CHAPTER 1
INTRODUCTION

1.1 Introduction and overview

1.2 What is Working Memory
   1.2.1 Development of Working Memory

1.3 Theories and Model of working memory
   1.3.1 Information Processing Model
   1.3.2 The ATKINSON – Shiffrin Model
   1.3.3 Baddeley’s Working Memory Model
   1.3.4 Kane and Engle’s Executive Attention
   1.3.5 Cowan’s Embedded Process Model
   1.3.6 Oberauer’s Facet Theory
   1.3.7 Integrated Model of Working Memory
   1.3.8 Deficit Models

1.4 Working Memory and Education Achievement
   1.4.1 Working Memory and Education
   1.4.2 Working Memory and Learning Disabilities
   1.4.3 Working Memory and Oral Language
   1.4.4 Working Memory and Reading
   1.4.5 Working Memory and Mathematics
   1.4.6 Working Memory and Written Language
   1.4.7 Working Memory in the Classroom
   1.4.8 Role of Visuospatial Working Memory
   1.4.9 Role of Phonological (Verbal) Short-term Memory
   1.4.10 Role of Verbal Working Memory
   1.4.11 Role of Executive Working Memory

1.5 Relation between Working Memory and Educational Achievement

1.6 Important of the study

1.7 Intervention of Working Memory and Educational Achievement

1.8 Composition of the study

1.9 Summary
1.1 INTRODUCTION

Memory is essential for human beings and animals, without it life is very difficult. It is used in everyday life and every aspect of life. Today Working Memory is very “Hottest” topics in the field of cognitive psychology & cognitive neuron Science. Working Memory plays important role in our day to day complex cognitive task, such as school cognitive task, reading newspaper, re-arranging furniture in bedroom to settle for other new furniture, calculating amount to pay in restraint. We feel embarrassed because we cannot remember the name of known person when we try to recall or anxious and helpless because everything we memorized well on the previous day before taking our examination have suddenly become unavailable. Memory is a needed human faculty - very fascinating, yet intriguing. Its functions are to preserve our sense of who we are, it maintains our interpersonal relationship and helps us taking decisions and problem solving. Since memory plays a central role in almost all cognitive process, such as thinking, perception, planning. Every aspect of our life depends on memory, those who cannot encode, store or retrieve in for matter must rely on others for their survival. Mild impairment in memory can make day to day activities challenging because learning depends on memory any deficiencies in any aspects of memory children and adolescents cannot acquire the skills and knowledge necessary for success in life. Many research result shows that memory problems are frequently the cause of learning problems and on other hand individuals with normal memory capacity utilize their memory resources efficiently they learn effectively. Working memory is the limited capacity of storage system which maintain and manipulates the information for brief period of time. We all are aware that memory plays on us throughout our lives. Working memory and educational achievement are inter related both are dependent on one another. Working memory is important for academic performance, educational achievement and students with educational problems often have working memory problems, for example when we using working memory for mathematic calculation, we trying memorizing something try to recall, listening and taking note and expressing ideas in verbally and in writing, reading and recalling, expressing ideas. In the day of ancient Greeks time crucial role in the life
was the reorganization of memory & learning can be tracked, in the nineteenth century advantage of the public Education. American education began to identify different types of memories to support memory and designed informational method to support memory.

The first systematic research on memory span in the history of psychology done over hundred years ago by Hermann German psychologist of late nineteenth century (1885). He had carried out many experiments on himself and found result that we do not forget the learned materials even piece or completely in the starting the rate of forgetting is faster but eventually it stabilizer. There is also another point of view on memory suggested by Fredrick Bartlett (1932) who points out that memory is not passive but it is an active process by using meaningful verbal material such as stories and text. He also demonstrated that the memory is constructive process. We can memorize and store many change and modifications over time. So there is a qualitative difference in what we memorized in starting and what we retrieve or recall later. Many other psychologists played major role in research memory. The young scientist of psychology was also quick to focus on memory models and memory measurement. (James, 1890). However psychologists were able to identify distinct memory dimensions and functions in the mid-twentieth century. Recently the memory construct known as “Working Memory” has emerged and refinement of constructing continues to the present day. At present day research in working memory is the most forefront of neuron scientific investigation. Also the fields of psychology and education have shown high interest in learning more about working memory.

The scientific knowledge and literature gives opportunity to learn about functions of memory and how we can treat the memory deficits individually. After getting more knowledge about working memory we can make our important contribution to our understanding of how students learn, remember, think, we can identify causes of learning difficulties, learning disability and memory deficiency and we can identify causes and suggest proper intervention.
1.2 WHAT IS WORKING MEMORY?

In the past 50 years working memory has been one of the most influential constructs in the study of human cognitive function. Working memory has been defined as an active memory system that is responsible for the temporary maintenance and simultaneous processing of information (Bayliss, Jarrold, Baddely, Gunn & Leigh, 2005).

Working Memory has been defined as the use of temporary stored information in the performance of more complex cognitive tasks (Hulme & Makenzie, 1992). Or as a mental workspace for manipulating activated long-term memory representations (Stoltzfus, Haser, & Zacks, 1996). Overall, working memory is viewed as a comprehensive system that unites various short and long-term memory subsystems and functions (Baddely, 1986). Working Memory is limited capacity of storage system which maintains and manipulates the information over the short period of time.

The concept of working memory in from or another predates the advent of psychology. In 1690 the philosopher John Locke differentiated between contemplation bringing an idea to mind and memory. Then William James (1890) was the first American psychologist to propose two types of memory primary and secondary memory.

James defined primary as conscious present and secondary memory as the vast amount of information stored for lifetime. Some psychologists still refer to working memory as primary memory and secondary memory as long-term memory. The term short & long term memory were given by Thorndike as early as 1910. During the first half of twentieth century memory was viewed as a united construct with short–term memory subsumed by what we now consider long-term memory. By 1950 most of the psychologist wanted for some sort of special memory process that could account for recall of information in the short–term memory. In 1949 Hebb said that the brain was divided brain in to separate storage systems, one temporary and other permanent. In the last 25 years many introduced many theories and models emerged. Due to advance in technology along with growing interest in neuron psychology and neuron science have spurred on brain based working memory research over the past 15 years.
1.2.1 Development of Working Memory

Working memory capabilities change over an individual’s life span. The working memory capacity that a person has in late adolescence remains constant until approximately 45 years of age, then it starts to decline (Alloway 2011, Cowan 2010; Simmering & Perone 2013)

Graph 1.1 showing the development of working memory capacity (Adapted from Alloway)

(Note: The axis represents the number of chunks recalled)

In the figure Y-axis shows the number of verbal (spotted bar) and visual (solid bar) items that the average individual can retain in working memory at different ages.

Working Memory refers to the “active “current information that must be kept in mind to carry out every task and many key skills such as reading vocabulary development and mathematics.
1.3 THEORIES AND MODEL OF WORKING MEMORY

Over the past half century the advancement of cognitive psychology, neuron psychology educational psychology and other related specialties have led to the propagation of several working memory theories and models. The first processing model of working memory was proposed by cognitive psychologist. Later, education psychologist had started to examine the role of working memory in academic learning currently neuron psychologist apply working memory models to various brain days functions. Due to continuous research working memory models become more intricate with the division of working memory into several and neuron science research to the field of educational.

1.3.1 Information Processing Model

In the 1960 the information processing model, a cognitive model of human mutual - processing was widely accepted. The model describes the flow and processing of information from sensory input to storage and behavioral responses (see Fig 1.1) According to the model the cognitive processing system is separate but interconnected information.

1.3.2 The ATKINSON - Shiffrin Model

In the 1960 the Atkinson – Shiffrin model emerged as the most accepted model. (See Fig.1.1) This model originally proposed by Broadbent (1985). This model is an elaboration of the information.

![Figure 1.1 Shows Atkison – Shiffrin Modal Memory model.](image)

Processing model which was originally proposed by Broadbent, 1958); Atkinson and Shiffrin divided memory in to three major type of storage brief sensory store short term store and long term store that all are exchange incoming and outgoing
information. Information filters from sensory short term memory & long term memory. The first component in model is sensory memory or storage known as immediate memory or sensory register which is closely associated with visual and auditory perceptual processing. It referred as an iconic memory. Short-term memory is the central feature of the model. It has very limited capacity. Information in short-term memory quickly facts it is maintained by rehearsal or visual repetition. In the process of encoding and transferring of information in to long-term storage or memory depends on short-term memory. This model assumes that short-term memory plays an important role in long-term retrieval.

This Atkinson – Shiffrin model was found to be an over simplification of memory and too much emphasis on structure and ignoring the processes but it’s three-part diisuon provides a useful frame work for interpreting memory performance.

**Levels of Processing Model**

This Model is more in corned with memory processes over structure. It was proposed that level of processing affected the durability of memory reorientation with deeper and more laborite processing and encoding leading to more long term learning. This model believes that the deeper process, the better learning and allow encoding weaker learning. Most of research on the level of processing model discovered the following inconsistencies.

(1) Even superficial encoding, such as rehearsal can produce memory traces that persist over time.

(2) Optimal method of encoding materials and retrieval cues.

(3) Retention may depends on model of processing (Verbal being storage than Visual).

(4) Shallow processing does not necessarily take less time than deeper processing with this model consensus was that parallel distributed processing models describes memory fomenting better than the model and levels of processing views.
Executive process

Processing subsystem with memory components constitute the core of system (Gagne, Yekovich & Yekovich, 1993). The model consist of selective perception, encoding, storage, retrieval, response organization and system control. The information processing model has identified working memory as a central component of information processing.
1.3.3 Baddeley’s Working Memory Model

Baddeley and Hitch (1974) the time was ripe for more constrict theory of short-term memory that could account for emerging empirical findings. Baddeley and Hitch developed the concept of working memory within short-term memory. They defined working memory as “A system for the temporary holding and manipulations of information during the performance of a range of cognitive task such as comprehensions, learning and reasoning. In original model of Baddeley & Hitch compressed three different aspects of working memory

(1) Phonological

(2) Visuospatial sketch pan and

(3) Central executive that controlled the other two sub-systems called as a slave system Baddeley’s model’s hierarchical in which central executive at top level that controls all other subcomponents.

Baddeley views it as the essence of working memory. He refers to the two subsidiary systems as short–term memory components. Then after Baddeley added another sub-component the episodic buffer (See e.g. 1.3) over the last 5 decades a large number of studies have investigated Baddeley’s model. Moreover the empirical evidence support the division of working memory into modality based short-term stores and modality free processing center where the work of working memory is conducted.

Figure 1.3 showing Baddeley’s (2006) Working memory model
The Phonological Loop

The phonological (The articulator Loop) is a limited capacity. It is speech based store of verbal information (Baddeley 1986, 2003 a; Baddeley, Gathercole & Papagho, 1998) Baddeley divides it in two sub-components temporary, passive phonological input store and a sub vocal articulator rehearsal process. In phonological loop information pressured in verbally gains it immediate direct and automatic stored in briefly in phonological form. Phonological loop has specific function and it stores limited information.

It transforms perceptual stimuli in phonological code that includes the acoustic, temporal and sequential properties of verbal stimulus then phonological code match it with existing codes - already stored in long-term memory and linked with meaning representations. All higher level of processing of verbal information like putting the words together in the form of idea that involves complex working memory functions are conducted by central executive system.

Verbal Short-Term Memory and Articulator Rehearsal

Unless action is taken to preserve the phonologically coded information; the phonological loop holds information for only seconds or less of it (Badeley, 1986; Hulme & Mackenzie, 1992. The number of verbal items that can be fitted on to the phonological “Tapo” loop depends on the time taken to articulate them. Also explains about why recall of short words better than for longer words. Longer words take longer to articulate and take more space on the phonological tap loop. The capacity of phonological loop can be explained as: words held in loop = the length of the loop speech rate (Hulm & Meckenzie). For example if individual speech rate is two words per second his or her memory span will be for words. Word recall is not tune time but important thing is that how many items are presented within 2 seconds. The implications are that any retention of verbal information in short-term memory beyond 2 seconds on rehearsal (Repetition) and amount of information rehearsal is also constrained by 2 seconds loop. There is relationship that verbal short-term memory span various length of the item and that span was strong positive correlation with speech rate. Individuals with faster articulation rates can maintain more items than individuals who are slow articulators (Hulme & Mackenzie).
Normal Phonological memory span for adult assumed to be approximately seven units (Miller, 1956). Memory span is measured with takes such as digit or word span. It is often referred to as verbal short-term memory span or verbal working memory span. Research finding reveals that memory span highly related to the time take to articulate to the stimulus word implies that working memory is not limited to seven, plus minus two unit of information as is usually believed. The individuals are able to few short words to sub vocally rehearse the complete sequence in less time than it takes for the morning trace to decay, thereby extending maintenance of the sequence indefinitely.

The immediate serial recall of word sequences decreases as the constituent word becomes longer (Baddeley, 1990). Many studies have investigated verbal span found to be an incredibly robust phenomenon with high relationships with cognitive functioning every task, academic learning e.g. the phonological loop plays important role in literary language and learning. It facilitates the acquisition of language. According to this individuals with longer phonological spans are better in vocabulary and language learning than those with short spans (Baddeley, 2003).

Phonological short term memory span is joint function of rate of decay and rate of rehearsal. Our verbal span is limited and our ability to rehearse all the verbal stimuli rapidly enough to avoid losing items due to decay (Baddeley 2006). Capacity of the phonological loop is not fully realized without the applications of articulator rehearsal strategies.

**Phonological Similarity Effects**

Another variable that is phonological similarity or length of serial recall affects the operation of the phonological loop. Individuals fine more difficult to remember similar second word list with normal phonological processing ability. Man, Mat, Mab, Map. Phonological similarity effects a broader interference effect that arises whenever there is similarity between content being stored and operated on, e.g. digit recall is lower when subject are required to engage in arithmetic calculation while trying to maintain a string of digits where as processing the meaning of sentences during digit span causes less interference. (Conlin & Gathercole, 2006).
Recently and Primacy Effects
According to Baddeley (e.g., 1990) recently means is the tendency of most recently presented oral items recalled better than prior items, especially items from the middle of a list. The phenomenon seems to result from the displacement or overwriting of earlier cues; recent items are remembered because they are still retained in phonological store at the time of recall they are automatically recalled without rehearsal being necessary or without their having been time for rehearsal. Findings reveal that little or rehearsal occurred is from subsequent long-term retrieval of items at the end of the list is poorer than for items at the beginning or middle, including that earlier items were rehearsal and encoded into long-term storage.

The Visuospatial Sketchpad
According to Baddeley (2006) Visual and Spatial information like objects and their locations short in short-term storage and the Visuospatial sketch pad is responsible for short-term storage of visual spatial information. It plays an important role in the generation and manipulation of mental image. Its decay is rapid like phonological decay is taking place within a matter of seconds. It’s rate of forgetting depends on functions of stimulus complexity and how long the stimulus is viewed. Refreshment of the visual trace appears to result of eye movement, image manipulation or some visual mnemonic (Baddeley, 1986). The Visuospatial sketchpad serves an important function during reading. It allows the reader to be back on track and keep their place in the text while visually encoder printed letters and words during maintaining a Visuospatial from.

Short-term Visuospatial rehearsal and processing is dependent on the central executive component them phonological storage.

Visuospatial Storage
The Visuospatial sketchpad storage was previously described as a united sub-component; later divided into two storage sub-components - Visuo and Spatial. The visual subcomponent is responsible for the storage of static visual information like shapes and colors if objects; and spatial subcomponents are responsible for storage of dynamic spatial information like information about motion and direction. Visuo sub
component also called as a visual cache, it is passive system if store visual information which is static visual representations where as spatial subcomponents called inner scribe it is active spatial rehearsal system that maintains sequential locations and movements.

Simple patterns retained easily than complex patterns complex means amount of variety in stimulus. For example block displayed in matrix are earlier than random display and dissymmetrical figures are difficult to recall than symmetrical.

**Rehearsal and Recording of Visuospatial Information**

Visuospatial rehearsal is necessary for the short-term retention of Visuospatial information may evidence also indicate that maintenance of short-term Visuospatial information depends more than on Visuospatial rehearsal process. Visuospatial sketch pad operate independently from phonological loop, when individual verbalizes. The names objects and location remember then access occurs through deliberate process of recording Visuospatial information into verbal information. It does not access automatically to the phonological store. When Individual able to Individual can not all Visuospatial input easily transfer.

Information transfer efficiency is limited at 5 years age of children at the age of 10 years individuals record visually inserted materials in to speech based form.

**Visual Imagery**

The Visuospatial sketchpad involve maintenance manipulation of Visual imagery, many studies claim that Visuospatial working memory is also involved in mental Imagery and in the construction of spatial models. Visual images are highly demanding for working memory resources for maintenance and manipulation. Working Memory’s central executive component involved whenever manipulated and generated internally visual images. Consciously manipulation of spatial information of images involves all aspects of the working memory.
The Central Executive
According to Baddeley the central executive is core working memory. It is responsible for controlling other three subsystems which are involved in cognitive process of working memory performance. It regulating and coordinating all process, like allocating limited attention capacity. Central executive controlling flow of information through working memory information is transformed or manipulated like during mental arithmetic. It is modality or domain free, acting as link between sub-system which are dependent on auditory or visual processing. It is analogous to an executive board that controls attention select strategies and integrates information from other sources. Central executive does have not its own capacity. It is least understood component of working memory. There is lack of clear construct due to measurement challenges and multi functions of the central executive. The central executive processes determined individual differences in working memory. Basis role of central executive is coordination of information from different sources and manage performance on separate simultaneous task. The central executive has limited resources to store and process limitation in processing of central executive mean that the greater competition with available resources and its efficiency at completing particular functions will be reduced.

Central Executive Core Functions
Baddeley has described several core functions of central executive which are:
(a) Selective attention ability focus attention on relevant information while inhibiting the disruptive effects of irrelevant information
(b) Switching the capacity for coordination of multiple concurrent cognitive activities like time sharing during the dual task
(c) Selecting the plan of executive and selecting flexible strategies
(d) Capacity for allocate resources to different parts of the Working Memory system.
(e) Capacity to retrieve, hold and maintained information from long term memory which are temporary activated information researchers have examined Baddeley’s structure and identified three broad functions which are related to central executive functions which are inhibition, switching and updating. Inhibition is the most critical functions of central executive it is ability to attend to one stimulus while screening out and suppressing disruptive effect of automatically generated or retrieved information
which is not pertinent to task at hand. It also discards information which is previously activated but no longer relevant and suppresses incorrect responses second function switching means ability to alternate between different task, sets and operations like switching retrieval plans. Third function updating which is similar to inhibition means ability to control and update information in working memory for e.g. when attempting to retain the last word of each sentence presented. It is a constant process of revision whereby never more relevant information replaces old and no longer relevant information. In short the main functions of central executive are coordination performance on two separate tasks switching between tasks like retrieval and encoding attending selectively to specific information while inhibiting irrelevant information and activating information from long–term memory.

Control of Attention
Baddeley (1986) reveled the control executive is not only controlling working memory but it also supervise attention system which are responsible for the control, monitoring and regulation of many complex cognitive process which are most reveled to working memory. Baddeley’s central executive components. Regulatory functions are similar to those of the supervisory attentional system (SAS) proposed by Norman and Shallice ( 1980).

Automaticity
It is very important in processing of control executive whenever there is any disruption or failure in automatic processing the control executive get benefits from the development of skill automatically like speech and reading fluency because mastered skills require less monitoring by central executive limited of central executive is required also depends on degree of automation of working memory routines and strategies.

Long – Term Memory Encoding and Retrieval
It is important to understand the central executive is not especially dedicated to short-term and working memory management. It also appointed in the service long-term memory. The central executive in strategy implementation and different function management plays as an effortful activation retrieval and manipulation of long-term
memory representational role. Its basic information with long-term memory include activating and retrieving information from long-term memory storage and then decide which information are relevant and forming associations between items which are novel information and previously acquired knowledge.

**The Episodic Buffer**

In the Baddeley’s model (2000, 2006) 4th added subcomponent is the episodic buffer is important for explaining the influence of long-term memory on the content of working memory. The episodic buffer interfaces with long-term episodic and semantic memory to construct integrated representation on new information with limited capacity subcomponent consciously accessible. It provides direct encoding into long-term episodic memory moreover the episodic buffer component can account for temporary storage of large amount of information that seen to exceed capacities of phonological and Visuospatial storage systems without sending on storage on executive component or direct retrieval from long-term memory.

Episodic buffer is very important for learning because its application as multimodal codes to integrate representations components of long-term memory and working memory into processing representations. It combines visual and verbal codes and link them with multidimensional representations in long-term memory and responsible for binding separate episodic of information into chunks and integrate elements into new coherent structure.

**Factor – Analysis Support for Baddley’s Model**

Factor-Analysis studies conducted to assess the validity of the construct of Baddeley’s working memory model. The results of studies have been supportive of Baddeley’s Multi component working memory model with two or three factor identified. Some other studies have discovered two broad factors that divide task into working memory and short-term memory, whereas other factor analysis have pointed to three factor which are similar with Baddeley’s original three components. Some factor analytic studies have reported that verbal and spatial working memory load on two different factors.
Contributions from p aint man and carpenter are very important. They expand the working memory construct to higher level linguistic processing with developing direct measure of working memory complex function. They noticed on simple span tasks like digit span have low correlations with demanding cognitive tasks like reading comprehension. They emphasize on processing dimension of working memory. Smaller storage capacity result in inefficient processing which reduce retention of information and various tasks, working memory capacity various depending on task at hand. From this point of view individual do not too much available capacity rather in processing efficiency. It means storage and processing capacity remain constant age related changes in memory span result from increased operating efficiency in short working memory performance determined by task demand individual processing efficiency.

1.3.4 Kane and Engle’s Executive Attention Model

According to Kane, Engle and colleagues (Engle 1996, 2002; Kane et al 2001) have described working memory as an executive attention function that is sap retable from short-term memory Kane and Eagle explained that working memory capacity is not about short-term span but no doubt about the ability to control attention in order to maintain information in active quickly retrievable state. Executive attention referred as controlled attention, as “An executive control capability that is ability to maintain stimulus effectively, or context information easily accessible state in the face of interference to effectively inhibit goal irrelevant stormily and response. The capacity of working memory function is not focus on length of retrieval or how much short-term storage available but its function is how well executive process can focus attention on the relevant material and goals.

Overall Kane and Engle’s (2000) model is not inadequate with Baddeley’s model. He also stresses on attentional and inhibitory aspects of central executive. Engle and colleagues are proposing that working memory consists of domain controlled activation of long-term memory structures showed individual differences in working memory reflect degree to which distracters can be inhibited and relevant information can be actively maintained as a focus of attention.
1.3.5 Cowan’s Embedded Process Model

This model is given by American psychologist Cowan (2005). He expanded concept of construct of working memory. The view of working memory capacity and closely linked working memory with long-term memory. Cowan theory of working memory addressed to Baddeley’s theory. His model emphasizes focus of attention, expertise and activation essential parts of working memory. Still he recognizes need for working memory and short-term memory constructs and he argued that at the very least long-term retrieval process short-term processing that well defined long-term structures and representations enhance working memory performance include the retrieval of recently presented information held briefly in short-term memory.

Cowan’s (2005) model mainly divide between activated part of long-term memory and focus. Attention there is long-term memory elements are in an inactive state and focus of attention is assumed to have limited capacity. Few highly activated elements at a time.

Figure 1.4 Shows Cowan’s (2005) Embedded – process model
The large pool of activated items is not capacity limited but items can be lost through decay or disturbance. Pool contains elements that activated above threshold but outside focus of attention. Activation of degree divided between three pools of information are:

(a) Interactive long-term memory structure vast pool that available for retrieval and activation.

(b) Long-term memory items pool that has been recently activated through unconscious automatic or conscious retrieval processes.

(c) Few items that are focus of attention in activated pool items quickly move in and out of focus attention. It depends on what is needed at the time. Cowan points that limited focus of attention restricts working memory retention and processing but not storage capacity. He explained focus of attention can handle three or five chunks of activated information at the time depending nature of the task whereas broader pool of activated long-term memory information behalf of our ability to directly handle much more information than is indicated by working memory span.

1.3.6 Oberauer’s Facet Theory

Oberauer et al. (2002, 2003) offered this model. In this model emphasis is given on the executive aspects of working memory. In this model divides working memory in two board dimensions.

(1) Content facet it has two components and

(2) Functional dimension it consists of two factors

   (a) Verbal and numerical

   (b) Figural and spatial.

The three functional factors are storage in the context of processing coordination and supervision. In the context of processing also referred as simultaneous storage and processing is the central function the working memory coordination is the ability to build new relation between elements to integrate relation into structures. Supervision most involves monitoring of ongoing processes activation of representation of
selective and relevant information and distracting representations. Effort is to better division between working memory and short-term memory.

**Long-term Working Memory**
There is close connection between long-term memory and working memory. It is not surprising that there are advocates (Ericsson & Kintsch, 1995) for a long-term working memory. According to this point of view, Working Memory is not structurally different from long-term memory.

Working Memory is utilization of stored information in long term memory. (Rechardson, 1996; Wanger 1996). According to this model working memory is not distinguish from long-term memory. Still working memory performs same functions like processing select sensory input and encoding new information into long form storage.

Longe term memory model also looks applicable to more than chess expert for example the process of reading comprehension makes large ongoing demands of working memory. Comprehension is important parts of text; it cannot be possible without long-term memory involvement.

**Neuropsychological Evidence**
Generally most of neuropsychological studies provide support to the multi component working memory models primarily Baddeley’s Models of memory attempt to represent the functional rather than structural properties. Research on neuron image has found activation of distinct brain regions during different working memory activities, the result of Hedden and Yoon’s (2006) study indicate that verbal, Visuospatial and central executive working memory are each associated with distinct brain regions. Many others neurological investigations Ceg-Prabhakaran et.al, 2000) have found evidence of separate neural circuitry for verbal and Visuospatial sub components several neuron psychological case studies of patients with acquired brain injury have established a large degree of independence in the brain mechanisms.
Table 1.1 Showing Brain regions with reported activation during working memory processes

<table>
<thead>
<tr>
<th>Working Memory Process</th>
<th>Hemisphere</th>
<th>Cortical Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phonological Storage</td>
<td>Left</td>
<td>Posterior parietal Inferior Parietal Brodmann’s area 40 Supra-marginal gyrus</td>
</tr>
<tr>
<td>Storage</td>
<td>Left</td>
<td>Broca’s area Anterior tempord Frontal</td>
</tr>
<tr>
<td>Rehearsal</td>
<td>Left</td>
<td>Premotor cortex Occipital Interior frontal</td>
</tr>
<tr>
<td>Visuospatial</td>
<td>Right</td>
<td>Occipital</td>
</tr>
<tr>
<td>Visual</td>
<td>Right</td>
<td>Parietal</td>
</tr>
<tr>
<td>Spatial</td>
<td>Right</td>
<td>Left hippocampus Right middle temporal</td>
</tr>
<tr>
<td>Episodiz</td>
<td>Left/Right</td>
<td>Dorsolateral Prefrontal Anterior angulated</td>
</tr>
<tr>
<td>Executive</td>
<td>Bilateral</td>
<td></td>
</tr>
</tbody>
</table>

Underlying Baddeley’s original three components, conclusions of this research studies support to neuron anatomy of working memory (see Table 1.1)

(1) Phonological loop is located in the temporal lobes of the left hemisphere

(2) Visuospatial memory is situated in the right hemisphere

(3) Central executive activities are primarily associated with the dorsolateral prefrontal cortex (Pickering & Gathercole, 2001) working memory task depending several brain regions activated simultaneously, including locations in the parietal, frontal and temporal lobes. Studies have shown the co activation of frontal and posterior system during working memory storage & processing.

**Phonological Loop Evidence**

Baddeley’s neuropsychological evidence is most important for phonological loop. It indicates that phonological loop and rehearsal process operate at a relatively deep at central level. Baddeley’s (2003) indicated that phonological activity is associated with left hemisphere activation with brodman’s area to associate with sub vocal rehearsal. Gathercole described it differently. Phonological storage is served by a neural circuit
in the left hemisphere spanning inferior parietal areas and rehearsal is associated with anterior temporal frontal areas.

**Visuospatial Sketchpad Evidence**
According to Baddeley (2003) neuron imaging studies indicate that Visuospatial working memory is most of but not entirety located in the right hemisphere of the brain in the occipital and inferior frontal areas. Studies also provided strong indications of separate neural systems serving two Visuospatial sub components of storage and rehearsal.

**Central Executive Evidence and Role of prefrontal**
Cortex executive processes of working memory core function processes are reside in the prefrontal cortex. (Engle, Kane & Tuholski1999). Some neuropsychological investigations have focused on role of frontal lobes in controlling working memory. The prefrontal areas seem to have a special role in updating different types of information in working memory, like when retaining both verbal and visual- spatial information about a stimulus. As per demands on working memory increase, there is greater activation in the prefrontal cortex conclusion of the studies on the role of the prefrontal cortex in working memory capacity are as

(a) Evidence consistently underscores the role of the dorsolateral prefrontal cortex in executive working memory

(b) Medicated individual differences in dorsolateral prefrontal cortex in normal individual differences in working memory capacity.

(c) Dorsolateral prefrontal cortex is necessary structure for working memory and neurological structures also necessary

(d) Basic role of dorsolateral prefrontal cortex is active maintain information and blocking distractions and blocking distractions and irrelevant information

(e) Support to working memory view and system in the posterior regions network to the dorsolateral prefrontal cortex

(f) Working Memory capacity predicts other tasks demand by executive attention.
**Episodic Buffer Evidence**

Neurological evidence for the phonological, Visuospatial and executive components of Baddeley’s theory also had been support to episodic working memory. Prabhakaran et al (2000) found evidence of buffer that allows for the temporary retention of integrated information. Many other researchers have collected neuron imaging data supporting the existence of episodic buffer processing. The left hippocampus posterior regions, including right middle temporal lobe are involved during episodic processing.

**Controversy over Working Memory Capacity**

Almost accepted that normal working memory capacity is very limited and all components of working memory are limited capacity. Exact nature of constraints and actual amount of working memory capacity is very controversial. Most of the researcher specially on working memory yet have to reach agreement on how can we retain information while we occupied with processing with other information. The main center of controversy over capacity whether singles overall system capacity or a separator capacity for each subsystem. Many questions remain unanswered from different concept of working memory.

(1) Does simple span represent working memory capacity?

(2) Do the subcomponents like phonological loop have separate store that unaffected by working memory processing?

(3) Is there total capacity include processes and stores to gather?

(4) Is there capacity set by limits of attention?

The terminology and specifics depend on theoretical respective. At the heart of the controversy is the debate over shared resources versus separate resources.
Shared Resources
These resources know the general capacity hypothesis. Many models of working memory represent working memory as a united limited capacity system where processing and storage demands compete of limited common pool of resources. This view promotes that working memory and short-term memory performance is supported by shared resources that are flexible divided between processing and storage.

Separate Resources
Some cognitive psychologist Halford, Wilson, Phillips, 2001) consider that three are separate capacity limits for storage short term memory and processing (central executive). Storage limits are determined by number of chunks that can be retained and processing is limited by number of ideas that can be operated on. According to this belief that storage and processing demands are quite different so different types of resources are required. According to this, point of view capacity of central executive decides the rate of information processing where as short-term memory span reflects storage capacity of phonological loop Visuospatial sketchpad. Each working memory component has its own pool of resources with storage. Central executive has its own storage capability phonological loop has their own capacity limitation which are distinct from working memory capacity.

Generally most researchers who are working in the field of working memory they accepted that no single factor determines of complex concept of working memory capacity and performance. There are separate resources with separate limits for processing storage capacity at the same time shared general resources other cognitive factor impact on capacity. Ability to control attention interferences, processing speed and long–term memory activation - all play important role. The influence strategies and processing efficiency is acknowledged but mostly underside. It is clear that working memory potential is not realized without application of strategies, most individuals recognize the effectiveness of strategies as they normally rehearse without being prompted. Perhaps we will never be able to decide whether poor performance of individual is due to really capacity limitation or insufficient use of strategies that allow for more retention and processing of material.
1.3.7 Integrated model of Working Memory

The integrated models have included long-term functions and representation within working memory (Cowan, 2005). In integrated model of working memory proposed (see Fig.00), Short-term Memory, Working Memory and Long-term Memory are all different and independent types of memory. Working memory often interfaces between two storage systems; short-term memory temporarily retained and activated permanent units of long-term memory. Focus of working memory at one time may be elements from long-term memory, material from short-term memory or may be combination of two short-term memory can encode automatically into Long-term memory without support of working memory and long-term memory can activate and retrieve automatically storage of information is passive in both short-term and long-term memory. Information encoded and retrieved directly without any conscious processing or manipulation short-term memory can work independently and automatically so does not consider a subsystem of working memory. Some working memory’s functions consider as a supervisory or managerial.

![Figure 1.5 Showing Integrated model of working memory](image-url)
Memory’s functions consider as a Supervisory or managerial it is not subsidiary system of short-term or long-term memory. Executive functions manage and supervise every cognitive function timely. Psychologists agree with separate memory system which is short-term long-term and working memory system.

In the integrated model close linked between short-term memory and working memory then long-term memory.

According to contemporary American models of working memory gave priorities for memory which are retrieval activation encoding maintenance and information restructuring from long-term storage and working memory interact with short-term memory but its resources intercept with long-term memory.

**Short-term Memory Components and Functioning**
Short-term memory process and structures are limited and passive instant and automatic. It is passive storage of verbal and Visuospatial information can pass through working memory and automatically information encode into long-term memory and representation automatically. In this model short-term memory component consists phonological short-term memory and Visuospatial short-term memory without conscious rehearsal aspects that are the responsibility of working memory. Main different between short-term and working memory is that working memory is involved in active and conscious processing of information. Whereas short-term memory has passive storage and automated subconscious processes.

**Interaction with Long-term Memory**
Long–term memory is passive store house of information its function is independent and automated functions. For e.g. when we read orally we retrieve automatically known words and convert them into a response directly without involvement of working memory. Logle (1996) believes that working memory involved with processing information after long-term memory schemas have been activated brought under working memory. Working memory consists of long-term memory representations that recently activated or retrieved. Working memory can process simultaneously there is pool of activated long-term memory items on structures which
working memory has immediate access. This pool adds total working memory capacity.

**Separating Executive Processing from Working Memory**

According to this point of view general executive processes and working memory processes need to be separate between working memory functions. Which are executive in nature and those are regular working memory operations. All models of information include executive processing system that monitors and controls other cognitive function whereas working memory cognitive. Process controlled by broad and higher level executive processing system.

**Working Memory Operations**

In integrated model, non executive functions are referred as working memory operations. The working memory operations include several processes that utilize contents which are selected from short-term and long-term storage fully mental or behavioral goal. Working memory consists manipulation of transformation of some type of information which are –

1. Encoding information into long-term memory
2. Associating of new information with existing long-term representations
3. Transforming information
4. Completing multistep computations
5. Holding sub products of computational procedures till final product reached
6. Conducting Conscious, direct searching information stored in long-term memory
7. Creating presentation for new memory
8. Chunking related items from groups or categories
9. Other procedure that involve manipulation of memory items or recombination of items working memory operations conscious and unconscious.

Most of theories and research focused on reportable, Conscious functioning.
**Definition of Working Memory**

Working memory is defined in a broad manner as the retention of information processing the same or other information. It is also described as information processing work space or gateway between short-term and long-term memory.

Working memory is defined as the management manipulation and transformation of information drawn from Short-term and Long-term Memory. Working Memory is not temporary or long term storage. Working memory is cognitive process its basic function is to facilitate and enhance the capacity of encoding storage and retrieval functions that are essential for learning and high level of information processing. The reality is built mainly on attempts to measures it and the relationship between working memory and academic learning are actually correlation between working memory test score and measure of academic performance score. The demands of the testing tasks inform us about the nature of cognitive process we are attempting to measure.

**Description of Memory Components**

- **Phonological short –term memory** is passive subcomponent short-term memory that limited shares speech based information in phonological form. It is continually receives information from auditory sensory stores and automatically activates related items which held in long-term storage.

- **Visuospatial short-term memory** is also passive subcomponent of short-term memory that limited stores visual and spatial which are object and colour and location and direction information. It is refreshed automatically and continually as objects in the environment change and as focus of attention charges.

- **Verbal working memory** include complex working memory operations in which analysis manipulation and transformation of verbal material tasks place basic functions of verbal working memory is extract meaningful representation which corresponds to phonological information which taken in by phonological short-term memory sometimes verbal working memory for measurement purpose includes phonological short-term memory.
• Visuospatial working memory operation combines Visuospatial information available in both short-term and long-term between Short-term working memory. The main different short-term memory and working memory is that Visuospatial short-term requires only passive retention of information, whereas with Visuospatial working memory is added processing component. Visuospatial working memory is involved wherever images are being manipulated.

• Executive Working Memory is broad executive processes it is restricted to management of memory system. Executive is involved when tasks require coordination of storage and processing. Executive is not any domain specific and not have any storage capacity.

• Long-term retrieval term refers conscious directed, specific information which are held in long-term memory. Long-term memory retrieval is working memory function. It is considered as a component and intervention purpose.

• Working memory operations involves all functions of working in nonexecutive nature, including manipulating, encoding, transforming, recoding and retrieving information. This operation modify and transform which are drawn short-term and long-term Storage. It has limited storage capacity, which is used to hold information unit information processing complete. Working memory operations are divided for measurement purpose into verbal working memory and Visuospatial working Memory.

• Activated Long-term Memory is large pool of recently activated Long-term memory items and structures in which working memory has quick access. Mani vanities in pool are automatically activated by short-term memory.

**Capacity of Working Memory Operations**

According to integrated model of working memory capacity is limited or may be greater than indicated span measures. Available activated pool of long-term memory items highly expands amount of information available in working Memory operations component has limited capacity. Backward digit span provides best measure for working Memory Capacity.
**Efficiency and Strategies:**

An individual’s ultimate capacity of working memory partially depends on how effectively individual utilizes his/her innate capacity. Practicing is very important procedure until they are thoroughly mastered will allow them to perform automatically without drawing on working memory resources, improving working memory performance during tasks involving procedure. According effective memory strategies will also improve working memory performance.

**Measurement Implications**

According to results of the studies nearly almost research designs and assessment tools fail to example difference due to poor control over confounding variable among the contributions of short-term memory, long–term memory. Generally executive processes and working memory, usually they are all collected together as working memory.

**Educational Intervention Implications**

Implications of the integrated model is that interventions for working memory deficits should include method that are usually considered as a long-term memory interventions strengthening broad executive processing, may enhance working memory performance. Finally teaching and effective memory strategies and mnemonics will allow individual to fully utilize their working memory capacities.

**Caution**

The integrated model’s various components given here are not original all previously proposed and researched. Here is try to pull out attempt to get here common understanding among existing models and to discuss all aspects of working memory functioning related to academic learning. It is also a try to provide more complete model by discussing full extent of working memory involvement in short-term and long-term memory and emphasis on interferon between long-term memory and working memory. Integrated model is proposed because of need for applied model of working memory that allows educators and psychologist to understand the functioning of working memory and its impact on learning daily functioning.
1.3.8 Deficit Models

In this point of view educator and practitioners take on the development of working memory capacity that rally determines how they will view points. First view is traditional deficit model believes that neuropsychological basis for poor performance. That is processing constraint is not necessarily specific to working memory it may be with function like processing speed that underlines working memory functions. Second point of view the processing efficiency – deficit perspective believes that poorly performing individual is not effectively utilizing his/her normal working memory capabilities. Processing inefficiency decides what are perceived as working memory impairments, and then the implications for educational intervention are different.

Some researchers believe that working memory deficits of individuals with learning disabilities reflect deficits in capacity not in efficiency low working memory performance and learning problems. It could be either a processing deficit or lack of efficiency or both.

This point of view many psycho educational evaluations and educational environments used term deficit often loosely or inconsistently some educators and practitioner classify deficit with any types of weakness or difficulty the term deficit apply when significantly lower than normal functioning that also related to weakness for group or individual working memory is deficit among the learning desalted population, it does not mean that working memory performance is well below average. It does not mean that working memories is significantly lower than their abilities or lower than working memory of nondisabled individuals with the same IQ.

Disorders and conditions with Working Memory Deficits

Working Memory has many cognitive processes, it is not only logical to assume that impairment in any higher level cognitive process or skill are either impacting working memory functioning or can be small attributed to working memory dysfunctions. Working Memory impairment are not innate but some are acquired through injury or illness, some appear after disorder and some are other result of life’s natural ebb and flow.
Attention – Deficit / Hyperactivity Disorder (ADHD) children with ADHD group who typically perform poorly on measurement of short-term and working memory (Klingbag, Fossberg & Westerberg, 2002). ADHD children can be causes of their poor control of intentional process and its capacity, both are important aspects of working memory.

Many studies have found result and concluded that children with ADHD show deficits in multiple components of working memory. That to normal controls, subjects related big important in Visuospatial working memory and moderate impairment in verbal working memory. Poor academic progress in ADHD children may be result of working memory deficiencies rather than consequence of inattention. ADHD children combined subtype perform very bad then normal students on short-term and working memory components, whereas primarily inattentive subtypes are deficient in Visuospatial and executive working memory and primarily hyperactive impulsive subtype may not display any deficits. Those who are primarily hyperactive – impulsive have working memory important so children with ADHD are not impairment in all aspects of working memory.

**Autism**

Autism disorder arising from frontal lobe dysfunction, working memory has been hypo assumed to be deficient in individuals with autism. Studies reveal that ADHD children deficient in Visuospatial Working Memory but not in verbal Working Memory. Current studies reported that children with autism are impaired in working memory because they fail to develop and utilize working memory strategies.

**Cognitive Disability**

Studies on working memory suggested that children with cognitive or Intellectual disability found weakness in working memory relation to their cognitive ability. In these children working performance does not keep pace with overall cognitive development. They are lower than same mental age in digit and word spans. Intellectual children weak in working memory and most weakness seen in verbal working memory which is most related to their delayed use of verbal rehearsal strategies. Some studies have found that Down’s syndrome children have lower
working than their cognitive ability and as their mental abilities grow their memory span lags farther behind working memory performance in children with mental retardation depends on the task. Some aspects of working memory may be better than others. Children with low cognitive disability may not be using certain strategies due to this lower in performance.

**Acquired Brain Injury**

Acquired brain injury usually involves the vulnerable frontal lobes, where executive processes and core working memory operations are headquartered. It is well known that children suffer with head injuries are at risk for ongoing memory problems and specially in working memory impairments.

**Schizophrenia**

Many researchers have reported that impairments in working memory and executive functions in schizophrenia patients then normal healthy individuals. These deficits are seen due to reduction in cognitive processing capacity, caused by dysfunction in the prefrontal cortex. Children and adults with schizophrenia seen to be affected their all aspects of working memory like Visuospatial, verbal and executive.

**Stress**

Stress also affects on working memory functioning. Stress decrease working memory capacity of individual because working memory must provide intentional resources to inhibit irrelevant, unwanted, intrusive thoughts about stressful event and reduce working memory performance on the task that depends on working memory.

**Aging**

Age also affected on working memory performance and also cause of decline is disputed. Declines in working memory with old age have generally been associated with slow in speed of information processing, decline fluid intelligence, slow retrieval speed and reduction in ability to inhibit irrelevant information.
1.4 Working Memory and Educational Achievement

Over the past two decades cognitive Psychologists have intensively investigated possible causes of low educational achievement. A consistent finding from the large numbers of studies is a close relationship between Children's performance on indicator of scholastic attainment and their working memory skills. Young people with low scores on standardize assessment of reading and mathematics usually score poorly on complex memory span task that involve both the temporary storage of verbal reading materials (e.g. Bull & Scerif, 2000; de Jong, 1998, Gathercol & Packering, 2000a; Mclean & Hitch, 1999; Passolunghi, & Siegel, 2001; Swanson; 1994). A typical example of such a task listening span, in which the participant makes a judgment about meaning of each of a series of spoken sentences; and then attempts to recall sequence the final word of each sentence.

The learning problems associated with the poor working memory skills are substantial. In England children low score on working memory assessment have been found to be performed poorly on national curriculum assessment at the age 7, 11, and 14 years. (Gathercole & Pickering, 2000b, Gathercole & Pickering, Knight, & Stegmann, 2003; Jarvis & Galette, 2003) In some case learning difficulties of children with below average working memory functions are sufficiently severe to warrant special education support in school (Alloway, Gathercole, Adams & Willis; in press, Gathercole, 2002; Gathercole & Pickering; 2001, Pickering & Gathercole; 2004). More generally many studies have shown that weak working memory function is characteristics of children with learning disabilities in literacy or numeracy or in both areas (Bull, & Scerif, 2001; De Jong, 1998; Myringer & Wimmer, 2000; Siegel & Ryan, 1998; Swanson, 1994; Swanson & Ashbaker, & Saches-Lee, 1996).
1.4.1 Working memory and Education

During the last 50 years, educational and psychological researches on working memory processes repeatedly supported that individual differences in learning ability working memory is required whenever anything be learned because learning required manipulation of information, interaction with long term memory storage and processing of information. Long term support of working memory and short term memory cannot be able to acquire knowledge. It is clear that working memory plays an important role in learning. All of what we learned and remembered must pass thorough working memory capacity and effective functioning of working memory finalizes the rate and extension of learning. Working memory capacity predicts performance of range of cognitive task. Classroom performance and development of verbal and academic skills reading, writing mathematics, oral language reading comprehension written expression depends adequate functioning of working memory. The strong relation between Table.1-1 Correlations between WJIII working memory and achievement – Ages- 6 - 8

Table 1.2 Showing Correlation between Working memory and Educational achievement

<table>
<thead>
<tr>
<th>Achievement Cluster</th>
<th>Working memory</th>
<th>Short term memory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broad Reading</td>
<td>54</td>
<td>48</td>
</tr>
<tr>
<td>Broad Math</td>
<td>58</td>
<td>50</td>
</tr>
<tr>
<td>Broad Written Language</td>
<td>54</td>
<td>48</td>
</tr>
<tr>
<td>Oral Expression</td>
<td>38</td>
<td>38</td>
</tr>
<tr>
<td>Listening Comprehension</td>
<td>53</td>
<td>49</td>
</tr>
<tr>
<td>Basic Reading Skills</td>
<td>56</td>
<td>50</td>
</tr>
<tr>
<td>Reading Comprehension</td>
<td>53</td>
<td>47</td>
</tr>
<tr>
<td>Math Calculation Skills</td>
<td>51</td>
<td>42</td>
</tr>
<tr>
<td>Math Reasoning</td>
<td>59</td>
<td>52</td>
</tr>
<tr>
<td>Basic Written Skills</td>
<td>51</td>
<td>45</td>
</tr>
<tr>
<td>Written Expression</td>
<td>52</td>
<td>56</td>
</tr>
</tbody>
</table>
Note: The numbers Reversed test B Part of both the short term and working memory clusters, producing greater similarity in the correlation each has with achievement cluster.


Specific areas of academic achievement and shorter memory and working memory components are well established (Berninger & Richards, 2002, Swanson. 2000, Swanson & Berninges, 1996) Correlation between working memory measures and academic achievement range as high as 55 to 92 (Swanson, 1995) working memory cluster from the Woodcock-Jhonson III (WJ iii) Tests of Cognitive ability has moderate correlation with the WJ III achievement cluster (See Table 1.1)

Generally in the classroom learning need proper structured environment, continuous heavy demands are placed on working memory. In common class room activities like listening to teacher and taking notes, follow complex instruction, decoding instiller words, reciting sentences from memory and doing arithmetic all these impose demands on storage processing. Individual interact his/has, stored knowledge. Learning is reduced when working memory overloading or divide attention in different work. Researchers have confirmed that secondary working memory tasks effect on working memory performance on primary task and also interfere in learning.

1.4.2 Working memory and Learning Disabilities

According to report in 2006 approximately 2.9 million school going children received special education in the United States specific in learning disability (U.S. Department of Education, 2006). Psychologist and educators accepted that individuals with learning disabilities have deficiency with learning disabilities have deficiency in one or more processes (Masoura, 2006) including phonological processing, attention, long-term retrieval, auditory processing, short-term memory and working memory. In research has continuously found children with all types of learning disabilities and difficulties display poor working memory performance most in verbal and executive working memory (see Table 1.3) when children with academic learning
Table 1.3 Showing Working Memory components most highly related to types of Academic learning.

<table>
<thead>
<tr>
<th>Reading Decoding</th>
<th>Reading Comprehension</th>
<th>Written Language</th>
<th>Mathematic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phonological STM</td>
<td>Executive WM</td>
<td>Executive WM</td>
<td>Visuo-spatial WM</td>
</tr>
<tr>
<td>Verbal WM</td>
<td>Verbal WM</td>
<td>Verbal WM</td>
<td>Executive WM</td>
</tr>
<tr>
<td>Executive WM</td>
<td></td>
<td>Phonological STM</td>
<td></td>
</tr>
</tbody>
</table>

Note STM – Short-term Memory WM = Working Memory

Disabilities are matched with same IQ the learning disabilities children displays deficits in specific aspects of working memory (Swanson & Alexander, 1997).

Other studies suggested that children with learning disabilities shows deficit in one or two components of working memory for example, children with specific reading disability have important in phonological short-term memory and verbal working memory whereas children with specific mathematics.

Disability has deficits in Visuospatial and executive working memory students with learning difficulties most deficient in executive processing component of working memory. Executive working memory deficits and verbal working memory spans of children with learning disability are lower than age and ability of peers most of researcher believes that internal working memory limitations are main cause of learning disabilities.

**Working Memory and Learning difficulties:**

Poor working memory is characteristics of children with many kind of learning difficulties. This include individual with language impairment with difficulties in reading and mathematics (include dyslexia), with some form of the ADHD and with developmental coordination disorder. Approximately 70% of children with learning difficulties in reading obtain very low score on test of working memory that are very rare in children with no special education need.
Not all children with special educational need have working memory problem. Individual with problem in areas that are not directly related to learning, such as emotional and behavioral disturbances, typically have working memory capacities that are appropriate for their age. (Sushan E. Gathercole and Dr. Tracy Paciam Alloway, 2007)

1.4.3 Working Memory and Oral Language

Many studies show relationship between verbal working memory and language development and oral language comprehension. Language learning and comprehension depends on phonological short term memory and verbal working memory. Developmental delays and disorder in language are due to dysfunction in verbal working memory. Working memory plays important role in language comprehension and constructing integrating ideas form a stream of successive words. The complex process to understand meaning of a sentence individual must be able to remember previous works in order to relate them to later coming words, during this process. Working memory must store results of comprehension and encode for later retrieval. Due to deficient working memory individual face difficulties in sentences processing.

1.4.4 Working Memory and Reading

Many studies have reported high relationship between working memory performance and reading skills. Reading skills or divided in two categories, reading decoding or basic reading skills and reading comprehension. Reading decoding depend on phonological processing, the ability to detect and manipulate sound of oral language whereas reading comprehension is complex and involves higher level cognitive processes.

(See table 1.4)

Reading skills comes from short-term memory, long-term memory and working memory differently. Reading decoding is related to phonological short–term memory and verbal working memory, whereas reading comprehension is related to long-term memory, verbal working memory and executive working memory.
Table 1.4 showing cognitive processes most highly related to types of academic learning

<table>
<thead>
<tr>
<th>Reading Decoding</th>
<th>Reading Comprehension</th>
<th>Written Language</th>
<th>Mathematics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phonological</td>
<td>Working Memory</td>
<td>Working Memory</td>
<td>Working - memory</td>
</tr>
<tr>
<td>Processing</td>
<td>Long-term memory</td>
<td>Executive processing</td>
<td>Fluid Reasoning</td>
</tr>
<tr>
<td>Short-term memory</td>
<td>Executive processing</td>
<td>Processing Speed</td>
<td>Processing Speed</td>
</tr>
<tr>
<td>Visual processing</td>
<td>Fluid Reasoning</td>
<td>Planning</td>
<td>Planning</td>
</tr>
<tr>
<td>Sequential</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Processing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Working memory</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Long-Term Memory</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Reading Decoding:-**

Phonological processing includes phonemic awareness in foundation of reading decoding (Kamhi & Pollock, 2005) Phonemic awareness is to recognize that words are composed of different sound. Phonological processing is important for manipulation of phonemes. It is recognizing, segmenting and blending phonemes.

**Reading Comprehension**

Reading comprehension components make nervy demands on both storage and processing functions of working memory. Reading comprehension depends on the capacity of working memory to retain text information that facilitates the Comprehension of Subsequent Sentences. Information caring information from sentence to the next sentence requires use of working memory. Working memory capacity is the highest predictor of reading comprehension in children, adult and students with reading disability.
1.4.5 Working Memory and Mathematics

Many Psychological and Educational researchers have found out the strong relationship between mathematics performance and measures of working memory. Mathematics skills are divided into two types, basic arithmetic calculation concept and mathematical problem solving. Math counting both types of skills involve short term memory and working memory components and process. Simple mathematics calculation requires three working memory processes; temporary storage to hold problem information, retrieval that accesses relevant procedures and processing operation that convert information into numerical output. (Brained 1983). Working memory resources are needed during the starting stage of mathematics skills acquisition, knowledge and skill growth. Working memory components and processes are responsible for various aspects of mathematics skills. Young students depend more on Visuospatial storage while older children primarily on phonological short-term memory as their mathematical functioning becomes more verbal and abstract.

Mathematics Calculation:

Mathematical Computation involves successful stages where each part is carried out and stored till the next step in the Computation is completed. Most researchers have found that simple mental arithmetic requires execution working memory resources. According to Swanson (200ba) the working memory component that best predicts mathematics calculation is Visuospatial. Others also found the combination of Visuospatial and executive to have the strongest association with mathematics calculation performance.

1.4.6 Working memory and written language

Writing is a complex cognitive task that requires some cognitive processes and memory components. He/she begins writing with planning during which writer generates ideas and constructs a preverbal message that corresponds to the ideas that he/she wants to communicate. After that the composer must translate ideas into words and construct grammatically correct sentences that involve retrieval of the semantic syntactic and morphological properties of words. Then motor program we have transformed linguistic message into text, then writer evaluates by comparing text
internal meaning. Writing is a parallel and repetitive process requiring constant shifting in the procedures. These steps put very high demands on working memory, most on the executive and verbal components. Visual spatial working memory is involved in planning of written language production and during recalling of concrete nouns not abstract nouns written expression involves retrieval and temporary storage of information from long-term memory where the writer uses trick multiple writing tasks. The relationship between working memory and written language compared with reading and mathematics fewer scientific inquiries for example, Individual with longer verbal spans write more complex sentences than individual with short span and written language increases as written language skills increase (Swanson & Siegel 2001). Due to limited research can be title doubt that written language production depends on working memory and all aspects of verbal working memory and executive working memory are fully involved in written language.

1.4.7 Working memory in the classroom

We often have to hold information in mind whilst engaged in an effortful activity. The information to be remembered may, for example, be the sentence that they intend to write while trying to spell the individual words. It could also be the list of instructions given by the teacher while carrying out individual steps in the task.

Individuals with small working memory capacities will struggle in these activities, simply because they are unable to hold in mind sufficient information to allow them to complete the task. Losing crucial information from working memory will cause them to forget many things: instructions they are attempting to follow, the details of what they are doing, where they have got to in a complicated task, and so on. Because those with small working memory capacity fail in many different activities on many occasions due to these kinds of forgetting, they will struggle to achieve normal rates of learning and so typically will make poor general academic progress.
1.4.8 Role of Visuospatial Working Memory
During the childhood developments look for the changing role of working memory in mathematics learning and performance. It plays main role in the pre-school year when the child’s mental arithmetic model is primarily Visuospatial instead of verbal and abstract. Studies suggested that pre-school children focus on Visuospatial working memory more than older children. Visuospatial working memory is the best predictor of pre-school performance on non-verbal arithmetic problems.

1.4.9 Role of Phonological (Verbal) Short-Term Memory
Phonological short-term memory is responsible for individual differences in solving mathematic problem, because numbers, words and story problems are texts phonological storage and processing are involved in basic arithmetic calculation and the solution of story problems. If phonological short-term memory is deficient in capacity it creates narrowing flow of information to the higher levels of processing, including verbal working memory that are necessary for mathematical problem solving.

1.4.10 Role of Verbal Working Memory
When the phonological short-term memory is in sufficient for mental arithmetic then verbal working memory plays important role in mathematical calculation. So Verbal working memory storage is in most demand; when digits must be temporarily stored during multistep procedure.

1.4.11 Role of Executive Working Memory
Short-term and working memory domains executive working memory plays important role in all types of mathematical computation and reasoning task. Executive working memory is responsible for coordinating sequencing and monitoring all processing steps which are involved in mathematical procedures. Executive working memory is responsible for coordinating sequencing and monitoring all processing steps which are involved in mathematical procedures. Executive working memory is necessary for counting estimating, maintaining order of information tracking information in
multistep procedure selecting and executive problem solving strategies. Findings relates that limited working memory capacity or high demands on working memory resources result in slow calculation and errors, even after mathematical facts have been mastered in skills.

In general sense, memory refers to the lasting effect of stimulation that is the effect that remains after the stimulus is gone. Memory is essential for learning. Working memory is the active part of memory; we are using working memory whenever we are making an effort to remember something for a short or long period of time; working memory helps transfer information from short term memory to long term memory; working memory is limited in everyone; working memory easily becomes overloaded and when it does miss information; forget it quickly, or do not get it stored in our long-term memory; working memory is extremely important for learning; and students with learning problem often have working memory problems, for example when we are using working memory, such as in doing mental arithmetic; trying to memorize something; trying to recall; that we do not immediately remember; listening and taking notes at same time; and expressing ideas in writing.

We have all experienced the limitation of working memory. How many times have we forgotten a pile of information because the focus of our attention shifted to something else? For example on countless occasions, we have not been able to remember what we were going to say or what someone else just said surely, we have all felt the frustration that occurs when we cannot retrieve information. Now try to imagine what it would be like if you were a student with sub average working memory capacity or a significant intra individual weakness in working memory.
1.5 RELATION BETWEEN WORKING MEMORY AND EDUCATIONAL ACHIEVEMENT

Working Memory is linked to key educational achievement. Research has found evidence of working memory problems in individuals with mathematical difficulties, reading, language impairments, developmental coordination disorder, and attention problems. Memory and education cannot be separate. The importance of memory in education cannot be underestimated. Memory is the process by which we achieve learning. There is a strong relation between working memory and educational achievement. Working memory required for learning working memory play key role in education. All we learned and remembered must pass through working memory. Working memory performance predicts range of cognitive task, classroom performance, and development of academic skills reading, writing, Mathematic, oral language, reading comprehension, written expression depends on adequate functioning of working memory.
1.6 IMPORTANCE OF THE STUDY

Working Memory is important in every one’s daily life like in academic, professional and social setting for example working memory include: remembering phone numbers, short driving direction, Names, One’s hotel room number and last sentence someone just said working memory is important in a combination skills. Working Memory is one type of tool which is used by everyone to help us to perform effectively & efficiently in everyday life and all aspects of our lives. This important and essential tool is defined as the ability to maintain and manipulate information in the mind a big period of time. According to Baddeley (1992) defines working memory as the brain system that provides temporary storage and manipulation of the information necessary for such complex cognitive task as language comprehension, learning and reasoning. Working memory is necessary for staying focused on task, blocking out distractions and keeping one updated and aware of things that are going in the environment working memory and education achievement very important for school age children daily routine. High and low educational achievement depends on high and low working memory capacity. Teachers and parents complain regarding low achievement of the students. It is estimated that 5% children have reading disability and out of them 80% students with specific learning disability suffer that academic problems in reading, causes of reading failure is verbal working memory. We can best serve to the struggling students’ school psychologist quickly and efficiently discriminate problematic students. Early academic success depends on working memory performances. We can predict education achievement by majoring of working memory ability in formal education. Working Memory performance is predictor of academic success.

Study on working memory and education achievement is a very important in field of education to recognize working memory in the classroom and early interventions and management of poor working memory thousands of children face problems in education achievement they have difficulties in following instruction, problems with learning activities, some appear to be inattentive, to have short attentions span, majority of the children with poor working memory are slow in education in the area of Maths, science and reading in primary and secondary level school. This study is important to guide to promote teacher awareness of working memory load created by
class room activities and instruction. We can try to education achievement, effectively teaching to student with impaired working memory, early iterance is important for brain and mind development earlier age for early development and also for early academic development at an earlier age. Poor academic progress in reading math, writing and oral language to help to inattentive to have short attention span have difficulties is following the instructions; problems with learning activities that require both storage and processing. Assessing working memory problems, Children class room behaviors, problem behaviors associate with the poor working memory. To monitor the child and evaluate working memory load and reduce working memory load, we can encourage use of memory aides, help to develop to child’s own strategies.

In short this study is useful for children with poor working memory and less balanced pattern deficit that are more severe for either verbal material or Visuospatial material knowing the profile of working memory strengths and weakness is useful in identifying effective learning support for individual children, know through working memory assessment for provide valuable prospective indicators at school entry of children at risk of poor academic progress over coming school. So we can help and support in every aspect of school aged children in their educational achievement and working memory.
1.7 INTERVENTIONS OF WORKING MEMORY AND EDUCATION ACHIEVEMENT

Psychologist believe that working memory capacity is primarily innate, but all agreed improved working memory performance should be attributed to more effective use of existing and generally immutable working memory capacity.

The results of new research on neuroscience show that children and adults can improve their working memory capacity. Scientists have identified and realized that human brain is much capable to building its capacity to hold more information in the part of brain that affects cognitive functions or working memory. The latest scientific discoveries and how educator can use this knowledge and tools to help students in their classes including students with ADHD, learning disabilities, down syndrome and children who are born pre-term. Educator can learn about new tools, they can understand what is causing of the disruptive behaviors they experience in the classroom and how to help children expansion of their current level of cognitive ability.

Early Intervention

Researcher emphasize on early intervention of academic and working memory. Most of research conducted brain based in early development and the ability of the brain to adept to impairment. Intervention of educational and working memory and other related field are more effective at earlier age. Most of memory intervention those are remedial type, need to occur before the maturing of specific brain regions where the process of concern B located.
1.8 COMPOSITION OF THE STUDY
The main aim of present study is to measure working memory and educational achievement of Intellectual disabled and normal children and also among boys and girls from urban as well as normal area. All the details regarding study described in 5 chapters.

Chapter – 1 “Introduction” under this title explained history of Working Memory & Educational Achievement. Importance of Working Memory and Educational achievement theories and model of working memory types of working memory, Educational achievement, Relationship of working memory and educational achievement Importance of the study.

Chapter – 2 : In this chapter under the title of review of literature “mentioned previous research studies in working memory and educational achievement and why this present study.

Chapter – 3 : In this chapter under title of “Research Methodology, Objectives design and process of the study” explained problem student. Objectives of the study Null hypothesis, Variables of the study sample selection, Research design, Tools procedure of data collection and statistical techniques.

Chapter – 4: Data analysis and Interpretation under this title explained difference statistical methods analysis of ‘T' test word action, Regression and ANOVAs result discussed.

Chapter – 5 : “Summary and Conclusion describe conclusion of the study limitation of the study and suggestions and significance of the study. At the end appendix and tools and Questionnaire.
1.9 SUMMARY

Working Memory is very important for educational achievement. High education achievement depends on high working memory capacity. There is in children’s academic achievement with or without learning difficulties. There is relationship between poor working memory capacity and academic failure. Working memory assessment holds the potential to identify children at risk of future low achievement. Working memory measure would be an appropriate addition to early school screening. Working memory intervention is for both normal or intra-individual weakness and deficits. Intervention is important for young children, students with learning disabilities, students with cognitive disabilities students with acquired working memory loss individuals with poor academic performance. Working memory is necessary for every aspects of academic learning. In this study we will try to investigate major working memory and education achievement in normal and intellectual disabled boys and girls from urban and rural areas.