on tests), (John H. Byrne 1997).

Since the early neurological work of Karl Lashley and Wilder Penfield in the 1950s and 1960s, it has become clear that long-term memories are not stored in just one part of the brain, but are widely distributed throughout the cortex. After consolidation, long-term memories are stored throughout the brain as groups
of neurons that are primed to fire together in the same pattern that created the original experience, and each component of a memory is stored in the brain area that initiated it (e.g. groups of neurons in the visual cortex store a sight, neurons in the amygdala store the associated emotion, etc). Indeed, it seems that they may even be encoded redundantly, several times, in various parts of the cortex, so that, if one engram (or memory trace) is wiped out, there are duplicates, or alternative pathways, elsewhere, through which the memory may still be retrieved. Therefore, contrary to the popular notion, memories are not stored in our brains like books on library shelves, but must be actively reconstructed from elements scattered throughout various areas of the brain by the encoding process. Memory storage is therefore an ongoing process of reclassification resulting from continuous changes in our neural pathways and parallel processing of information in our brains. The indications are that, in the absence of disorders due to trauma or neurological disease, the human brain has the capacity to store almost unlimited amount of information indefinitely. Forgetting, therefore, is more likely to be result from incorrectly or incompletely encoded memories, and/or problems with the recall/retrieval process. It is a common experience that we may try to remember something one time and fail, but then remember the same item later on. The information therefore is still there in storage, but there may have been some kind of a mismatch between retrieval cues and the original encoding of the information. “Lost” memories recalled with the aid of psychotherapy or hypnosis are other examples supporting this idea, although it is difficult to be sure that
such memories are real and not implanted by the treatment. Having said that, though, it seems unlikely that, as Richard Schiffrin and others have claimed, all memories are stored somewhere in the brain, and that it is only in the retrieval process that irrelevant details are “fast-forwarded” over or expurgated.

It seems more likely that the memories which are stored are in some way edited and sorted and that some of the more peripheral details are never stored. Forgetting, then, is perhaps better thought of as the temporary or permanent inability to retrieve a piece of information or a memory that had previously been recorded in the brain. Forgetting typically follows a logarithmic curve, so that information loss is quite rapid at the start, but becomes slower as time goes on. In particular, information that has been learned very well (e.g. names, facts, foreign-language vocabulary, etc), will usually be very resistant to forgetting, especially after the first three years. Unlike amnesia, forgetting is usually regarded as a normal phenomenon involving specific pieces of content, rather than relatively broad categories of memories or even entire segments of memory. Theorists disagree over exactly what becomes the material that is forgotten. Some hold that long-term memories do actually decay and disappear completely over time; others hold that the memory trace remains intact as long as we live, but the bonds or cues that allow us to retrieve the trace become broken, due to changes in the organization of the neural network, new experiences, etc, in
the same way as a misplaced book in a library is “lost” even though it still exists somewhere in the library.

1.6.3 Memory retrieval

Recall/Retrieval of memory refers to the subsequent re-accessing of events or information from the past, which have been previously encoded and stored in the brain. In common parlance, it is known as remembering. During recall, the brain “replays” a pattern of neural activity that was originally generated in response to a particular event, echoing the brain's perception of the real event. In fact, there is no real solid distinction between the act of remembering and the act of thinking. These replays are not quite identical to the original, though - otherwise we would not know the difference between the genuine experience and the memory - but are mixed with an awareness of the current situation. One corollary of this is that memories are not frozen in time, and new information and suggestions may become incorporated into old memories over time. Thus, remembering can be thought of as an act of creative re imagination. Because of the way memories are encoded and stored, memory recall is effectively an on-the-fly reconstruction of elements scattered throughout various areas of the brains.

Memory retrieval therefore requires re-visiting the nerve pathways the brain formed when encoding the memory and the strength of those pathways determines how quickly the memory can be recalled. Recall effectively returns a memory from long-term storage to short-term or working memory, where it can be
accessed, in a kind of mirror image of the encoding process. It is then re-stored back in long-term memory, thus re-consolidating and strengthening it. The efficiency of human memory recall is astounding. Most of what we remember is by direct retrieval, where items of information are linked directly to a question or cue, rather than by the kind of sequential scan a computer might use (which would require a systematic search through the entire contents of memory until a match is found). Other memories are retrieved quickly and efficiently by hierarchical inference, where a specific question is linked to a class or subset of information about which certain facts are known. Also, the brain is usually able to determine in advance whether there is any point in searching memory for a particular fact (e.g. it instantly recognizes a question like “What is Socrates’ telephone number?” as absurd in that no search could ever produce an answer). There are two main methods of accessing memory: recognition and recall. Recognition is the association of an event or physical object with one previously experienced or encountered, and involves a process of comparison of information with memory, e.g. recognizing a known face, true/false or multiple choice questions, etc. Recognition is a largely unconscious process, and the brain even has a dedicated face-recognition area, which passes information directly through the limbic areas to generate a sense of familiarity, before linking up with the cortical path, where data about the person's movements and intentions are processed.
Recall involves remembering a fact, event or object that is not currently physically present (in the sense of retrieving a representation, mental image or concept), and requires the direct uncovering of information from memory, e.g. remembering the name of a recognized person, fill-in the blank questions, etc. Recognition is usually considered to be “superior” to recall (in the sense of being more effective), in that it requires just a single process rather than two processes. Recognition requires only a simple familiarity decision, whereas a full recall of an item from memory requires a two-stage process (indeed, this is often referred to as the two-stage theory of memory) in which the search and retrieval of candidate items from memory is followed by a familiarity decision where the correct information is chosen from the candidates retrieved. Thus, recall involves actively reconstructing the information and requires the activation of all the neurons involved in the memory in question, whereas recognition only requires a relatively simple decision as to whether one thing among others has been encountered before. Sometimes, however, even if a part of an object initially activates only a part of the neural network concerned, recognition may then suffice to activate the entire network.
There are three main types of recall:

- **Free recall** is the process in which a person is given a list of items to remember and then is asked to recall them in any order (hence the name “free”). This type of recall often displays evidence of either the primacy effect (when the person recalls items presented at the beginning of the list earlier and more often) or the recency effect (when the person recalls items presented at the end of the list earlier and more often) and also of the contiguity effect (the marked tendency for items from neighbouring positions in the list to be recalled successively).

- **Cued recall** is the process in which a person is given a list of items to remember and is then tested with the use of cues or guides. When cues are provided to a person, they tend to remember items on the list that they did not originally recall without a cue and which were thought to be lost to memory. This can also take the form of stimulus-response recall, as when words, pictures and numbers are presented together in a pair, and the resulting associations between the two items cues the recall of the second item in the pair.

- **Serial recall** refers to our ability to recall items or events in the order in which they occurred, whether chronological events in our autobiographical memories, or the order of the different parts of a sentence (or phonemes in a word) in order to make sense of them. Serial recall in long-term memory appears to differ from serial recall in short-term memory, in that a sequence
in long-term memory is represented in memory as a whole, rather than as a series of discrete items.

1.7 INTRODUCTION TO MULTISENSORY PROCESSES

We live in a world rich in sensory information. This information is conveyed through various forms of stimulus energy (e.g., chemical, mechanical, electromagnetic, thermal etc.), and our sensory systems have evolved specialized peripheral organs to transduce these energies into a common neural code (i.e., action potential). Remarkable efforts in neuroscience research over the past fifty years have focused on understanding the nature of these transduction processes, and on elucidating the “neural code” for each of the sensory systems. Intriguingly, this work has largely focused on understanding these processes within the individual sensory systems, and as a result we have a detailed understanding of the mechanics of the transduction and encoding events within the visual, auditory, somatosensory, vestibular, gustatory and olfactory systems. However, intimate knowledge of these events in each of these sensory systems is ultimately inadequate for understanding the nature of our perceptual gestalt, since this unity is built also from the synthesis of information across the different senses. Numerous examples serve to highlight the powerful ability that the different sensory systems have in influencing one another and ultimately to shape our view of the world around us. One of the most entertaining of these examples is that of the ventriloquist; in which discordant visual cues (i.e., the movements of the
dummy’s lips and head) can dramatically alter our judgments about the source of an auditory signal (Thurlow and Jack 1973). In this particular example we refer to the ability of the visual cues to bias our localization of an auditory signal. In addition to these biasing effects under discordant conditions, visual cues can also dramatically improve the intelligibility of an auditory signal when presented in spatial concordance.

Although these perceptual examples are compelling, they are not the reasons why the different sensory systems have evolved with the capacity to influence one another. These reasons are undoubtedly rooted more in changes in behavioral processes mediated by multiple sensory inputs.

1.8 APPROACHES IN TEACHING – LEARNING PROCESS

An approach is an enlightened viewpoint toward teaching. It provides philosophy to the whole process of instruction. The method and technique are just part and parcel of approach. Approach gives the overall wisdom; it provides direction, and sets expectations to the entire spectrum of the teaching process. Furthermore, approach sets the general rule or general principle to make learning possible.

Teaching Approach is like a description of how we go about teaching our students. This description explains what we do when we teach.

- The sorts of teaching and learning activities that we have planned (lecture, tutorial, self-directed learning, case study, workshop, workplace learning);
• Ways in which we try to engage students with the subject matter (provide students with basic facts, relate new knowledge to what students already know, build in interaction, be passionate, be enthusiastic);
• The ways in which we support our students (encourage questions, set formative assessments and provide constructive feedback).

1.9 MULTISENSORY INTEGRATION APPROACH

Multi-sensory learning, as the name implies, is the process of learning a new subject matter through the use of two or more senses. This may include combining visual, auditory, tactile or kinaesthetic, olfactory and gustatory sensation (Scott, 1993). By activating brain regions associated with touch, flavour, audition and vision, they indicate a direct relationship between perceptual knowledge and sensory brain mechanisms (Barsalou, 1999). In Multisensory Integration approach, a child gets the opportunity to seen, auditory, touch, feel, taste, handle, and smell. Such sensory experiences are caused by external environmental stimulations. These result in perception; it develops form impressions or an awareness of sensations caused by an environmental stimulus which requires little interpretation. Perceptions are primary factors in thinking which often initiate train of thought.

When perceptions are recalled at some later time without the use of external stimuli, the memories and images are already formed. The perception in the form of images and memories develop into greater abstractions called concepts. The
concept is usually organised as a result of many related sensation, percepts and images with verbal symbols incorporated.

Thus from the above discussion it is clear that in the Multisensory Integration approach of science learning.

1.10 STATEMENT OF THE PROBLEM

Science is a search for explanation and interaction of facts and ideas. The major task of professional preparation for science teacher is to develop a teaching style based on approach which helps students to develop memory process. Information constantly enters into our minds through stimulation, sensation, attention, perception and this information is stored in the long-term memory. Teachers can take advantage of these processes to help students retain the information and retrieval it when needed. These are possible only by a student having good memory. Such students have properly integrated sensory stimuli towards learning process. This made the investigator to proceed to develop a model to raise the level of memory and achievement in science. The title of the present study is ‘EFFECTIVENESS OF MULTISENSORY INTEGRATION APPROACH ON ENHANCING MEMORY AND ACHIEVEMENT IN SCIENCE AMONG IX STANDARD STUDENTS’.

1.11 NEED AND SIGNIFICANCE OF THE STUDY

Students’ achievement in science is derived from the teachers’ capacity to reach out to deprived children and to create a rich and multisensory environment
for them. Effective teaching depends on the methodology and technology of teaching. Teaching is a process in which the teacher and the students create an interactive environment in such a way that the students become effective and productive learners. So it is necessary to enhance the students’ achievement in science.

1.12 SCOPE OF THE STUDY

In this rapidly changing world the main challenge of teaching is to help students’ skills which will not become obsolete. Multisensory Integration Approach model is essential for the twenty first century. They will enable the students to successfully cope up with new situations. Teachers in particular and school in general to refer cognitive strategies that have been more successful in increasing sustained voluntary attention in classroom settings than approaches that assumes a passive learner. Research on cognitive strategies has produced effective tools for classroom teaching and learning.

1.13 CONCLUSION

From the perspectives of instructional methodologies multisensory integration approach which involves more efficient use of knowledge and strategies is found desirable. Multisensory integration benefits the learners more than any other learning methodology. This is because in a multisensory environment enhance optimum level information processing ability. The focalization and concentration of attention is achieved through facilitating
consciousness. A case is made out in this thesis for the promotion of a multisensory integration approach and corresponding creation of a multisensory environment to facilitate effective instruction and learning of science.