5.1 Introduction

Intellectual disability is characterized by significant limitations both in intellectual functioning and in adaptive behaviour which covers a range of everyday social and practical skills. This disability originates before the age of 18 years (Schalock & Luckasson, 2015). In general, to understand intellectual disability, there has to be difference in the mental age and chronological age of a child. When chronological age is increasing but mental age does not increase at the same pace, it is called as Intellectual disability. The severity of intellectual disability is directly proportional to this disparity between mental age and chronological age. A child with Mild Intellectual Disability (MID) comes under the IQ range of 50 to 69, Moderate intellectual disability under 35 to 49, severe intellectual disability under 20-34, and profound Intellectual disability falls below 20. Working memory is a dynamic memory system that is responsible for the temporary maintenance and simultaneous processing of information (Bayliss et al., 2005). Alternatively, working memory defined as the use of briefly deposited information in the performance of more difficult cognitive tasks or as a mental work station (Hulme & Mackenzie, 1992; Richardson et al., 1996). Altogether, working memory can be understood as an inclusive and comprehensive system that ties various short and long-term memory storage and functions (Baddeley, A.D., 1986). The working memory is very fundamental to learning which is involved in learning all aspect of life (Radvansky, 2015b). It is a known fact that it affects academic achievement, language skills learning among the so called normal children (Susan E. Gathercole & Pickering,
2000; Susan E. Gathercole, Pickering, Knight, & Stegmann, 2004). It may have more implications specifically for children with Intellectual Disability (ID). The working memory is central to everyday academic and non-academic activities.

### 5.2 Rational of the Study

Intellectual disability affects almost all the areas of development. It is essential to know their problem to understand and support these children’s to survive more independently. It is important to understand the underlying basic constructs and limitations in processing information among these children. It has been found out that these children who are identified with intellectual disabilities lag behind to their normal peers. But how far the degree of ID influence the WM has not been explored. In this group of disability, children with mild intellectual disability are the children who are although lagging behind from typically developed children have capacity to lead life relatively independently as compared to the other groups of ID. Thus, children with MID are the appropriate group to explore their working memory and its relationship with language skills and academic achievement in subjects: mathematics and language as these children can express their learning through reading and writing. It is believed that a child who is good on linguistic expression is found to be good achievers in comparison to those who have linguistic poverty. This will help the education planner in developing insight in planning inclusive education by understanding their limitations to organize academic and technological support. It would be more systematic based on the limitations and strengths of these children. This delay in developing foundational skills in reading and math, coupled with delay in language skills may result in delays in other academic areas that require the use of these skills. The Children with MID can develop basic literacy and functional mathematics skills. For example, most children with mild intellectual disabilities can
learn basic computational skills and functional arithmetic skills related to money, time, and measurement. However, they often get stuck with complex tasks requiring higher skills of learning. They are also found to be poor readers sharing a deficit in PSTM and language skills (Fletcher, Blair, Scott, & Bolger, 2004). Thus, even if children with MID develop the ability to read individual words and strategies for reading comprehension, they often have difficulty in comprehension (Torgesen, 2000).

The WM is one of the basic constructs and a central aspect of learning (Radvansky, 2015a). Hence it may affect language skills and academic achievement. The children with intellectual disability face difficulties in learning academic subjects and developing language skills as this has lots of evidences that the working memory measures used by the typically developed children are found to be vital predictor of educational achievement and language skills (Leather & Henry, 1994). Though the available researches in this area of ID and working memory are very scanty yet it may be made base for assessment of their cognitive skills. As far as in India context, there are no studies available on working memory, language skills and academic achievement among these children. Even if there are few research studies available on WM among children with intellectual disability abroad, these studies are also found to be using different kind of population, grade, language and research designs. There is no single agreement in the findings of these studies. Hence, this area needs to be attempted to find out the role of working memory and its relation with language skills and academic achievement more systematically. If the level of working memory, level of language skills development and their relationship with academic achievement is explored, it will be helpful in minimizing learning difficulties of these children and also in providing more appropriate academic support for their education. It is in this light the investigator attempted this area for research.
5.3 Statement of the Problem

The present study proposed to investigate the relationship between Working memory, language skills and academic achievement in Hindi and Mathematics among Children with Mild Intellectual Disability in the IQ range 50 to 69 studying in 3rd grade in special and Inclusive Hindi medium schools of NCR Delhi. The WM in this study only included three components: viz. (i) phonological short-term memory, (ii) visual short-term memory, and (iii) executive loaded working memory. The academic achievement here means the achievement score on mathematics and Hindi, the language skills on their respective tests used in the study.

5.4 Main Objectives of the Study

• To find out the relationship between phonological short-term memory and achievement in Mathematics of children with mild intellectual disability (MID).
• To find out the relationship between visual spatial short-term memory and achievement in Mathematics of children with MID.
• To find out the relationship between executive loaded working memory and achievement in Mathematics of children with MID.
• To determine which component of working memory predicts achievement in Mathematics of children with MID.
• To find out the relationship between phonological short-term memory and achievement in Hindi of children with MID.
• To find out the relationship between visual spatial short term memory and achievement in Hindi of children with MID.
• To find out the relationship between executive loaded working memory and achievement in Hindi of children with MID.
• To determine which component of working memory predicts achievement in Hindi of children with MID.

• To find out the relationship between phonological short-term memory and total academic achievement of children with MID.

• To find out the relationship between visual spatial short term memory and total academic achievement of children with MID.

• To find out the relationship between executive loaded working memory and total academic achievement of children with MID.

• To find out the relationship between phonological short-term memory and language skills of children with MID.

• To find out the relationship between visual-spatial short-term memory and language skills of children with MID.

• To find out the relationship between executive loaded working memory and language skills of children with MID.

• To determine which component of working memory predicts Language skills of children with MID.

• To find out the influence of economic status of the parents of children with MID on Working Memory.

5.5 Hypotheses

• There is no significant relationship between phonological short-term memory and achievement in Mathematics of children with MID.

• There is no significant relationship visual spatial short term memory and achievement in Mathematics of children with MID.

• There is no significant relationship executive loaded working memory and achievement in Mathematics of children with MID.
• Working memory components do not act as a predictor of achievement in Mathematics of children with MID.

• There is no significant relationship between phonological short-term memory and achievement in Hindi in children with MID.

• There is no significant relationship visual spatial short term memory and achievement in Hindi of children with MID.

• There is no significant relationship executive loaded working memory and achievement in Hindi of children with MID.

• Working memory components do not act as a predictor of achievement in Hindi of children with MID.

• There is no significant relationship between phonological short-term memory and total academic achievement of children with MID.

• There is no significant relationship between visual-spatial short-term memory and total academic achievement of children with MID.

• There is no significant relationship between executive loaded working memory and total academic achievement of children with MID.

• There is no significant relationship between phonological short-term memory and language skills of children with MID.

• There is no significant relationship between visual-spatial short-term memory and language skills of children with MID.

• There is no significant relationship between executive loaded working memory and language skills of children with MID.

• Working memory components do not act as a predictor of Language skills of children with MID.
• There is no significant influence of economic status of the parents of children with MID on working Memory of children with MID.

5.6 Operational Definitions

(i) Working Memory

1.1 Phonological Short Term Memory (PSTM)-In this study PSTM refers to immediately repeating the digits or syllable exactly in same order as presented by investigator.

1.2 Visual Spatial Short term memory (VSSTM)-In this study VSSTM refers to immediately pointing to series of lines/drawing of cubes exactly in the same order as presented by the investigator on the spatial short-term memory test of working memory test battery for children and or arranging the abstract/irregular picture exactly in the same order as presented by the investigator on the abstract visual memory test of Indian child intelligence test.

1.3 Executive loaded working memory (ELWM)-In this Study ELWM refers to scores obtained on the listening span test, odd one out test and reverse digit test. In these tests ELWM was defined as follows.

1.3.1 Listen to a sentence read by researcher, make judgment about the sentence and then recall the first word of the sentence.

1.3.2 Pointing on odd one out picture among three pictures of lines drawings and following the pointing on the spatial location of the odd one out on set of blank response sheet.

1.3.3 Immediately repeating the digit in the reverse order as presented by researcher.
ii. **Language Skills:** In this study, language skills are the scores of children with intellectual disabilities on language skills on BASIC-MR\textsuperscript{16} test.

iii. **Children with Mild Intellectual Disability:** Children with mild intellectual disabilities in the range of IQ-50 to 69.

iv. **Academic Achievement:** It refers to the marks obtained by the children on Hindi and Mathematics\textsuperscript{17}.

5.7 **Variables of the Study**

Predictor variables: PSTM, VSSTM and ELWM

Criterion variables: a. Academic achievement (Hindi and Mathematics)

b. Language Skills

Background Variable: Socio-economic status

5.8 **Research Design**

The researcher conducted the present study in two stages as follows:

**Stage 1**- In first stage of study the investigator made selection of schools, sample, tools and pilot study was done to try out the selected tests.

**Stage 2**- Main study was conducted in the stage two. In main study data was collected by administering standardized tests individually by the investigator on the children. After these tests were administered the collected data was tabulated and statistically analysed. Details explanation has been given below.


\textsuperscript{17} Narayan, J. (2003). *Grade level assessment device for children with learning difficulties*. Secunderabad: NIMH.
5.9 Sampling Procedures and Sample of the Study

The population of this study consisted of children with Mild Intellectual Disability studying in schools of NCR-Delhi. The investigator used non-probability purposive sampling technique. The investigator surveyed the schools both special and inclusive of NCR Delhi based on the list provided by website of NIMH and Amrita foundation for people with disabilities, Delhi. The researcher approached total 30 special and inclusive schools of NCR-Delhi over the phone and through emails. Out of 30 schools, there were 16 special schools and 14 inclusive schools. The selected criteria for the school were infrastructure facilities, and minimum availability of five children with mild intellectual disability in the schools. The researcher could select only 7 schools fitting in the criteria adopted. Out of 7 schools, 2 were inclusive schools and 5 were special schools. The Children with MID were selected based on the clinical assessment records available in their schools certified by a clinical psychologist. The investigator could get only 53 children with selected criteria, out of 53, 7 showed the unwillingness to take part in the study due to some personal reasons; four were absent, and six could not complete the tests. Hence 36 children with MID constitute the sample for the study. Out of 36, there were 24 boys and 12 girls with the IQ 50 to 69 from 3rd grade from NCR, Delhi.

5.10 Details of Tools

The following tools were selected for the study.

i. Working memory

a. Phonological Short-Term Memory—Two tests were used to assess the phonological short term memory: a digit span (DS) and syllable span (SP) test taken from immediate memory test of Bhatia’s Battery.18

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b. Visual Spatial Short-Term Memory—Two tests were used to assess the visual-spatial short term memory: (1) Irregular figure short term memory span test taken from the Indian Child Intelligence Test\textsuperscript{19} and (2) spatial short term memory span taken working memory battery for children.\textsuperscript{20}

c. Executive loaded working memory (ELWM)—ELWM refers to scores obtained on the listening span test, odd one out test (Henry, L.A., 2011, 2013)\textsuperscript{21,22} and reverse digit test of Bhatia’s Battery of Performance Test of Intelligence.

ii. Language skills—BASIC-MR, Behavioral Assessment Scales for Indian Children with Mental Retardation.\textsuperscript{23}

iii. Academic achievement—Grade Level Assessment Device (GLAD)\textsuperscript{24}.

iv. Socio-economic status—NIMH Socio-Economic Status Scale, Revised Version (2012)\textsuperscript{25}.

Details of each test are given in the Chapter III (3.7).

5.11 Pilot Study

A Pilot study is a “Small scale version or trial run in preparation for a major study” (Polit-O’Hara & Beck, 2006). A pilot study was conducted in Mysore city of


\textsuperscript{24}Narayan, J. (2003). \textit{Grade level assessment device for children with learning difficulties}. Secunderabad: NIMH.

Karnataka. Total 15 Hindi native speaker children were taken for the pilot study which were divided into two groups. Group one had 8 typically developed children, whereas, group two had 7 children with Mild intellectual disability. The pilot study was conducted with the following objective (i) to check whether children with and without ID can understand the instructions and perform the test (ii) to check the validity and reliability of the working memory tasks which is given in the details below.

5.12 Reliability and Validity of the Working Memory Tests

All the working memory tasks have been taken from the standardized tests with their age and norms. As listening span test for measuring executive loaded working memory was translated and adapted and all standardised tests were from different sources so investigator checked for the validity and reliability of the working memory tests. Reliability Coefficient (Cronbach’s Alpha) of seven tasks of WM tests was .88 which is very good for internal consistency of tool. The correlation coefficient between the span tests: span test of (DSF, SP .630**), VSSTM (IFSTMS, SSTMS .603**), and ELWM (LST, OOO, and RDS .480* to 905**) were positively correlated. This showed the construct validity.

5.13 Main Study

Procedure of the Data Collection

Prior permission and written consent was taken from the special and inclusive schools of NCR, Delhi for the data collection. The consent was taken from the parents of the children with MID to take part in the study. The oral consent from each child was also taken before administering the test. A separate area was used for administrating tests as to avoid distractions. All the tests were administered individually. The test was conducted in three sessions to avoid fatigue and to control
other administering precautions. Each session lasted for approximately 50 minutes. In
the first session, task comprising PSTM and VSSTM were administered. In the
second session, ELWM task and language skills assessment were administered. And
in the third session, Hindi and math’s Grade level test of 3rd Grade were administered.
Appropriate breaks and reinforcement was given to keep them active and motived to
undertaking the tests with interest.

5.14 Statistical Analysis

The data was normally distributed and Shapiro-Wilk value was more than .05.
Data was checked for all the assumptions of Pearson’s product moment correlations
and multiple regressions. Only 36 children with ID were considered for the analysis.
Researcher has used SPSS 20 software for the analysis. Mean and SD were calculated
for all the variables and all the probabilities are two tailed.

5.15 Major Findings of the Study

The analysis of the data found that

- Phonological short-term memory ($r^2=17$, $F(1,34)=6.94$, $p=0.01$) predicted
  achievement in Hindi which showed that phonological short-term memory plays
  an important role in the academic success and functional skills of children with
  mild intellectual disability.

- Visual short-term memory ($r^2=0.143$, $F(1,34)=5.66$, $p=0.02$) predicted
  achievement in mathematics which showed that Visual short-term memory play a
  significant role in learning the mathematics. Children use visual and spatial
  memory as mental board for simple mathematics sums.

- Central executive ($r^2=0.157$, $F(1,34)=6.35$, $p=0.01$) predicted language skills. With
  this result it can be predicted that keeping information in mind and processing at
  same time plays major role in language comprehension in children with MID.
- The results of socio-economic status and working memory did not show any significant difference between group means of PSTM (F(1,34) =0.392, p=0.53), VSSTM (F(1,34)=0.338, p=0.565), ELWM (F(1,34)=0.840, p=0.366) and SES. Socio-economic status of parents of children with MID does not play any role in the working memory of children with MID.

5.16 Educational Implications of the Study

- Poor working memory skills are always associated with lack of attention. Hence, intervention of working memory skills can be helpful in academic achievement.

- To improve mathematics skills of children with MID, strategies based on visual spatial skill and central executive skills can be used.

- For inclusive education to be successful for this group of children, working memory can be pioneer. If units, chapter and other learning tasks are planned keeping the working memory functions of children with ID.

- Working memory plays unique component of cognitive skills and play an important role in academic achievement. In conclusion, these results of the study are important implications for education and even for early identification and intervention.

- Screening of poor working memory skills in the early years of learning can be helpful in enhancing academic success of children.

- Curriculum modification can be suggested according to the working memory components. Like short sentences with functional vocabulary can be used in the initial years of the schooling for children with intellectual disability. Games to enhance the visual spatial memory can be introduced.
Working memory of children with MID gets over loaded soon, which often results in poor academic performance. Hence, splitting the units and teaching through small commands can be very effective.

5.17 Suggestions for Further Research

- Learning requires working memory as a perquisite. Hence, further researches required to find out which working memory is prominent and contributes to which area of learning and academic achievement in children with ID.
- Further studies are needed to disentangle the manner in which specific subcomponents of the central executive influence development of mathematical skills in children.
- Working memory functioning of all the groups such as severe, moderately intellectually disability, etc. is needs to be examined to understand their process of working.

5.18 Delimitations of Study

- The study is confined to Hindi speaking children of NCR, Delhi studying in 3rd grade.
- The study is restricted to children with MID.
- Academic achievement was assessed only in Hindi and mathematics.