CHAPTER – II

REVIEW OF RELATED LITERATURE

2.0 Context

To understand, comprehend and plan any research study review of related literature and studies is an essential pre-requisite. The review not only helps in making base to select the research problem but also helps in selecting tools, research design and techniques to analyse data with latest methods. In other words it can be stated that it becomes the base of knowing the problem, its nature and scope for researching. It explains the development, trend, and gaps in research. The understanding the development of the study area provides a basic framework for conducting research more systematically. Hence, the researcher needs to review literature and studies to understand the issues related to working memory, academic achievement, and language skills both for typically and atypically developing children. The researcher has attempted to reviews such studies and literature available. The studies are discussed under the following subheads:

2.1 Studies related to working memory

2.1 Studies related to working memory and academic achievement

2.2 Studies related to working memory and language skills

2.1 Studies Related to Working Memory

This section reviews studies related to both typically and atypically developing Children. The working memory (WM) one of the basic construct and a central aspect of learning (Radvansky, 2015). The working memory comprises a number of skills that underpin thinking, reasoning, remembering and perhaps even consciousness. Hence, the role of working memory and its relation with language and academic
achievement needs to be explored more in the area of language skills and academic achievement. These sorts of research can be very helpful for providing appropriate remediation and help in planning proper intervention programme. There are lots of studies available on typically developing children, but few have been done on atypically developing children. Most of these studies are not covering children with mild intellectual disabilities from the elementary stage which is considered to be formative stage for learning stage if and given appropriate supportive assistance they can grow more independently. The available researches in the area of Intellectual Disability and working memory are found to be very scanty. Following studies reflect the working memory in typically and atypically developing children.

In a study Berggren et al. (2016), who studied the influence of emotion, and anxiety on visual working memory of individuals found that working memory performance, and state anxiety was negatively correlated. The investigator also reported that external signals could strongly modulate state anxiety’s influence on visual working memory to the threat. Hence, the study shows an interaction between memory performance and self-reported state anxiety and cue valence.

2.1.1 Studies Related Working Memory in Typically Developing Children

A study conducted on 4337 children of grade 2 to 6 by Van de Weijer et al. (2015) on relationship between verbal and visual-spatial working memory and performance in mathematics, reported that the predictive value of visual-spatial working memory for individual differences in levels of mathematics performance declined and predictive value of verbal working memory increased with the increases in grade level. However, the working memory did not predict individual differences in levels of mathematics performance with an increase in grade level.
In a comparative study among North American and United Kingdom 178 children aged between 5 and 9 years assessed using the Automated working memory test. Nadler and Archibald (2014) found that the two population showed the cultural difference in short-term memory but not on working memory measures. These findings support a three-factor model of memory. It was in line with the domain-specific storage and domain-general processing components of working memory model.

Wilson and Wolf (2009) investigated the impact of particular design factors on individuals ability to understand and remember health information. The researchers did a critical review of the potential impact of relevant cognitive and learning theories on the optimal design of health materials. In the study, working memory was measured as an individual’s limited ability to hold and manipulate information in active awareness. The study reported that the readily available material could minimize the heavy cognitive demands placed on the individuals.

In an experimental study, the effect of working memory capacity in the initial learning stage was examined on the relearning stage by Sasaki (2008). In the Experiment-1, the effect of articulatory suppression in combined associative learning was examined using the relearning method. In the learning stage, 28 participants learned all word-nonword associations under conditions of articulatory suppression. After a delay, the participants answered a cued recall task in a non-suppressed condition and a performed a relearning assignment in a simple tapping condition. The investigator found that the participants who learned under the simple tapping condition in the learning stage took more trials in the relearning stage. In Exp. 2, 28 participants participated, and the result was same as trial one. The study reported that the working memory capacity facilitates relearning.
Miyahara (2007) examined the younger and older adults in working memory for hand moment through role verbal labels play. He reported that only 20% older adults could spontaneously form verbal level, whereas, all the young adults did so. However, after instructed to use verbal labels, the older adults accomplished to the level of the young adults. Hence, he reported that an age-related decline in spontaneously recruiting a verbal labeling could be learned and retained.

In a study on preterm births, Sansavini et al. (2007) investigate the effects of preterm birth on specific linguistic competencies and phonological working memory at preschool age. The study was aimed to find the relationship between early grammatical performance in cognitive development, biological and social factors in healthy premature birth. The study reported linguistic and cognitive variances between preterms and full terms. The result showed that premature births affect grammatical, cognitive and phonological working memory components. They found close relations between phonological working memory and grammar in preterm and full terms delivery and highlighted the mutual support of these abilities in development.

Cokely et al. (2006) examined the relationship between attentional control (measured with operation span) and interference in a part-list cueing paradigm. The researchers found that superior attentional control enhanced interference. The relationship reflected the participants use of more complex encoding strategies rather than superior interference control at retrieval. The study reported that complex span measures predict individual differences in task strategies related to interference control.

According to Alloway et al. (2006), all the components of working memory get well established by four years of age. They analysed the structural and cognitive
process underlying visuospatial and verbal working memory in the children between the age of 4 and 11 years, using multiple tasks to measure different memory components. They explained that common resource pool supported processing components of working memory, while storage aspect was dependent on domain-specific verbal memory and visuospatial resources. The model was largely stable across the developmental period, although some evidence existed that the links between the domain-specific visuospatial construct and the domain-general processing construct was higher in the 4-6 year age group.

Baldo and Dronkers (2006) examined the two groups of patients to find out the role of inferior parietal and frontal cortex in working memory. Results showed that inferior parietal patients were unduly impaired on the span, rhyming, and repetition tasks and thus showed a phonological storage deficit. Whereas, inferior frontal patients did not show any deficit on these storage tasks but did exhibit deficits on the visual rhyming task, which requires articulatory rehearsal. These findings supported working memory model and provided evidence of the roles of inferior parietal and inferior frontal cortex in working memory processes.

To analyse the effect of stereotype threat on test performance, Schmader and Johns (2003), conducted three experiments. They assumed that stereotype threat interferes with test performance because it reduces individuals working memory capacity. They demonstrated that priming self-relevant negative stereotypes reduce women’s (Experiment 1) and Latinos’ (Experiment 2) working memory capacity. The final study revealed that a reduction in working memory capacity mediates the effect of stereotype threat on women’s math performance (Experiment 3).

Oberauer (2001) tested the ability of young and old grown-ups using modified Stenberg recognition task, to remove irrelevant information from working memory.
The task involved two memory sets, out of which they cused one test as irrelevant. The recognition task was presented at a variable time after prompting two displays of inhibition. The set size effect of the irrelevant set and reaction time loss of instructions tasks were dissociated. It was found that the Irrelevant set size effects did not differ between old and young adults. And intrusion costs lasted up to 5 and were disproportionately large for old adults.

Kemtes and Kemper (2001) measured the age based construct similarity for verbal working memory (VWM). One hundred younger and 100 older adults had their working memory assessed across three separate experiments and examined the role of working memory in complex sentence comprehension. Simple forward digit recalls backward digit recall, and the reading or listening span was measured. Results showed that single factor models accounted well for the associations among the sets of VWM tasks. The construct was also measured wells across, age groups and different samples. The authors suggest that the factor score comparison methods may be useful for small-scale studies that require assessment of age-based measurement similarity in cognitive constructs.

In an experiment on 127 individuals who ranged in age from 18 to 90 years tested them on a reading span test and measures of on-line and off-line sentence processing efficiency (Waters and Coplan, 2001). Older participants had reduced working memory spans compared with younger participants. The on-line measures were sensitive to local increase in the processing load and off-line were sensitive to the syntactic complexity of the sentences. Older and younger participants showed similar effects of syntactic complexity on the on-line measures. These were some evidence that older participants were more affected than younger participants by
synaptic complexity on the off-line measures. The results support the hypotheses that
on-line processes involved in recognizing.

Seitz and Schumann (2000) examined the role of working memory resources
in mental multiplication. In 2 experiments a dual-task paradigm was used in
12 psychology students (mean age 28.4 years). Results showed that the 1st experiment
revealed decays in performance on different sums under articulatory suppression but
no interference effect for easy sums. To examine the role central executive processes,
a 2nd experiment extended the range of interference conditions of a central executive
interference task. Now articulatory suppression and random generation caused a
decreased of performance in difficult sums. In addition, performance on easy sums
was negatively impacted by random letter generation as well. The authors suggested
that solving complex multiplication sums demand phonological loop and central
executive processed. Whereas retrieving numerical facts in solving simple
multiplication sums requires only central executive processes.

Oberauer et al. (2000) examined that WM capacity can be differentiated
theoretically along two dimensions: Contents and function. The 3x3 matrix was
operationalized by 23 tasks sampled from the literature. Data for these tasks from
128 (18-46 years) old participants were analyzed by exploratory and confirmatory
factor analysis. Regarding the content facet, spatial working memory was clearly
separate from the additional two content categories. A distinction between verbal and
numerical working memory was not justified. On the functional dimension the
postulated categories of simultaneous storage and transformation and of coordination
couldn’t be separated. The 3rd category was clearly separate from the first two
function the factor could be interpreted to reflect a mixture of variance due to mental
speed and to supervisory functions of the central executive.
Gathercole et al. (2016) reported the extent to which deficits in working memory (WM) were characteristic of children with reading and mathematics difficulties in large group of sample aged 5-15 years old. Results showed that working memory capacity was highly correlated with reading and mathematics score. Short-term memory and WM deficits found in half of the children with learning difficulties. Three-quarters of the children with low reading and mathematics scores secured working memory scores in the deficit range. These findings were in line with proposals that working memory was critical for core classroom activities including remembering instructions.

### 2.1.2 Studies Related to Working Memory in Atypically Developing Children

Kudo et al. (2015) synthesized literature that compares the academic, cognitive and behavioral performance of children with and without reading disabilities. Forty-eight studies were selected for the meta-analysis. Hierarchy linear modelling reported that verbal working memory, visuo-spatial working memory, central executive, short-term memory and intelligence facilitates differences in groups. Results were consistent with the assumption that cognitive deficits in children with reading disabilities were persistent.

Carney et al. (2013) examined the verbal and visuo-spatial executive function task in children with Down Syndrome (DS) and William syndrome (WS). Tasks related to executive function-executive loaded working memory, inhibition, fluency, and set-shifting-were administered to DS and WS. The sample in the study included was 2 children and adolescents with WS, 25 children and adolescents with DS and 26 typically developing children. Hierarchical multiple regression were used to compare performance in both the groups to control for potentially cognitive/developmental factors. Findings showed that executive loaded working memory was deficit in group
of individuals with DS and inhibition for individual with WS. WS and DS group showed difficulties in executive function in comparison to typically developing children.

Soltani and Roslan (2013) aimed at finding out the contribution of phonological awareness, phonological short-term memory, and rapid automated naming to decoding ability among 60 participants with mild intellectual disability of age ranging from 15 to 23 year old. Results of correlation analysis revealed that all three aspects of phonological processing were significantly correlated with decoding ability. Hierarchical regression analysis indicated that after controlling the effect of IQ, phonological awareness, and rapid automated naming were two distinct ability, but phonological short-term memory significantly contributed to decoding ability.

Lanfranchi et al. (2012) investigated the dual task deficit in individual with Down Syndrome (DS). Forty-five children with DS and 45 without Intellectual Disability (ID) matched for verbal, mental age with verbal and visuo-spatial working memory tasks. Results revealed that children with DS had two distinct deficits: impairment in verbal tasks and further impairment in all dual task conditions. The results confirmed the assumption of a central executive deficit in children with DS.

Danielsson et al. (2012) investigated a comprehensive range of executive functioning measures (verbal and non-verbal demands) in children with intellectual disability (ID) and compared their performance to groups matched on mental age and chronological age. Twenty-two children with ID were taken in each group. Children with ID performed like same MA age group on the switching, verbal executive-loaded working memory, and most fluency task. However, these children were comparatively low on inhibition, in planning and non-verbal executive loaded working memory of same mental age group.
Levén et al. (2011) assessed the performance of prospective memory, working memory and self-rated memory in five children with intellectual disability (ID) and ten individuals without ID. Prospective memory was assessed with video-based procedure and naturalistic task, working memory with digit and picture span task, and a questionnaire was used to measure the self-rated prospective and retrospective memory. Results revealed differences between the two groups and more differences were there in the ID group. The short delay prospective memory, recognition, picture and digit span task were all difficult for the individuals with ID. ID groups performance were chance level 50% of the individuals without ID. Self-rated memory did not differ in between the groups.

Lee et al. (2010) examined the phonological and semantic contributions to the verbal short-term memory (VSTM) deficit in Down syndrome. 18 individual with Down syndrome age ranging 11-25 and 18 typically developing children of age 3-10 matched on receptive vocabulary. Findings revealed that phonological weakness contributes to the VSTM deficit in Down syndrome individuals.

In a longitudinal study for five years by Danielsson et al. (2010) investigated executive functions in adults with intellectual disability (ID) and compared them to a matched control group. Tower of Hanoi, executive loaded dual task version of word recall and verbal fluency were assessed in 5 years on two occasions. No significant difference found in two times of assessment. Results showed that individuals with ID have a problem with speed of accessing the lexical items and with working memory (executive control at encoding) which includes shifting of the task.

Alloway et al. (2009) compared the working memory (WM) skills among different types of diagnosis whether the impact on working memory skills. Findings showed that there were differential WM profiles of the following developmental
disorders: Specific language impairment, developmental coordination disorder, Attention Deficit/Hyperactive Disorder and Asperger syndrome (AS). Language impairment was associative with deficit in verbal working memory. Motor impairments were associated with selective deficit in visuo-spatial short-term and working memory. Children with attention deficits were impaired in WM in both verbal as well as in visuo-spatial component and children with AS had problem in verbal short-term memory.

Peeters et al. (2009) examined the precursor of verbal working memory in 52 children with intellectual disabilities (ID) and cerebral palsy with varying degree of speech impairments in the first grade of special education. Children’s working memory was assessed using force-recognition task, and intelligence, speech rate, speech intelligibility, auditory perception and phonological were also administered. Results revealed that verbal working memory correlated with intelligence, auditory perception, and speech ability. Children with ID and speech impairments had limited verbal working memory spans.

Alloway and Archibald (2008) compared 6 to 11 year old children with developmental coordination disorders (DCD) and specific language impairment (SLI) on components of working memory (WM) and learning. Children with DCD were deficit in WM and SLI group were impaired in standard scores. Visuo-spatial WM strongly related with number in SLI groups and WM were correlated with at least one attainment measurement in the DCD groups.

In a study by Henry and Maclean (2001) examined the relationship between working memory (WM), expressive vocabulary and arithmetic reasoning in children with and without children with intellectual disability (ID). For the age group of children with ID central executive was a most significant predictor of both expressive
vocabulary and arithmetic reasoning. In addition, phonological short-term memory also had a correlation with expressive vocabulary. For children without ID, phonological short-term memory was highly correlated with expressive vocabulary. Visual memory predicted arithmetical reasoning. However, phonological memory was an only marginal predictor. In the third group, where mental age (7-8 years) was matched with children with ID. For them, the best predictor of expressive vocabulary was a phonological short-term memory and visual short-term memory. The arithmetical reasoning was most predicted by the central executive and phonological short-term memory.

2.2 The Studies Related to Working Memory and Academic Achievement

Cameron et al. (2014) examined the relationship between two working memory task paradigm and academic achievement in 202 Australian primary-school children. Children were assessed with complex auditory span evaluation (CASE), reverse digit span and number memory reverse test (NMR). Results reveal that CASE and NMR had significant correlation with literacy and numeracy. Both types of tests of working memory were related to academic achievement.

Thorell et al. (2013) viewed the relationship between academic achievement and executive functioning among the children of age group 6-11 from four countries: Sweden, Spain, Iran and China. The childhood executive functioning Inventory (CHEXI) was administered by both parent and teacher. Findings showed that children in China found more deficit in executive function compared to other country children. Opposite pattern found in China where boys were rated poor executive functioning and in Iran girls were rated poor functioning by the teachers. In all four countries inhibition and working memory subscales of CHEXI was related to academic achievement.
Richardson et al. (2013) presented the paper on the role of working memory in children’s mathematics achievement. In the study 83 children of age range 8-9 year old participated. Mathematical test, complex span task, simple span task and speeded processing measures were administered. Results showed that together working memory components explained 43% variance on the numerical operation task and 46% variance on the mathematics reasoning task. However, complex span task contributed for both types of assessments. Speeded processing contributed for mathematical word problem and complex span task.

Dessemontet et al. (2012) examined the effect of inclusion on the academic achievement and adaptive behavior of children with intellectual disabilities (ID). A group of 34 children with ID from mainstream school and control group of 34 from special school had been included in the study. A comparison was made among two schools of academic achievement and adaptive behavior of children with ID. Results showed that children who had attended mainstream school found slightly more progress in literacy skills than the children who went to special schools. There was no difference in the progress of the two groups in mathematics and adaptive behavior.

Rasmussen and Bisanz (2011) examined the relationship between mathematics and working memory in young children with fetal alcohol spectrum disorders (FASD). The sample size was 41 (21 FASD group and 20 Comparison group) children of four to six years of age group. All were tested with standardized mathematics and working memory tools. FASD group found impaired in math’s and even performed less in phonological short-term memory component. In a group of FASD, math scores found significantly correlated with phonological short-term memory and executive loaded working memory. In conclusion, a mathematics problem in FASD group was found to be associated with working memory.
In a study by Nevo and Breznitz (2011) discussed the relationship between working memory skills, IQ, language phonological awareness, literacy, rapid naming, and speed of processing at six years of age. All these skills were tested before reading was taught and a year later to found the relationship between reading achievement (decoding, reading comprehension and reading time) and working memory of 97 children. Results revealed that complex phonological memory contributed more to predict all reading skills. It was suggested that a minimal ability of complex memory required to achieve normal reading level. Assessment of working memory before entering the school may predict the future academic success of the children.

Alloway and Passolunghi (2011) investigated the relationship between working memory, IQ and math’s skill in children. In the study, sample consists of 206 children of age group ranging seven to eight-year-old typically developing children. Math performance was predicted by visual-spatial and verbal short-term memory in seven-year-old children. Whereas in the eight-year-old children visual spatial memory predicted math scores. In vocabulary, differences were significantly, even then working memory skills were predicted to math and arithmetic scores.

Differential contribution of specific working memory components were seen with mathematics achievement in second and third graders by Meyer et al. (2010). In the study, sample consists of 48 2nd and 50 3rd standard children who were assessed with standardized working memory tests. Central Executive loaded working memory, and phonological short-term memory both predicted mathematical reasoning skills whereas visuo-spatial short-term predicted both mathematical reasoning and numerical operation in 3rd grade children. It was concluded that the central executive loaded working memory and phonological short-term memory facilitate performance during early years math’s learning whereas visual spatial plays a major role in later
stages. In the study, it was proposed that these changes during math’s skill acquisition happen because of the shift from prefrontal to parietal cortical function.

Alloway and Alloway (2010) investigated the predicted variance of working memory and intelligent quotient in academic achievement. In the study, the sample consists 98 children who were tested two times first at the age 4.3 to 5.7 and retested again at the age of 10.0 to 11.3 year. The standardized test was administered to assess the working memory, IQ, and academic achievement. Findings revealed that after six years of testing, working memory components were the predictor of literacy skills and numeracy. Working memory did not play as a proxy of IQ but a unique component of cognitive skills and also play an important role in academic achievement. In conclusion, these results of the study are important implications for education and even for intervention and identification.

Gropper and Tannock (2009) explored the relationship between working memory and academic achievement in children with attention-deficit/hyperactive disorder (ADHD). In the study, sample consists of 16 students with ADHD and 30 normal studying in the University. ADHD population found significant weak in auditory working memory and one visual-spatial task. Within the entire sample, there was a significant relationship between academic achievement and auditory working memory. In conclusion, it is evident that working memory had a significant role in the academic achievement of children with ADHD.

In an exploratory study Simmons et al. (2008), the possible relationship between phonological awareness, visual-spatial short-term memory and arithmetic attainment in young children were examined. Forty-two children were tested for visual-spatial short-term memory and phonological awareness at the age five years. Then after one year their non-verbal reasoning, vocabulary, arithmetic and reading
attainment were tested. Phonological awareness was the significant independent predictor of reading achievement and visual-spatial short-term memory were contributing in both arithmetic and reading.

Mabbott and Bisanz (2008) examined the level of computational skill and the conceptual knowledge in the older children with mathematics learning disability (MLD). The 92 children were matched on the following criteria; typically achieving age match, low achieving age-matched and ability matched peers. Children were tested individually with WRAT-III, a multiplication computational task and task of working memory. Findings reported that children with MLD were differing then typically achieving in multiplication, calculation fluency and working memory. A child with MLD was poor in executing backup procedure than typically achieving children. On multiplication measures and knowledge children with MLD was mostly equal to the ability matched younger children. The reason of MLD might be the poor working memory and difficulty in computational skills.

Lee & Peh (2008) reported differences in working memory profiles amongst children with low verses average academic performances. 150 children of primary 5 participated in the study. Standardized tests for mathematics, English literacy and working memory were used in the study. Working memory was assessed with Working Memory Test Battery for Children. Children who scored below the 25\textsuperscript{th} percentile were classified as poor working memory profile children. Poorer performance by children in both literacy and math’s (PML) had similar working memory profiles as poorer in literacy (PL), but had lower score than poorer performance in mathematics (PM). Children labelled as PM had similar profiles as did normally achieving children. Finding suggested that working memory intervention may not be beneficial for children with difficulties in different areas equally.
Pérez and Beltrán (2008) studied the effect of intervention programme which was based on the theory of multiple intelligence on the academic achievement of children with low intellectual capacity. The study was quasi-experimental with a non-equivalent control group and post-assessment. Total participant in the study was 113 students of age group 11 to 16 years. The results revealed that intervention contributed to the development of intelligence and found that teaching process one of the best methods to enhance academic achievement.

Holmes and Adams (2006) examined the contribution of working memory components with math’s skills. There were 148 children of the 3rd and 5th year. Children were tested with working memory measures and age appropriate design math’s skill. Results revealed that visual-spatial short-term memory and central executive loaded working memory predicted the calculation’s achievement score whereas phonological short-term did not show any predicted variance with math’s skill. After doing re-analysis, it revealed that visual spatial short term memory showed the vital role in younger children in math’s achievement.

Alloway et al. (2005) found the relationship of working memory skills and teacher rated progress of the children at the time of school entry. A sample 194 of age group 4 to five years were tested on working memory skills, phonological awareness, and non-verbal ability. Baseline assessment of reading, writing, mathematics, and speaking, listening, personal and social development were also taken from the schools. Results revealed that complex memory tasks related to writing skills, a phonological short-term with mathematics, personal and social skills. Reading skills found an association with phonological awareness. Awareness of phonological structure may play an important role in the learning areas of children at early school years.
Swanson (2004) explored the relationship between working memory (WM) to mathematical problem solving in younger children (8-year-old) and older (11-year-old) children. The results revealed that executive system a significant predictor of age-related changes in problem-solving beyond the contribution of reading and math skills. The system operates independently of the phonological system and domain specific knowledge.

Gathercole and Pickering (2000) investigated the working memory deficits in children with low achievement. The sample consists of 6 to 7-year-old children studying in school. Working memory was assessed by a test battery developing by Baddeley and Hitch (1974). Children were divided into normal and low achievement groups based on their performance on national curriculum test in the subject of English and Mathematics. Children with low achievement showed impairment in central executive function and visuo-spatial short term memory. A single cut-off score on working memory test battery successfully identified the majority of children who were failing to achieve the nationally expected level of achievement. Complex working memory found closely related to academic achievement in the early years of school. The research suggested that assessment of working memory skills would be useful method to identify poor scholastic progress of children in school.

Leather and Henry (1994) investigated the relationship between complex memory span, simple memory span, phonological awareness tasks, and reading. Children with seven-year age were assessed with memory tasks. Results revealed that phonological awareness tasks were highly correlated with one another and with both of the complex tasks. Regression analyses showed that the phonological awareness and reading span scores shared portion of the variance in all three cognitive abilities. The arithmetic related complex tasks scores contributed to the variance in arithmetic.
The result showed that phonological awareness and complex span tasks make shared contribution to the variance in all three cognitive abilities.

2.3 Studies Related to Working Memory and Language Skills

Davidson et al. (2015) presented the paper on the relationship between reading, oral language and working memory in children and adolescents with autism spectrum disorder (ASD). In this study, sample consists of children and adolescents of 8 to 14 years of age group with (24) ASD and 23 typically developing children. After bivariate correlation and series of regression analyses outcomes revealed that decoding skills and language was significantly correlated to passage comprehension. Only oral language was a significant predictor in typically developing children. In the case of children with ASD, non-verbal working memory and language were significantly correlated to passage comprehension. In conclusion decoding, working memory and oral language were interconnected variables and decoding was a significant predictor of passage comprehension in children and adolescents with ASD.

Barker et al. (2013) examined the structure of phonological processing, language (expressive and receptive) and reading in children with mild intellectual disability. In this study, sample consists of 294 school children with mild intellectual disability. Phonological awareness and naming speed were the two distinct latent abilities of phonological processing. Phonological processing was strongly related to receptive and expressive language skills and reading skills. Whereas naming speed was moderately correlated with language skills and reading skills. Results indicated that children with mild intellectual disability use same components for learning to read as typically developing children. As phonological awareness had strong correlation with language and reading skills, it was suggested that phonologically based reading strategies could be used as important approach.
Schuit et al. (2011) investigated the language development of 50 children with intellectual disabilities and 42 typically developing children of age range 4 to 5 years. The aim of the study was to see the roles of phonological working memory and intelligence in vocabulary and syntax development in both the groups. Results revealed that non-verbal intelligence predicted variance in phonological working memory in children with Intellectual disabilities of age group 4-5 years. Same skills were predicted in the age of 4 in typically developing children.

Vandereet et al. (2011) reported the expressive vocabulary acquisition and how much they depend on the manual signs of the children with intellectual disabilities. Twenty-three children with intellectual disability were monitored for the duration of two years with their parent report. A baseline assessment was taken of their cognitive, communicative and vocabulary comprehension. Results showed that there were four different profile of vocabulary acquisition. Children who shown delay in baseline had acquired smallest vocabulary and these variables were related to the children’s degree of dependence on manual signs.

In their study Pierpont et al. (2011), the phonological, working memory and language development in 44 adolescents with Fragile X syndrome (FXS) of mean age=12.61 years) were examined. The assessment of verbal short-term memory, verbal working memory, vocabulary, and syntax skills and cognition were administered. After a gap of two years these same tests were administered again. Analysis of study reported that after controlling non-verbal cognition skills and severity of autism symptoms, phonological short-term memory significantly predicted the improvement in vocabulary and syntax skills. Verbal working memory also contributed gain in vocabulary in boys with FXS. In girls with FXS, there was
significant correlation between working memory skills and language change over two years.

Wise et al. (2010) studied the structure of phonological processing and relationship between phonological process and language skills in children mild intellectual disabilities. A total number of participants in the study were 222 school-aged children with mild intellectual disabilities. There was a negative significant correlation between phonological process and naming speed and positive correlation between phonological processing and expressive and receptive language skills. Results were supportive for the previous researches with typically developing children, showing similarities in the relationship between phonological process and language in children with mild intellectual disabilities.

Rodrigues and Befí-Lopes (2009) reviewed the literature on phonological working memory (PMW) and language development in normal children. According to the reviewed literature studies, there was relationship between PMW, phonological and lexical knowledge. PMW plays a major role in language development and communication as it was allowing the child to remember and integrate experiences and use suitable vocabulary for the present situation. During the language learning, PMW helps the child to analyses structure properties of the sentence.

Conners et al. (2006) reported the acquisition of reading skills in children with mental retardation (Intellectual disability). An intervention program on reading skills was given for ten weeks to (20) children with intellectual disability of age group 7 to 12 years. Results revealed that instruction group did better in sound out the learned and transferred words than the control group. Sound out in the both the group were predicted by Reading skills. Sound out were predicted phonemic awareness and articulation speed in the control group and language ability in the instructional group.
Verbal working memory and IQ were not significantly correlated with final sounding out ability.

Marton and Schwartz (2003) examined the relationship between working memory and language comprehension in children with specific language impairment (SLI). In this study 13 children with SLI and 13 age-matched (7-10 years) typically developing were included. Results indicated that children with SLI showed more limitations in processing and attention capacity than the age-matched group. Children with SLI showed limitations in online processing rather than encoding skills in different tasks and phonological structure of the non-words. Error pattern was also different in both the groups which indicate the qualitative difference and syntactic difficulty affected more on performance than the sentence length.

Daneman and Merikle (1996) presented the meta-analysis of the data of 6,179 individuals of seven studies. The main goal of the study was to find the predictive measure of working memory developing by Daneman and Carpanter (1980). Results supported the findings of Daneman and Carpanter (1980) that reading span and listening span task was the best predictor of language comprehension. It also showed that math process plus storages measures were contributor of language comprehension.

Conners et al. (2001) conducted a study on children with intellectual disability to see the differences and similarities between stronger and weaker decoders. Total 65 children were taken for basic training of phonological reading skills. Within 65, 21 were had high decoding skills were separated to compare with 44 children with low decoding skills. Both the groups were compared on the base of intelligence, language skills, phonological awareness and memory. After analysing it was found that stronger decoder was better than the weaker decoder in language skills,
phonological awareness and phonological memory except for intelligence. When age was controlled in the groups, there was only significant difference in phonological memory. Results showed that working memory plays an important role in reading success of children. Poor phonological representation and output make decoding difficult for some children with intellectual disability.

2.4 Conclusion

On the basis of above stated reviews done of related studies and literature on the issues related to research study, the following conclusions can be drawn:

As evident from the above review of literature that there are plenty of studies done in the area of working memory on typically developing children but a very few studies found on atypically developing children that to finding the relationship between working memory, language skills and academic achievement among children with Intellectual disabilities. Even if some studies have taken these dimension they differ in their research design, population taken and on other varibales. The result of these studies on working memory and intellectual disability are also not consistent. The differences in their approach to undertake the studies could be considered to produce these contradictions. All most all the studies have taken mixed population of children with intellectual disability; that (i) children with intellectual disability who have the specific disorder, and their exact cause known such as Down syndrome, Williams syndrome, Fragile X, etc. and (ii) children with intellectual disability without any known specific cause. In the present study, the research has restricted to children with mild intellectual disability without any known organic cause to avoid research methodological errors.

Studies on language skills are also ample in typically developing children, and almost all the aspects and construct of language skills have been studied in relation to
working memory. However, when it comes to children with intellectual disabilities, the number falls to countable on finger tips. Hence, on the basis of understanding after reviewing available studies the investigator has only tried to find out the relationship between working memory and language skills based on standardised test.

In the context of the modern trend for the education of children with MID it is essential to investigate relationship of working memory not only with language skills but also demand to find out the relationship with academic achievement of these children. The main objective of our education policies and commissions is to provide education to all in inclusive education setting to children with MID at least. The review of studies have revealed that these children mainly lag behind in language skills due to this they may be doing poorly on their academic achievement. The importance of language cannot be ignored as language is not only learnt as subject but it is used as medium of instruction. The investigator was very careful in selecting the language of the sample. He has chosen only those children with MID who were native speaker of Hindi and were also studying through Hindi medium. The investigator selected to find out relationship of working memory with achievement in mathematics as this subject is considered more complex than the other subjects. The investigator decided to find out the relationship between working memory and academic achievement in mathematics and Hindi among these children.

Even if there are research studies available on working memory among children with intellectual disability in other countries, but these studies as stated earlier differ in the population, grade, language, and methodology used. Hence, there is need to explore this area.