Cognitive Factors in Determining the Causes of Poor Performance in Mathematics of School Children

THESIS

Submitted for the Degree of Master of Philosophy

in

Educational Psychology

BY

MST. AFROZA PARVIN

Registration No. 289

Session: 2009-10

Department of Psychology

Supervised by

PROF. DR. SHAHEEN ISLAM

Department of Educational & Counselling Psychology

University of Dhaka, Dhaka 1000, Bangladesh

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Certificate

*This is to certify that **Mst. Afroza Parvin** has carried out her research entitled **"Cognitive Factors in Determining the Causes of Poor Performance in Mathematics of School Children"** under my supervision. This title was not used before by anyone for completion of any degree.*

*It is further certified that her work is an original piece of work and is fit for submission for the award of **M. Phil** degree in **Educational Psychology**.*

Dated: 26/11/2012

Prof. Dr. Shaheen Islam

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18 Nov, 2012 *Mst. Afroza Parvin*

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Abstract

Attainment in Mathematics depends on a number of cognitive factors. The present study was designed to investigate the role of verbal comprehension, fluid reasoning, working memory, processing speed, and verbal working memory on student's poor performance in Mathematics. To achieve this goal, Wechsler Intelligence Scale for Children- Fourth Edition (WISC-IV) was used after translating the key instructions into Bangla. The test was administered on 30 students (15 boys & 15 girls) to determine psychometric properties of the Bangla translated instructions. Internal consistency, split-half reliability and test-retest reliability were satisfactory. Significantly moderate to high correlations between scaled score of subtest and Full scale IQ score as well as between scaled score of subtest and composite score within the same index provided the evidence of convergent validity. Content validity also determined on the basis of experts' opinion. Sixty six students of primary & secondary school level were included in the study. Students were divided into three Math performance groups on the basis of attainment in school: i)"Math specific group" consisted of students who had failed only in Mathematics in last two consecutive exams; ii) "Math general group" comprised of students who had failed in Mathematics as well as at least one of other subjects in last two consecutive exams; and iii) "Comparison group" consisted of students who had neither failed in Mathematics nor in other subjects in last two consecutive exams. Wechsler Intelligence Scale for Children- Fourth Edition (WISC-IV) using the translated Bangla key instructions was administered individually. Verbal comprehension, Fluid reasoning, Working memory, Processing speed and Verbal working memory were found to be positively correlated with attainment in Mathematics and the correlation coefficients were (r=.63; p,.01), (r=.42; p,.01), (r=.61; p,.01), (r=.47; p,.01), and (r=.48; p,.01) respectively. Math performance groups had significant effect on Verbal comprehension (*F value*= *24.19, df=2 p<.01*), Fluid reasoning (*F value= 10.49, df=2; p<.01*), Working memory (*F value= 17.79, df=2 p<.01*) & Processing speed (*F value= 10.98,df=2 p<.01*) and grade and bilateral interaction of grade and Math performance groups had no significant effect. Both Math performance groups (*F value= 12.17, df=2; p<.01*) and bilateral interaction of grade and Math performance groups (*F value= 3.63, df=2; p<.05*) had significant effect but grade had no significant effect on Verbal working memory. Logistic regression revealed that Verbal comprehension, Fluid reasoning, Working memory and Processing speed together account for 52% the explanation of why student's attainment in primary and secondary level was poor in Mathematics. It also showed that coefficient (B) was significant for Verbal comprehension

(B=-.516; p<.05), Working memory (B=-.171; p<.05) and Processing speed (B=-.414; p<.05) but not significant for Fluid reasoning. The likelihood of being failed in Mathematics of students in Primary and secondary level reduced by .597, .843, .661 times for one unit increase in scaled score of Verbal comprehension, Working memory & Processing speed respectively while Working memory & Processing speed; Verbal comprehension & Processing speed; and Verbal comprehension & Working memory were controlled of respectively. Verbal working memory was account for 45% and 9% the explanation of why student's attainment in Mathematics was poor in Primary and Secondary grade respectively. Results also showed that coefficient (B) was significant for Verbal working memory was significant for primary grade (B=-.891; p<.05) but not significant for secondary grade. The likelihood of being failed in Mathematics of students in Primary level reduced by .410 times for one unit increase in scaled score of digit span backward (Verbal working memory). The findings of this study would be helpful for the educational psychologists and other professionals in the field of education to develop intervervention programmes for students having difficulties in Mathematics.

Chapter-1

Introduction & Literature review

Cognitive Factors in Determining the Causes of Poor Performance in Mathematics of School Children

1. Introduction & Literature Review

No human beings are able to live proper life without education. By the means of education only one's potential can be used to maximum extent. Education tells us how to think, how to work properly, and how to make decision. Through education only one can make separate identity. It is most important aspect of life of human being like basic need foods, clothe and shelter. Education plays a vital role in the personal growth and the social development among all of us. It's the education which transforms a person to live a better life and more importantly as a socially well being.

The goals of education are to learn about a subject, to acquire certain skills and to become better people. The dynamic interactions among these goals constitute education. Like many other subjects, acquisition of knowledge and skills in Mathematics is very important to achieve the goals of education.

Mathematics as a subject affects all aspects of human life at different degrees. The social, economics, political, geographical, scientific and technological aspects of man is centered on numbers. The inter-relationship between mathematics, development and advancement of humans shows the importance of mathematics in life due to its numeral and symbolic nature, it is more related to the scientific and technological facets of man's world than to any other aspect as it occurs and re-occurs in the physical and natural sciences [68].

Mathematics is often thought of as a subject that a student either understands or doesn't, with little in between. In reality, mathematics encompasses a wide variety of skills and concepts. Although these skills and concepts are related and often build on one another, it is possible to master some and still struggle with others. For instance, a child who has difficulty with basic multiplication facts may be successful in another area, such as geometry.

An individual student may have some areas of relative strength and others of real vulnerability [68].

In recent years, researchers have examined aspects of the brain that are involved when children think with numbers. Most researchers agree that memory, language, attention, temporal-sequential ordering, higher-order cognition, and spatial ordering are among the neuro-developmental functions that play a role when children think with numbers. These components become part of an ongoing process in which children constantly integrate new concepts and procedural skills as they solve more advanced math problems [68].

For children to succeed in Mathematics, a number of brain functions need to work together. Children must be able to use memory to recall rules and formulas and recognize patterns; use language to understand vocabulary, instructions, and explain their thinking; and use sequential ordering to solve multi-step problems and use procedures. In addition, children must use spatial ordering to recognize symbols and deal with geometric forms. Higher-order cognition helps children to review alternative strategies while solving problems, to monitor their thinking, to assess the reasonableness of their answers, and to transfer and apply learned skills to new problems. Often, several of these brain functions need to operate simultaneously[68].

Because Math is so cumulative in nature, it is important to identify breakdowns as early as possible. Children are more likely to experience success in Math when any neuro-developmental differences that affect their performance in Mathematics are dealt with promptly - before children lose confidence or develop a fear of Math which ultimately has an impact on psychosocial development [68].

Competence in Mathematics is increasingly important in many professions. And it's important to remember that this competence draws on more than just the ability to calculate answers efficiently. It also encompasses problem solving, communicating aboutMathematical concepts, reasoning and establishing proof, and representing information in different forms. Making connections among these skills and concepts both in Mathematics and in other subjects is something students are more frequently asked to do, both in the classroom setting, and later in the workplace [68].

However, the performance of students in Mathematics has been a great concern to the society. Mathematics does involve some special mechanisms of representation and mental processing which are appropriate for the representation and processing of quantitative relations. So the performance in Mathematics of a student largely depends on his/her cognitive factors or intelligence since it is a mental ability of individual [9].

During the past three decades, teachers and researchers have been exploring factors related to achievement in Mathematics. Among the affective variables identified in the literature are students' academic self-concepts, attitudes toward success in Mathematics, confidence in their ability to learn Mathematics, Mathematics anxiety, test anxiety, perceptions of the usefulness of Mathematics, motivation, self-esteem, and locus of control[2,3,8,14,32, 33,34,37] . Researchers have also been examining relationships between cognitive factors such as preferred learning styles, visual and spatial ability, the use of specific cognitive strategies and critical thinking skills, and performance in Mathematics [16,43,116] as well as relationships among affective variables[63]. It has been demonstrated that both cognitive and affective aspects are important in predicting and explaining attainment in Mathematics.

1.1: Cognitive Factors in Mathematics:

Performance in Mathematics largely depends on many cognitive factors such as IQ, memory, thinking ability etc. Literature related to contributions of some cognitive factors on performance in Mathematics has been presented in the following section.

1.2: Verbal Comprehension & Mathematics: Verbal comprehension is the ability of verbal concept formation, in other words the ability to reason verbally, the ability to listen to a question, draw from learned (formal and informal) information, reason to create a response, and express thoughts verbally.

The Cattell-Horn-Carroll (CHC) broad ability, Comprehension-Knowledge (*Gc*), is sometimes referred to as acculturation knowledge, crystallized intelligence, or verbal abilities. It is typically viewed as a store of acquired knowledge that includes both declarative and procedural knowledge. Two of the tests that compose the *Gc* cluster are Verbal Comprehension and General Information. The Verbal Comprehension test comprises four subtests: Picture Vocabulary, Synonyms, Antonyms, and Verbal Analogies. They measure the CHC narrow abilities of lexical knowledge (i.e., vocabulary knowledge) and language development (i.e., general development of spoken language skills that do not require reading ability). In contrast, the General Information test measures the CHC narrow ability of general (verbal) information. For children and adolescents, Comprehension-Knowledge (*Gc*) is moderately to strongly related to reading [36] and Mathematics [40] achievement.

Cognitive clusters from the Woodcock-Johnson III (WJ III) Tests of Cognitive Abilities that measure select Cattell-Horn-Carroll broad and narrow cognitive abilities were shown to be significantly related to Mathematics achievement in a large, nationally representative sample of children and adolescents. Multiple regression analyses were used to predict performance on the Math Calculation Skills and Math Reasoning clusters from the WJ III Tests of Achievement for 14 age groups ranging in age from 6 to 19 years. Comprehension-Knowledge (Gc) demonstrated the strongest relations with the Mathematics clusters from age 5 through late adulthood. Comprehension-Knowledge (Gc) demonstrated moderate relations with Math Calculation Skills after the early school-age years and moderate to strong relations with Math Reasoning [40].

1.3: Fluid Reasoning & Mathematics: Reasoning is a complex, hierarchical cognitive function that can rely on many other cognitive processes, depending on the nature and requirements of the task. Inductive and deductive reasoning are the hallmarks of fluid reasoning ability. Reasoning also often relies on emergent properties; that is, those functions that cannot be predicted based on simple interactions between other functions.

Fluid intelligence or fluid reasoning is the capacity to think logically and solve problems in novel situations, independent of acquired knowledge. It is the ability to analyze novel problems, identify patterns and relationships that underpin these problems and the extrapolation of these using logic. It is necessary for all logical problem solving, especially scientific, Mathematical and technical problem solving. Fluid reasoning includes inductive reasoning and deductive reasoning.

In the Wechsler Intelligence Scale for Children-IV (WISC IV) [125] , the Perceptual Reasoning Index contains two subtests that assess Gf: Matrix Reasoning, which involves induction and deduction, and Picture Concepts, which involves induction[39] . Since Matrix Reasoning and Picture Concepts involve the use of visual stimuli and do not require expressive language, they are considered to be non-verbal tests of Gf [39].

Cognitive clusters from the Woodcock-Johnson III (WJ III) Tests of Cognitive Abilities that measure select Cattell-Horn-Carroll broad and narrow cognitive abilities were shown to be significantly related to Mathematics achievement in a large, nationally representative sample of children and adolescents. Multiple regression analyses were used to predict performance on the Math Calculation Skills and Math Reasoning clusters from the WJ III Tests of Achievement for 14 age groups ranging in age from 6 to 19 years. Fluid Reasoning (Gf) demonstrated moderate relations with Math Calculation Skills and moderate to strong relations with Math Reasoning throughout childhood and adolescence[40].

Research that has included instruments that appear to measure Gf abilities (e.g., the Wisconsin Card Sort Test and the Halstead Category Test) has indicated that such abilities are significant correlates of Mathematics achievement [21, 40,104,110,114].

1.4: Working memory & Mathematics: Learning is a complex task that requires a student to use and apply a range of cognitive skills. A student's ability to retain information while performing concurrent processing, often referred to as working memory (WM), is critical to the acquisition of increasingly more complex knowledge and skills [48]. Not surprisingly, WM is often linked to successful learning and student academic achievement. According to the academic literature, WM is a very useful measure of a student's capability to acquire new information [99]. Most students are able to successfully respond to classroom instruction that requires them to rely on their WM to acquire new knowledge or skills. Unfortunately, some students struggle and ultimately fail to process information effectively which, in turn, negatively affects the outcome of instruction.

WM deficits [5] manifested as:

- Difficulties in following instructions
- Remembering the detailed content of ongoing activities
- Keeping track of progress through multi-step tasks
- Seeing through an activity to satisfactory completion

1.4.1: Working Memory (WM): The term "working memory" is defined as a person's ability to temporarily hold and manipulate information for cognitive tasks performed on a daily basis (e.g., following directions and performing mental Math) [50]. It provides a mental workspace that is used in many important activities in learning. Working memory is a pure measure of a child's learning potential. As it is not influenced by the child's prior experiences such as pre-school education, or their socio-economic background, it tells us about a child's capacity to learn. It is important in higher-order thinking, learning, and achievement. It can tap concentration, planning ability, cognitive flexibility, and sequencing skill, but is sensitive to anxiety too. It is an important component of learning and achievement, and ability to self-monitor.

A student's ability to master the content of daily instruction largely depends on his or her ability to successfully process information in WM. This requires students to move information from short-term memory to long-term memory, where it is stored indefinitely [22]. Most students are able to do so successfully. However, if information that a student is trying to process overloads their WM, learning and understanding will be negatively affected [86]. Working memory provides the temporary storage that underpins our capacity for complex thought [11] . WM is generally conceived as a dynamic mechanism that involves the capacity to store information over short periods of time while engaging in other cognitively demanding activities [109].

Baddeley and Hitch (1974) proposed a three-component model of working memory in which two "slave systems" are responsible for short-term maintenance of information, and a "central executive" is responsible for the supervision of information integration and for coordinating the slave systems (Phonological Loop & Visuospatial Sketchpad) [13].

Three main components of WM include:

1. Central Executive: It is an attentional control system that selects and operates strategies [11]. The central executive system is responsible for directing attention to relevant information, suppressing irrelevant information and inappropriate actions, and for coordinating cognitive processes when more than one task must be done at the same time.

2. Phonological Loop: It is a system for holding and manipulating sound and speech. It is one of the slave systems of WM which stores phonological information (that is, the sound of language) and prevents its decay by continuously articulating its contents, thereby refreshing the information in a rehearsal loop. It can, for example, maintain a seven-digit telephone

number for as long as one repeats the number to oneself again and again.

3. Visuospatial Sketchpad: It is the other slave system, the visuo-spatial sketchpad, stores visual and spatial information. It can be used, for example, for constructing and manipulating visual images, and for the representation of mental maps. The sketchpad can be further broken down into a visual subsystem (dealing with, for instance, shape, colour, and texture), and a spatial subsystem (dealing with location).

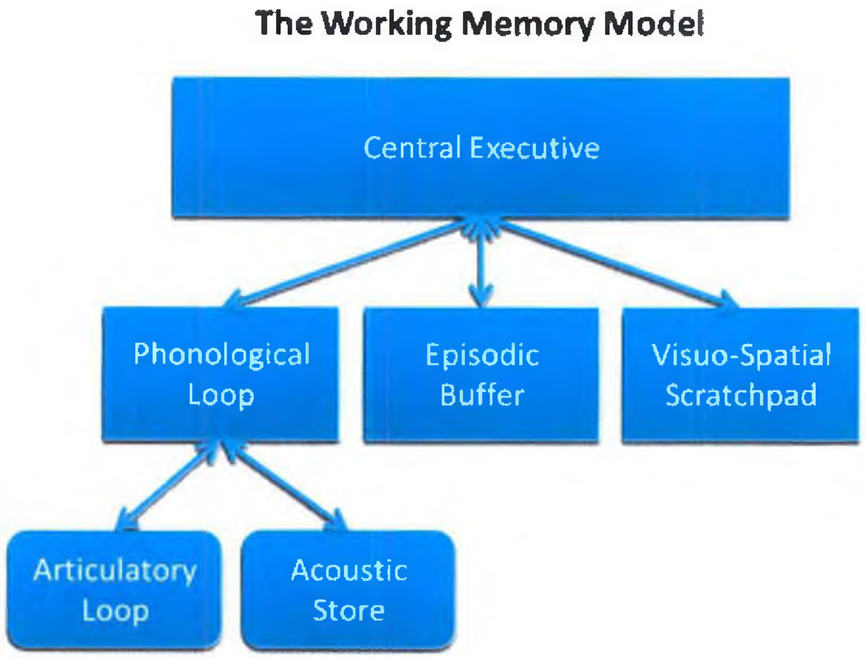


Figure-1: Baddeley and Hitch's Working Memory Model.

Source: http://en.wikipedia.org/wiki/Working_memory

In 2000 Baddeley extended the model as multi-component model by adding a fourth component, the episodic buffer, which holds representations that integrate phonological, visual, and spatial information, and possibly information not covered by the slave systems (e.g., semantic information, musical information). The component is episodic because it is assumed to bind information into a unitary episodic representation[12].

1.4.2: Capacity of Working Memory: Working memory is generally considered to have limited capacity. The earliest quantification of the capacity limit associated with short-term memory was the "magical number seven" suggested by Miller (1956) [88]. He noticed that the memory span of young adults was around seven elements, called chunks, regardless whether the elements were digits, letters, words, or other units. Later research revealed that span does depend on the category of chunks used (e.g., span is around seven for digits, around six for letters, and around five for words), and even on features of the chunks within a category. For instance, span is lower for long words than for short words. In general, memory span for verbal contents (digits, letters, words, etc.) strongly depends on the time it takes to speak the contents aloud, and on the lexical status of the contents (i.e., whether the contents are words known to the person or not) [69]. Several other factors also affect a person's measured span, and therefore it is difficult to pin down the capacity of short-term or working memory to a number of chunks. Nonetheless, Cowan (2001) has proposed that working memory has a capacity of about four chunks in young adults (and fewer in children and old adults) [24].

1.4.3: Measures of working memory: Working memory capacity can be tested by a variety of tasks. A commonly used measure is a dual-task paradigm combining a memory span measure with a concurrent processing task, sometimes referred to as "complex span". Daneman and Carpenter invented the first version of this kind of task, the "reading span", in 1980 [28]. Subjects read a number of sentences (usually between 2 and 6) and try to remember the last word of each sentence. At the end of the list of sentences, they repeat back the words in their correct order. Other tasks that don't have this dual-task nature have also been shown to be good measures of working memory capacity.[97] The question of what features a task must have to qualify as a good measure of working memory capacity is a topic of ongoing research.

1.4.4: The basis for proposing relations between working memory and Mathematical processing: Working memory refers to a mental workspace that is involved in controlling, regulating, and actively maintaining relevant information to accomplish complex cognitive tasks[94]. Mathematical competence entails a variety of complex skills that encompass somewhat different conceptual content and procedures (e.g., arithmetic, algebra, and geometry); problem solving in these domains often involves the holding of partial information and the processing of new information to arrive at a solution, which ought to require working memory resources. This description applies to both early informal Mathematical problem solving in preschool children [15] and complex Mathematical tasks in older children and adults, such as multi-step procedures in multi-digit arithmetic, word problem solving, and numerical estimation [73,112,114,121]. Furthermore, very young children may touch and point to objects to compensate for their developmentally-limited working memory skills, which are necessary for representing and updating quantitative information [4]. Thus, the very nature of many Mathematical tasks would seem to require or at least be supported by working memory, and this may be relevant when thinking about both typical and atypical development of Mathematical skills.

Skills required to solve Mathematical problems are performed by different systems of working memory. For example: retrieval of Math facts and writing dictated numbers are performed by the phonological loop of working memory. Mental Math, magnitude comparisons, and geometric proofs are performed by the visuospatial sketchpad. On the other hand, deciphering word problems, determining plausibility of result and transcoding mental operations are performed by the central executive system of working memory.

Working memory allows children to hold together the parts of Math problems in their heads. For example, to perform the mental computation 11 x 25, a child could say, "10 times 25 is 250 and 1 times 25 is 25, so adding 250 with 25 gives me 275." The child solves the problem by holding parts in his or her mind, then combining those parts for a final answer. Children with low working memory may have following difficulties in Mathematics:

- Forget Math steps
- Poor regrouping skills
- Difficulty with mental rotation

1.4.5: Research on working memory and Math difficulties: An important and consistent finding is that working memory is strongly associated with children's abilities to learn in key academic domains such as reading and Mathematics [66].

Cognitive clusters from the Woodcock-Johnson III (WJ III) Tests of Cognitive Abilities that measure select Cattell-Horn-Carroll broad and narrow cognitive abilities were shown to be significantly related to Mathematics achievement in a large, nationally representative sample of children and adolescents. Multiple regression analyses were used to predict performance on the Math Calculation Skills and Math Reasoning clusters from the WJ III Tests of Achievement for 14 age groups ranging in age from 6 to 19 years. Working Memory displayed moderate relations with both Mathematics clusters throughout childhood and adolescence [42].

A cluster analysis divided the Mathematical items into two discrete categories that differed depending on age: For the younger children, items fell into "pure" Math (namely number and algebra, and mental arithmetic items) and "applied" Math (mainly geometry and measurement and data handling items); whereas for the older children, the resulting clusters were easy and difficult items. In the younger children, the central executive, and to a lesser extent the visual–spatial sketchpad, contributed to performance on both the pure and applied areas of Math. For the older children, the central executive predicted performance on both the easy and the hard items, but the phonological loop task predicted performance on the easy items, and the visual–spatial sketchpad task predicted performance on the difficult items [66]. In adolescents, relations between visual–spatial working memory and Math have been found [80,104] with some differences reported for static and dynamic measures of visual– spatial working memory, depending on the particular Math skill being measured (e.g., static related to mental arithmetic and dynamic related to geometry and word problem solving).

One recent study that has combined an individual difference approach with more precision over Mathematical processes looked at components of working memory as mediators of performance on several Mathematical tasks in typically developing children and in children with less and more severe difficulties in Math [54] . For children in grade 1 with more severe disabilities, tasks tapping the central executive (consisting of verbal and numerical working memory tasks) fully or partially mediated performance of this group in detecting errors on a measure of counting knowledge, retrieval errors in simple arithmetic, and accuracy on a number line estimation task. In contrast, the phonological loop or verbal memory composite (digit, word, and non-word span) and the visual–spatial memory composite (static and dynamic tasks) contributed to more specific deficits in Mathematical cognition: Verbal memory was integral to counting knowledge and visual–spatial memory was important for the use of min counting while solving complex problems, to number line estimation, and to identifying and processing number-set information.

In general, the findings from studies of preschoolers, elementary school children, and adolescents suggest that executive and visual–spatial skills may be recruited for the learning and application of new Mathematical skills/concepts, whereas the phonological loop may come into play after a skill has been learned. This may explain the seeming paradox in the literature that it is both preschoolers and adolescents who use visual–spatial resources to accomplish developmentally appropriate Mathematical tasks. In the preschool Math literature, a mental models hypothesis has been applied to explain how visual–spatial memory resources are linked to Mathematical learning and performance. What is unclear is whether this same explanation can be applied to new Mathematical learning and/or the use of particular strategies in older children though it might help to explain some counter-intuitive findings such as why visual–spatial abilities are sometimes related to performance on Math word problem solving [56]. These studies point to the importance of task analysis and knowledge of strategy use as a function of age and experience for both the predictors (working memory task) as well as the outcomes (particular Mathematical task) when trying to understand the relation of working memory and Math.

Many studies have examined the relationship between working memory subsystems, executive functioning, and arithmetic or Mathematics ability. Some studies have attributed individual differences in Mathematical problem solving (particularly arithmetic) to inefficiencies in the utilization of the phonological system [42, 45, 46, 50, 107, 111,], with the role of the phonological loop being to encode and retain verbal codes used for counting and/or retain interim solutions. However, a number of studies of children with poor Mathematical skills have revealed no significant limitations in verbal short-term memory, or limitations being due to a third factor such as processing speed or co-occurring reading difficulties [19, 53, 57] .

Recent research is placing more emphasis on the important role of the visual- spatial sketch pad in children's early arithmetical skills [65,89]. Visual-spatial skills and visual-spatial working memory have been found to be related to children's early counting ability [76] , and to Mathematics ability in children aged 10 years [88] , 11 years, and 14 years [71] . Studies of children with specific Mathematical difficulties have shown that they typically perform poorly on visuo-spatial span measures [90,124,127] . One of the identified subtypes of Mathematical learning disabilities includes those individuals believed to have deficits in visual-spatial skills[55]. Visual-spatial skills may impact Math at various levels-number inversions and reversal, misalignment of column digits, problems in visual attention and monitoring such as ignoring signs or changing operation part-way through completion of problem, and acquiring concepts of borrowing and carrying. The visual- spatial system also supports other aspects of non-verbal numerical processing such as number magnitude, estimation, and representing information in a spatial form, as in a mental number line [30, 31,129]. Therefore, spatial visualization and understanding and manipulation of spatial relations appear to be particularly important in Math skill development [29, 53, 92].

Holmes, J. & Adams, J. W. (2006) examined the contributions of the different components of the working memory (WM) model to a range of Mathematical skills in children, using measures of WM function that did not involve numerical stimuli. A sample of 148 children (78 Year 3, mean age 8 years and 1 month, and 70 Year 5 pupils, mean age 9 years and 10 months) completed WM measures and age-appropriate Mathematics tests designed to assess four Mathematical skills defined by the National Curriculum for England. Visuo-spatial sketchpad and central executive, but not phonological loop, scores predicted unique variance in children's curriculum-based Mathematical attainment but the relative contributions of each component did not vary much across the different skills. Subsequently, the Mathematics data were re-analysed using cluster analysis and new performance-related Mathematics factors were derived. All three components of WM predicted unique variance in these performance-related skills, but revealed a markedly distinct pattern of associations across the two age groups. In particular, the data indicated a stronger role for the visuo-spatial sketchpad in the younger children's Mathematics performance [65].

Working memory can be defined as the ability to hold in mind information in the face of potentially interfering distraction in order to guide behavior. The experimental manipulation of working memory tasks has shed considerable light on the probable structure of the human working memory system, and, to a lesser extent, the specific processes captured by working memory paradigms. However, individual differences research has also had a crucial role to play in the development of theories of working memory. In particular, correlational approaches have been particularly informative in three areas of working memory research, each of which is reviewed here. These are, first, the importance of working memory measures as correlates of high-level cognitive skills such as reading, Mathematics, reasoning, and fluid intelligence; second, the extent to which human working memory relies on domain-general or domain-specific component subsystems, and third, the precise reasons why working memory measures do relate to other important indices of human cognitive functioning. The findings from each of these areas suggest that working memory depends on a combination of domain-specific representational systems and domain-general processing and control systems, and that working memory measures capture individuals' ability to combine maintenance and processing demands in a manner that limits information loss from forgetting or distraction.

Many contributing factors, both domain specific and domain general, influence children's performance in school achievement. Passolunghi MC & et al. (2012) conducted a study to verify the importance of kindergarten measures of cognitive abilities and numerical competence in the role of predicting Mathematical school achievement at the end of first grade. A total of 70 children (38 females and 32 males) took part in the study. Children were tested at the beginning of their last year of kindergarten (time 1) on the following cognitive abilities: IQ, phonology, counting skills, verbal short-term memory, visuo-spatial short-term memory, working memory, and processing speed. Then, they were tested at end of their last year of kindergarten (time 2) on a measure of numerical competence and at the end of their first year of primary school (time 3) on a test of Math achievement. Path analysis models revealed the direct influence of working memory and processing speed on predicting numerical competence in pre-schoolers and the influence of processing speed and verbal IQ on predicting Math achievement in first graders. Moreover, this study found a direct link between numerical competence and Math achievement. Both domain-specific and domain-general factors contribute to determining Math achievement at the end of first grade[103].

The majority of children with poor working memory are slow to learn in the areas of reading, Math and science, across both primary and secondary school years [48, 49,50,75].

The cognitive literature now shows that Math performance depends on working memory, for any form of arithmetic and Math that involves processes beyond simple memory retrieval. In a study on "Visuospatial Working Memory (VSWM) in Adolescents with Poor Performance in Mathematics: Variation Depending on Reading Skills". Kyttala, M (2008) found that a general VSWM deficit in pupils with both Mathematics and reading problems and a specific VSWM deficit in pupils with only Mathematics problems [85].

The central executive system of working memory is involved in control of attention, switching retrieval strategies, and activating information in long-term memory. Tasks that assess it involve both processing and storage of information. The simplest test is back-ward digit span -recalling a set of digits in the opposite order to that heard. Other tests include listening span where a child must make judgments about a series of sentences and subsequently recall the last words of each sentence, and counting span, in which the child must count the dots on each of a set of pictures and subsequently recall the number on each picture. Of all the working memory components, central executive assessments tend to correlate the highest with variation on number tasks (e.g. Cowan, Donlan, New-ton, & Lloyd, 2005), though this can vary with group[62] Using other measures of executive functioning, some studies have been able to account for more variation[20, 21] .

Close links between children's capacities to store and manipulate information over brief periods have been found with achievements on standardized measures of vocabulary, language comprehension, reading, and Mathematics.

Gathercole SE & et al.(2000) aimed to investigate whether working memory abilities are also associated with attainment levels in the national curriculum assessments at 7 years of age. Eighty-three children aged 6 and 7 years attending local education authority schools participated in the study. Working memory skills were assessed by a test battery designed to tap individual components of Baddeley and Hitch's (1974) working memory model. Children were assigned to normal and low achievement groups on the basis of their performance on national curriculum tasks and tests in the areas of English and Mathematics. Children with low levels of curriculum attainment showed marked impairments on measures of central executive function and of visuo-spatial memory in particular. A single cut-off score derived from the test battery successfully identified the majority of the children failing to reach nationally expected levels of attainment. Complex working memory skills are closely linked with children's academic progress within the early years of school. The assessment of working memory skills may offer a valuable method for screening children likely to be at risk of poor scholastic progress [48].

A longitudinal study by Passolunghi, MC & et al (2008) was designed to investigate precursors of Mathematics achievement in children. A total of 72 children were tested at both the beginning and end of first and second grades on measures of the following cognitive abilities: phonology, counting skills, short-term memory, working memory, and verbal and performance IQ. Path analysis models revealed differences in the variables predicting Mathematics skills of first and second graders. Specifically, in first graders both short-term and working memory measures mediated the role of verbal IQ in predicting Mathematics skills. Also, there was a direct relationship between performance IQ and Mathematics at first grade. In contrast, in the longitudinal model, working memory measured both in first and second grades predicted Mathematics achievement, whereas the relationship between performance IQ and Mathematics disappeared. In conclusion, the results demonstrated that Mathematics learning is predicted not by phonology or counting skills and that working memory is a plausible mediator in predicting Mathematics achievement in primary school age children[103].

Geary DC & et.al (2007) conducted a study identifying cognitive factors of Mathematics. Using strict and lenient Mathematics achievement cutoff scores to define a learning disability, respective groups of children who are Math disabled (MLD, n=15) and low achieving (LA, n=44) were identified. These groups and a group of typically achieving (TA, n=46) children were administered a battery of Mathematical cognition, working memory, and speed of processing measures (M=6 years). The children with MLD showed deficits across all Math cognition tasks, many of which were partially or fully mediated by working memory or speed of processing. Compared with the TA group, the LA children were less fluent in processing numerical information and knew fewer addition facts [54].

Approximately 3 to 6% of school children have Mathematical disability many more children struggle with Mathematics. Empirical investigations have consistently implicated working memory as a central deficit in children with Mathematical disability [102].

1.5: Processing Speed & Mathematics

1.5.1: Processing Speed: Processing Speed is one of the measures of cognitive efficiency or cognitive proficiency. It involves the ability to automatically and fluently perform relatively easy or over-learned cognitive tasks, especially when high mental efficiency is required. That is, for simple tasks requiring attention and focused concentration. It relates to the ability to process information automatically and therefore speedily, without intentional thinking through [125]..

According to National Center for Learning Disabilities, Processing speed affects how the brain organizes information. It impacts upon a person's ability to focus on important things while ignoring less important items, and is what allows the brain to shift from one activity to another. There are many ways the brain receives information. In school, the two most common ways students receive and process information are through auditory and visual input.

Processing speed generally refers to the varying speed with which individuals are able to perform cognitive activities such as recognition of simple stimuli. According to the WISC, processing speed measures children's abilities to focus attention and quickly scan, discriminate between, and sequentially order visual information. It requires persistence and planning ability, but is sensitive to motivation, difficulty working under a time pressure, and motor coordination too. Cultural factors seem to have little impact on it. It is related to reading performance and development too. It is related to Working Memory in that increased processing speed can decrease the load placed on working memory, while decreased processing speed can impair the effectiveness of working memory [125].

Students with processing speed difficulties may take more time to:

- recognize simple visual patterns and in visual scanning tasks
- take tests that require simple decision making
- perform basic arithmetic calculations and in manipulating numbers, since these operations are not automatic for them
- perform reasoning tasks under time pressure
- make decisions that require understanding of the material presented
- read silently for comprehension
- copy words or sentences correctly or to formulate and write passages

Efficiency of cognitive processing based on speed of mental activity is diagnosed by means of standardized tests measuring mental processing speed, which is below the 25th percentile on psychometric tasks, such as the Processing Speed Index of the Wechsler Intelligence Scale for Children (WISC-IV) or Wechsler Adult Intelligence Scale (WAIS-II). A cognitive processing disability must be accompanied with significant academic and/or professional difficulties.

Slow processing speed affects a number of cognitive and learning processes. For example, lack of Math fluency has been associated with slow processing speed. Lack of automaticity in Math facts contributes to lower achievement in Math computations and/or Math reasoning.

1.5.2: The basis of processing Speed& Mathematics: Many factors can affect academic performance besides intelligence. If processing speed is slow, performance may be poor—not because a student is a slow thinker or because he lacks ability, but because he has to wait for information to be processed before he can think about it. For Math to be done efficiently, Math facts must be retrieved almost instantly. When a student sees the fact "7 X 6" he must immediately think, "42." Sometimes, however, even though the student knows this fact, he cannot instantly retrieve it. It might take two or three seconds to pull the number out of memory. If that happens, Math performance is slowed down tremendously, because a Math assignment might require the retrieval of hundreds of Math facts.

Children with low processing speed may have following difficulties in doing Mathematics:

- Difficulty with skill drills
- Slower visual pattern recognition skills

1.5.3: Research on processing speed & Math difficulties: Navarro JI & et.al (2011) identified the cognitive processes that underlie the individual differences in early Mathematical performance in elementary school children. Taking into account the Baddeley framework multicomponent model, the inhibitory processes, working memory, phonological awareness, and naming speed are considered to be related to early Math learning. To examine this relationship, we compared the performance of a total of 424 typically developing middle-class children, aged between 4 and 7 years in a battery of cognitive and early numeric tests: The Utrecht Early Numeracy Test, the Rapid Automatized Naming Test, Spanish version of the Stroop task, the Numeracy Interference Test, Digit Span test, and Phonological Knowledge Test. The mean age of the participants was 72.21 months (sd = 14.8), and 48.6% were male and 51.4% were female. The results demonstrated that children performing worst on central executive, phonological processing, and inhibitory processes showed lower results in early Mathematical tasks measured by The Utrecht Early Numeracy Test. Results supported the notion that the executive system is an important predictor of children's Mathematical performance [95].

A study was conducted to identify the beginning of 1st grade quantitative competencies that predict Mathematics achievement start point and growth through 5th grade. Measures of number, counting, and arithmetic competencies were administered in early 1st grade and used to predict Mathematics achievement through 5th (n = 177), while controlling for intelligence, working memory, and processing speed. Multilevel models revealed intelligence and processing speed, and the central executive component of working memory predicted achievement or achievement growth in Mathematics and, as a contrast domain, word reading. The phonological loop was uniquely predictive of word reading and the visuospatial sketch pad of Mathematics [51].

Rose SA & et.al (2011) identified deficits in executive functioning in pre-adolescent pre-terms and modeled their role, along with processing speed, in explaining preterm/full-term differences in reading and Mathematics. Pre-terms (< 1750 g) showed deficits at 11 years on a battery of tasks tapping the three basic executive functions identified by Miyake - updating/working memory, inhibition, and shifting. Confirmatory factor analysis showed that these executive functions, though correlated, were distinct from one another and from processing speed, which later proved to account for much of the intercorrelation among executive functions. In the best-fitting structural equation model, the negative effects of prematurity on achievement were completely mediated by the three executive functions and speed in a cascade of effects: prematurity → slower processing speed → poorer executive functioning (working memory) → lower achievement in Math and reading [106].

Chan BM & et al.(2010) examined how four domain-specific skills (arithmetic procedural skills, number fact retrieval, place value concept, and number sense) and two domain-general processing skills (working memory and processing speed) may account for Chinese children's Mathematics learning difficulties. Children with Mathematics difficulties (MD) of two age groups (7-8 and 9-11 years) were compared with age-matched typically achieving children. For both age groups, children with MD performed significantly worse than their age-matched controls on all of the domain-specific and domain-general measures [23].

Children's arithmetical difficulties are often explained in terms of a short-term memory deficit. However, the underlying cause of this memory deficit is unclear, with some researchers suggesting a slow articulation rate and hence increased decay of information during recall, while others offer an explanation in terms of slow speed of item identification, indicating difficulty in retrieving information stored in long-term memory. General processing speed is also related to measures of short-term memory but has rarely been assessed in studies of children's arithmetic. Measures of short-term memory, processing speed, sequencing ability, and retrieval of information from long-term memory were therefore given to 7-year-old children. When reading ability was controlled for, arithmetic ability was best predicted by processing speed, with short-term memory accounting for no further unique variance. It was concluded that children with arithmetic difficulties have problems specifically in automating basic arithmetic facts which may stem from a general speed of processing deficit [19].

Processing Speed (Gs) demonstrated strong to moderate relations with Basic Mathematics Skills throughout the lifespan and moderate relations with Mathematics

Reasoning through young adulthood. McGrew KS & et al. (1997) found that Fluid reasoning (Gf), Comprehension-Knowledge (Gc), and Gs were strong predictors of Mathematics Reasoning[83]. Keith (1999) also found that measures of Mathematics achievement were strongly influenced by Full Scale IQ and a number of other CHC broad cognitive abilities, such as Gc, Gf, and Gs. The relations between Processing Speed (Gs) and more domain-specific processing of Mathematical information corroborate the results of a number of studies that have demonstrated a strong influence of speed of processing (a.k.a., operational efficiency) during Mathematics performance[75]. These findings also are consistent with a wide array of research that indicates that speed of processing is important during the early stages of acquiring most cognitive and academic skills [41,73,88,96, 105,113,126].

Whereas Bull & Johnston (1997) found general processing speed was the strongest predictor of arithmetic proficiency and explained away the associations with working memory and Rapid Automatic Naming (RAN)[19], others have not: Hitch GJ & et al. (2001) found working memory to be a stronger predictor than processing speed[64].

1.6: Verbal working memory & Math

1.6.1: Verbal working memory: A particularly human form of working memory that appears to play a significant role in language comprehension and problem-solving is verbal working memory (Jonides, 1995). According to at least one influential model, verbal working memory has three components: a buffer to store phonological codes, a rehearsal process to refresh those codes, and a set of executive processes to manipulate the contents of the buffer in the service of higher cognitive demands (Baddeley, 2000).

Recent research has found that verbal working memory factor associated with both the phonological loop and verbal central executive tasks, and non-verbal working memory factor associated with both the visuospatial sketchpad and non-verbal central executive tasks [72].

1.6.2: Measures of Verbal working memory: Since Digit span backward is most often described as a measure of verbal working memory, involving both the phonological loop and the central executive [107].

Digit span backward tasks can be performed using non-verbal strategies. Although most researchers agree that digit span backward is a measure of simultaneous storage and transformation, in what form is the relevant information stored and how is it transformed? There does not appear to be a definitive answer to this question, as strategy use is likely to be important. Digit span backward is most often described as a measure of verbal working memory, involving both the phonological loop and the central executive, and in some studies digit span backward does show effects of phonological similarity[107] .

In a recent study, children's ability of verbal working memory was measured by the combination of following tasks. In *the listening recall task*, the child is presented with a series of spoken sentences, has to verify the sentence by stating ''true'' or ''false,'' and recalls the final word for each sentence in sequence. Test trials begin with one sentence, and continue with additional sentences in each block until the child is unable to recall three correct trials at a block. In the *counting recall task*, the child is presented with a visual array of red circles and blue triangles. She or he is required to count the number of circles in an array and then recall the tallies of circles in the arrays that were presented. The test trial begins with one visual array, and increases by an additional visual array in each block, until the child is unable to correctly recall four trials. Each visual array stayed on the computer screen until the child indicated that she or he had completed counting all the circles. If the child made an error in counting the circles and recalled this incorrect sum, they were not penalized. In the *backwards digit recall task*, the child is required to recall a sequence of spoken digits in the reverse order. Test trials begin with two numbers, and increase by one number in each block, until the child is unable to recall four correct trials at a particular block. The number of correct trials was scored for each child. For children aged 4.5 and 11.5 years, test – retest reliability is .81, .79, and .64 for listening recall, counting recall, and backward digit recall, respectively.

It is worth noting that the present study included forward digit recall as a measure of verbal short-term memory and backward digit recall as a measure of verbal working memory. This decision was based on findings that in forward digit recall, the processing load is minimal as children immediately recall number sequences. In contrast, in the backward digit recall task there is an added requirement to recall the digits in reverse sequence that imposes a substantial processing load on the child as illustrated by the finding that forward digit spans are higher than backward digit spans [70, 123]. Correspondingly, short-term memory skills (such as forward digit recall) are much more weakly associated with general academic and cognitive performance than working memory skills as measured by backward digit recall[27, 46].

1.6.3: Research on verbal working memory and Math difficulties: In a recent study, children at Key Stages 2 and 3 of the National Curriculum (aged 11 and 14 years) were tested on measures of the phonological loop and visuospatial sketchpad as well as both verbal and nonverbal central executive tasks. Analyses were then used to explore the relationship between working memory and National Curriculum test scores in English, Mathematics and science. The results suggested that both verbal and non-verbal working memories are important predictors of National Curriculum test scores [72].

The relationship between verbal and visual-spatial working memory and Mathematical computation skill was examined in children and adults with and without disabilities in Mathematics. A hierarchical regression analysis showed that, when partialing for the influence of reading ability, age, and gender, Mathematical computation was better predicted by verbal than by visual-spatial working memory[116].

A recent meta-analysis of 28 studies comparing the cognitive characteristics of children with and without Math difficulties suggests that differences in verbal working memory characterize children with Math difficulties after controlling for effects of several other variables, such as age, IQ, naming speed, and short-term memory for words and digits[110]. However, the measures of verbal working memory often required the use of number information because some studies combine verbal and numerical working memory tasks into a composite measure of the central executive [54,60] and other studies use only numerical tasks as their indicator of verbal working memory[53,57,81,126]. Although working memory tasks that employ numerical information are considered to tap verbal working memory, these tasks have also been referred to as domain specific (i.e., number-specific) measures of working memory [84] . The two most commonly used numerical working memory tasks are digit span backward, whereby participants are presented with a sequence of numbers and are asked to reproduce the sequence in the reverse order of presentation; and counting span, which involves remembering numbers of counted objects, for example, counting the yellow dots in a set of yellow and blue dots for a specified number of sets (typically 2–5), and then recalling the counts for each set in the correct order. The assumption that numerical working memory tasks are de facto measures of verbal working memory and that different numerical working memory tasks provide similar measures of verbal working memory deserves some scrutiny as discussed below.

Numerical measures of verbal working memory are more frequently related to Math difficulties than are non-numerical measures of working memory. Studies that have separated verbal working memory measures without numerical information (e.g., word span backward) from those involving number (e.g., digit span backward) have found that the latter, but not the former distinguish children with difficulties in Math [100, 101, 102].

Furthermore, studies employing verbal working memory tasks, such as the listening span task (with concurrent language comprehension and recall) that likely require greater central executive resources than backward word span or digit span tasks do not consistently differentiate between children with and without Math difficulties[26,42,100,104,111,117,124] . The stronger relation between numerical versus non-numerical measures of verbal working memory and Math is consistent with studies demonstrating the importance of domain specific knowledge to general cognitive performance including memory [17].

Math difficulties are more consistently predicted by counting span versus backward digit span. In several studies, counting span distinguishes children with Math difficulties from their typically achieving peers [58, 64,101,102,111,128]. The findings are not as consistent for digit span backward: several studies report null findings[53,81,124] ; some studies find differences between groups of children with Math difficulties and typically achieving children [26,42,101,102,117,128]; and yet other studies find that digit span backward specifically distinguishes children with severe Math difficulties from both children with less severe Math difficulties, and children with typical achievement in Math[86] .

1.7: Evidence Related to Poor Performance in Mathematics of Children in Bangladesh:

In Bangladesh one of the major causes of academic failure is student's poor performance in English and Mathematics. But there is very few evidence about the causes of poor performance in Mathematics of school children in Bangladesh.

Reviewing literatures and both of the results of Primary Education Terminal Examination, and Junior School Certificate Examination (JSC), it was found that school children in Bangladesh showed lack of competency and lack of performance in Mathematics and English which had a huge impact on overall pass rate in those exams.

In the results of Primary Education Terminal Examination-2009, subject-wise stats showed that students did well in Paribesh Parichiti Samaj (social science) with 99.46 percent passing while they did not do that well in Mathematics and English as the pass percentages in these subjects are 90.57 and 94 respectively[120].

After announcing first Junior School Certificate Examination (JSC) exam results of Bangladesh, Education Minister Nahid said "most of the students failed in three subjects - English, Mathematics and science. "We've formed three committees to know the reasons and overcome it in future. [67]"

In 2000, Campaign for Popular Education (CAMPE) in Bangladesh conducted a study to assess the achievement of students in terms of the terminal competencies at the end of primary cycle. A paper-pencil based standardized achievement test for 27 cognitive competencies and a separate tool for 40 non-cognitive competencies in which teachers appraised their own students were developed for the purpose. The instruments developed were satisfactory in terms of both the internal and external validity. Students of Class V of three sub-systems, viz., government, private (non-government registered/ unregistered), and non-formal were assessed just before the end of their five-year cycle of primary education. Competencies in Mathematics included arithmetic skills of the students including geometry. The five competencies assessed under this area included basic numbers, four basic rules, problem solving in everyday life, measurement units, and identification of geometric figures. A total of 15 question items were included in the instrument. Performance in Mathematics was much worse than that of Bangla, but slightly better than English language. Only 11.6% of the assessed students achieved all five Maths competencies and 13.3% achieved none [1].

In 2007 Campaign for Popular Education (CAMPE) in Bangladesh conducted a study to assess the extent of attainment of the learning objectives by the students of the two streams and identifying factors affecting their attainment. Development of a uniform test on four subject areas, viz., Bangla, English, Mathematics and Everyday Science through a rigorous process and its administration on the students of grade X in 2007 created the necessary data for this objective. Of the four subject areas, the students showed best performance in Everyday Science followed respectively by Bangla, English, and Mathematics. The boys demonstrated significantly better performance than the girls. And the results also revealed that the students find Mathematics most difficult subject followed by English [38].

From the above discussion, it has been found that failure in Mathematics of students have a great impact on the National Pass Rate which need to be addressed to minimize the discrepancy of pass rate with developed countries. To handle the existing situation, programmes and initiatives need to be taken both from governmental and non-governmental levels. Knowing the accurate causes regarding the situation is the first considerable aspects of designing effective programmes. From this perspective, the present study gives attention to identify the causes of failure in Mathematics of school children in Bangladesh since there were very limited literatures regarding this issue. From the existing literature, it has been found that a great variety of cognitive factors contributing in performance of Mathematics. Among various cognitive factors, the present study was restrained to know the contributions of cognitive factors such as: verbal comprehension, fluid reasoning, working memory, processing speed, and verbal working memory on failure in Mathematics. Definitions of verbal comprehension, fluid reasoning, working memory, processing speed, and verbal working memory for this study were presented below:

Verbal comprehension is children's ability to listen to a question, draw upon learned information from both formal and informal education, reason through an answer, and express their thoughts aloud.

Fluid intelligence or fluid reasoning is the capacity to think logically and solve problems in novel situations, independent of acquired knowledge. It is the ability to analyze novel problems, identify patterns and relationships that underpin these problems and the extrapolation of these using logic. Fluid reasoning includes inductive reasoning and deductive reasoning.

Processing speed is children's abilities to focus attention and quickly scan, discriminate between, and sequentially order visual information. It requires persistence and planning ability, but is sensitive to motivation, difficulty working under a time pressure, and motor coordination too.

Working memory assesses children's ability to memorize new information, hold it in short-term memory, concentrate, and manipulate that information to produce some result or reasoning processes. It is important in higher-order thinking, learning, and achievement. It can tap concentration, planning ability, cognitive flexibility, and sequencing skill, but is sensitive to anxiety too. It is an important component of learning and achievement, and ability to self-monitor.

Verbal working memory is a form of working memory that appears to play a significant role in language comprehension and problem-solving is called verbal working memory. It is associated with both the phonological loop and verbal central executive tasks.

1.8: Rationale of the Study

Many students all over the world struggle with Mathematics. Also, in Bangladesh one of the major causes of academic failure is student's poor performance in English and Mathematics. However, the performance of students in Mathematics has been a great concern to parents and teachers since it affects all aspects of students' life. Mathematics is considered as an important subject for students as it carry solid marks which have a great impact on their overall academic results. Futher choice of education also depends on students' performance and confidence in Mathematics. For example, performance in Mathematics is one of the important considerations for our multi-tract education system for deciding whether students' take science or not as their stream of education. Mathematical reasoning also facilitates our day to day functioning. Mathematics is considered as a difficult course since its content and procedural aspects are completely different from other subjects. Because lots of practices and understanding are required for solving math problems while students can answer questions of other subjects simply by rote memorization. Performance in Mathematics also affects the psychological aspects of students. Students who perform poor in Mathematics become helpless, lose their confidence and ultimately develop Math anxiety.

National pass rate of Bangladesh is affected greatly by the pass rate in Mathematics. According to Education for All (EFA), national pass rate is one of the important determinants of ensuring quality education of Bangladesh. And in case of national pass rate Bangladesh is also lagged behind from the developed countries in the world. So, the concern is to increase national pass rate. By reducing failure or poor performance in Mathematics could be one of the significant means of it.

To resolve the existing situation, first of all it is necessary to identify the factors affecting performance in Mathematics. Several studies have been conducted for identifying causes of poor performance in Mathematics. These studies suggested that both cognitive and affective factors related to poor performance in Mathematics. But in Bangladesh there were very few evidence regarding association of cognitive factors with attainment in Mathematics. So, the present study was designed to identify contributing cognitive factors in failure of Mathematics.

The findings of this study would provide a clear understanding about contribution of cognitive factors with poor performance in Mathematics which would play a vital role in the field of educational psychology. It would be helpful for the educational psychologists as well as other professionals to develop appropriate and early intervention for children with Math difficulties. It could also contribute in improving National pass rate of students in

Bangladesh and thereby ensure quality education . This study will also highlight the potential areas for further researches.

1.9: Objective of the study

1.9.1: General objective: To investigate the contribution of cognitive factors as determining cause of poor performance in Mathematics.

To meet the objective of the study, cognitive factors of three types of Math performance groups were compared. First Math performance group included students who failed only in Mathematics, second group included students who failed in Mathematics as well as in one of other subjects, and the third group included students who did not fail in Mathematics or in other subjects in their last two successive exams of schools.

1.9.2: Specific Objectives:

1. To see whether Math performance groups differ in terms of verbal comprehension
2. To see whether Math performance groups differ in terms of fluid reasoning
3. To see whether Math performance groups differ in terms of working memory
4. To see whether Math performance groups differ in terms of processing speed.
5. To see whether Math performance groups differ in terms of verbal working memory.
6. To explore the contribution of verbal comprehension in poor performance of Mathematics.
7. To explore the contribution of fluid reasoning in poor performance of Mathematics.
8. To explore the contribution of working memory in poor performance of Mathematics.
9. To explore the contribution of processing speed in poor performance of Mathematics.
10. To explore the contribution of verbal working memory in poor performance of Mathematics.

Chapter-2

Methodology

2: Methodology

2.1: Research Design:

The purpose of the present study was to investigate role of cognitive factors as the causes of failure in Mathematics of school children. 3 X 2 quasi experimental design was used to meet this objective.

Table-1

The study design

Grade Level	**Math performance groups**		
	Math Specific	**Math General**	**Comparison group**
Primary	*Measures of cognitive factors*	*Measures of cognitive factors*	*Measures of cognitive factors*
Secondary	*Measures of cognitive factors*	*Measures of cognitive factors*	*Measures of cognitive factors*

A. Independent Variable: Independent variables of the present study were based on two major characteristics. One important characteristic of independent variable was levels of Math performance which was divided into following groups:

i. ***Math Specific group:*** The group of students who have failed in only in Mathematics in last two consecutive exams was denoted as Math-specific group.

ii. ***Math General group:*** The group of students who have failed in Mathematics and at least one of other subjects in last two consecutive exams was denoted as Math-general group.

iii. ***Comparison group:*** The group of students who have neither failed in Mathematics nor in other subjects in last two consecutive exams was denoted as Comparison group.

Another important characteristic of independent variable was grade level which was divided into two groups: i) Primary level & ii) Secondary level.

B. Dependent Variable: Dependent variables of the present study included cognitive factors: Verbal Comprehension, Fluid Reasoning, Working Memory, Processing Speed, & Verbal working memory.

2.2: Sampling:

The sample was comprised of a total 66 school children between age range of 8 to 16 years of both primary and secondary grade levels. The sample of the present study was drawn from south west zone of Dhaka city. Three Thanas were selected conveniently from this zone. These were: Dhanmondi, Newmarket and Nilkhet Thana. One of the purposes of chosing these Thana was to cover wide range of socio-economic class. A list of schools in Dhaka was collected from the Board of Intermediate and Secondary Education, Dhaka. Both government and non-government schools followed curriculum provided by National Curriculum and Textbook Board were included in this list. Five schools were selected randomly from 15 schools located in those three Thanas. Students were selected in following ways:

2.2.1: Sampling of Math Specific Group: From each school a list of Math specific students was prepared based on academic records maintained by the schools. They were sent an informed consent letter explaining the purpose of the study. Among those who have given consent to take part in the study were included as Math specific group.

2.2.2: Sampling of Math Specific Group: A list for Math general group was prepared based on academic records maintained by the schools. . They were sent an informed consent letter explaining the purpose of the study. Among those who gave consent and matched in terms of sex, grade, and school with Math specific group were included as Math general group.

2.2.3: Sampling of Comparison Group: In the same way, a list of comparison group was prepared from each school based on academic records maintained by the schools. Among those who were matched in terms of sex, grade, and school with Math specific and Math general group were sent an informed consent letter explaining the purpose of the study. Among those who have given consent to take part in the study were included as comparison group.

2.3: Sample

The sample was comprised of a total 66 students of three Math performance groups.

i) Math specific group: This group was consisted of 22 students of both primary and secondary levels. Both boys and girls were included in this group.

ii) Math general group: This group was consisted of 22 students of both primary and secondary levels. Both boys and girls were included in this group.

iii) Comparison group: This group was consisted of 22 students of both primary and secondary levels. Both boys and girls were included in this group.

All of the students of above groups were collected from 4 schools. As sample with required criteria was not available one school has been excluded. The schools were: University Laboratory School & College, Nilkhet High School, Dhanmondi High School and Meherunnessa Girls' School & College.

Distribution of sample has been presented in the following tables:

Table-2: Sex wise distribution of three groups of children.

Sex \ Math performance group	**Math Specific**	**Math General**	**Comparison group**	**Total (%)**
Boy	13	13	13	39(59.1%)
Girl	9	9	9	27(40.9%)
Total	**22**	**22**	**22**	**66(100%)**

Above table shows that boys are higher in number than girls in the representative sample of present study.

Table-3: School wise distribution of three groups of children

School \ Math Performance Group	**Math Specific**	**Math General**	**Comparison Group**	**Total (%)**
U. Lab School & college	9	9	9	27(40.9%)
Nilkhet High School	6	6	6	18(27.3%)
Dhanmondi High school	5	5	5	15(22.7%)
Meherunessa Girls' School	2	2	2	6(9.1%)
Total	**22**	**22**	**22**	**66(100%)**

From the table-3, it has been found that more than one third of the total students were taken from University Laboratory School & College.

Table-4

Distribution of three groups of students of primary & secondary level

Math performance group / Level	Math Specific	Math General	Comparison group	Total (%)
Primary	8	8	8	**24 (36.4%)**
Secondary	14	14	14	**42 (63.6%)**
Total	**22**	**22**	**22**	**66(100%)**

Above table showed that students of secondary grade level were higher in number than students of primary grade level.

Table-5

Grade wise distribution of three groups of children.

Grade \ Math Performance group	Math Specific	Math General	Comparison Group	Total (%)
Three	2	2	2	6(9.1%)
Four	3	3	3	9(13.6%)
Five	3	3	3	9(13.6%)
Seven	5	5	5	15(22.7%)
Eight	7	7	7	21(31.8%)
Nine	2	2	2	6(9.1%)
Total	**22**	**22**	**22**	**66(100%)**

From the above table it has been found that highest numbers of students were taken grade eight while the lowest numbers of students were taken from grade three and grade nine. It was also found that, about half of the total students were taken from grade 7 & grade 8.

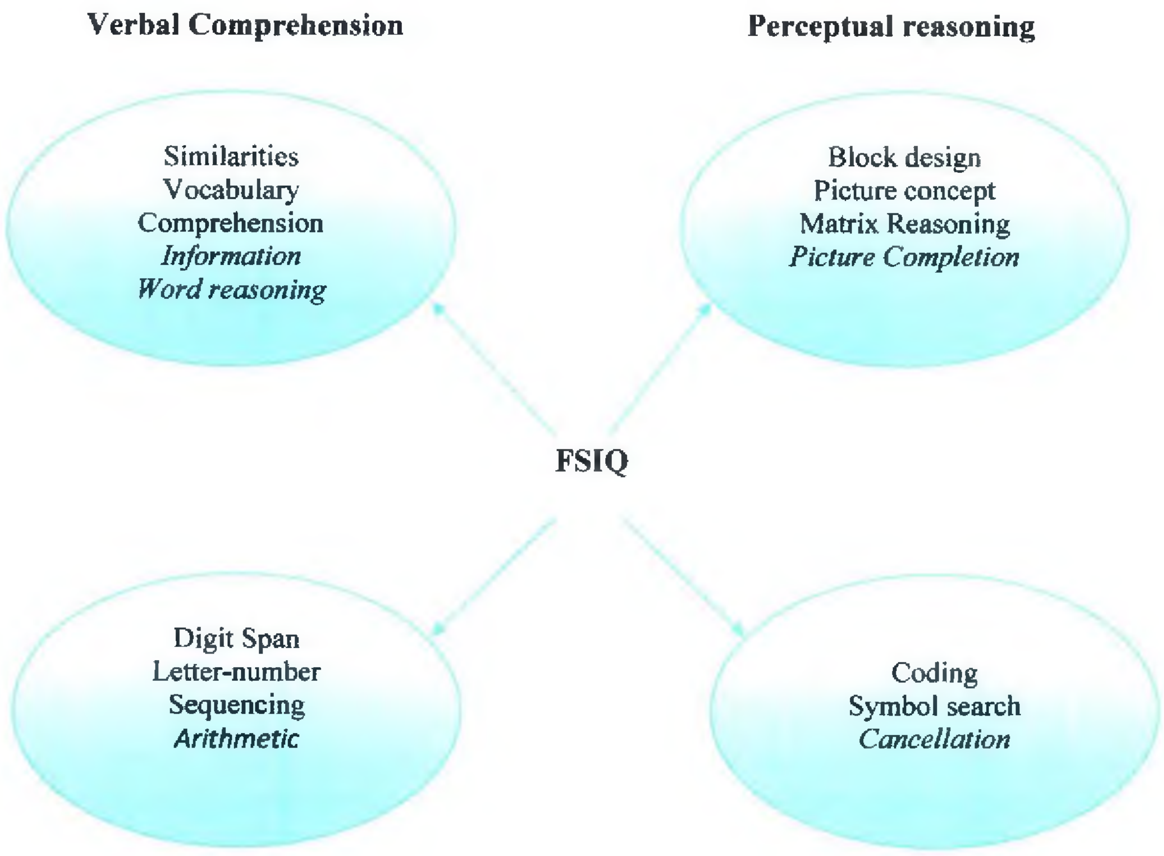
2.4: Measuring Instruments:

Verbal Comprehension, Fluid Reasoning, Working Memory, Processing Speed, & Verbal working were measured by using Wechsler Intelligence Scale for Children –Fourth Edition (WISC-IV). The description of this scale has been presented in the following section.

2.4.1: Wechsler Intelligence Scale for Children –Fourth Edition (WISC-IV): The Wechsler Intelligence Scale for Children –Fourth Edition (WISC-IV) is an individually administered clinical instrument for assessing the cognitive ability of children aged 6 years through 16 years 11 months. It can be used to conduct research on cognitive development, intellectual assessment and cognitive processes. The WISC-IV is composed of 15 subtests: 10 core subtests and 5 supplemental subtests. Ten core subtests are block design, similarities, digit span, picture concepts, coding, vocabulary, letter-number sequencing, matrix reasoning, comprehension, and symbol search, and five supplemental subtests are picture completion, cancellation, information, arithmetic, and word reasoning. Ten core subtests are divided into four indices such as: verbal comprehension, perceptual reasoning, working memory and processing speed. Similarities, vocabulary, and the comprehension are the core verbal comprehension subtests. Block design, picture concepts, and matrix reasoning are the core subtests for perceptual reasoning. Digit span and letter-number sequencing are the core working memory subtests and Coding and symbol search are the core processing speed subtests [125].

Subtests of WISC-IV are divided into four indices: Verbal Comprehension Index, Perceptual Reasoning Index, Working Memory Index and Processing Speed Index.

Verbal Comprehension Index (VCI): The VCI is a measure of verbal concept formation. It assesses children's ability to listen to a question, draw upon learned information from both formal and informal education, reason through an answer, and express their thoughts aloud. It can tap preferences for verbal information, a difficulty with novel and unexpected situations, or a desire for more time to process information rather than decide "on the spot." It's a good predictor of readiness for school and achievement orientation, but can be influenced by background, education, and cultural opportunities [125].



Note: Supplemental subtests are shown in italic

Figure-2: WISC-IV Test Framework

Subtests of VCT:

i. Similarities: The similarities subtest is a core verbal comprehension subtest. The child is presented two words that represent common objects or concepts and describes how they are similar. It designed to measure verbal reasoning and concept formation. It also involves auditory comprehension, memory, distinction between non-essential and essential features, and verbal expression. The similarity has 23 items [125].

ii. Vocabulary: Vocabulary is designed to measure a child's word knowledge and verbal concept formation. It also measures a child's fund of knowledge, learning ability, long-term memory, and degree of language development. Other abilities that may be used by the child during this task include auditory perception and comprehension, verbal conceptualization, abstract thinking. Vocabulary has 36 items, including 4 picture items and 32 verbal items [125].

iii. Comprehension: Items require the child to answer questions based on his or her understanding of general principles and social situations. It is designed to measure verbal reasoning and conceptualization, verbal comprehension and expression, the ability to evaluate and use past experience, and the ability to demonstrate practical information. It involves knowledge of conventional standards of behavior, social judgment and maturity and common senses. The comprehension has 21 items [125].

iv. Information: Information is a supplemental verbal comprehension subtest. For each item, the child answers questions that addressed a broad range of general knowledge topics. It is designed to measure a child's ability to acquire, retain and retrieve general and factual knowledge. It involves crystallized intelligence, long-term memory, and the ability to retain and retrieve information from school and environment. Other skills that may be used by the child include auditory perception and comprehension, and verbal expressive ability. The information has 33 items [125].

v. Word Reasoning: Word Reasoning is a supplemental verbal comprehension subtest. The child is asked to identify the common concept being described in a series of clues. It is designed to measure verbal comprehension, analogical and general reasoning ability, verbal abstraction, domain knowledge, the ability to analyze and synthesize different types of information, and the ability to generate alternative concepts [125].

Perceptual Reasoning Index (PRI): The PRI is a measure of non-verbal and fluid reasoning. It assesses children's ability to examine a problem, draw upon visual-motor and visual-spatial skills, organize their thoughts, create solutions, and then test them. It can also tap preferences for visual information, comfort with novel and unexpected situations, or a preference to learn by doing [125].

Subtests of PRI

i.Block Design: It is a core Perceptual Reasoning subtest. All items require the child to view a constructed model or picture in the Stimulus Book and use red and white blocks to re-create the design within a specified time limit. It designed to measure the ability to analyze and synthesize abstract visual stimuli. It also involves non-verbal concept formation, visual perception and organization, simultaneous processing, visual-motor coordination, learning, and the ability to separate figure and ground in visual stimuli. The Block Design has 14 items [125].

ii.Picture Concepts: It is a core Perceptual Reasoning subtest. For each item, the child is presented with two or three rows of pictures and chooses one picture from each row to form a group with a common characteristic. It is designed to measure abstract, categorical reasoning ability. Items are sequenced to reflect increasing demand on abstract reasoning ability. The Picture Concept subtest has 28 items [125].

iii.Matrix Reasoning: It is a core Perceptual Reasoning subtest. For each item, the child looks at an incomplete matrix and selects the missing portion from 5 response options. It has long been recognized that matrix analogy tasks are good measures of fluid intelligence and reliable estimates of general intellectual ability. Matrix reasoning task are relatively culture fair and language-free and require no hand manipulation. The matrix reasoning subtest has 35 items [125].

iv.Picture Completion: It is a supplemental Perceptual Reasoning subtest. All items require the child to view a picture and then point to or name the important part missing within a specified time limit. It is designed to measure visual perception and organization, concentration, and visual recognition of essential details of object. The picture completion subtest has 38 items [125].

Working Memory Index (WMI): The WMI is a measure of working memory. It assesses children's ability to memorize new information, hold it in short-term memory, concentrate, and manipulate that information to produce some result or reasoning processes. It is important in higher-order thinking, learning, and achievement. It can tap concentration, planning ability, cognitive flexibility, and sequencing skill, but is sensitive to anxiety too. It is an important component of learning and achievement, and ability to self-monitor [125].

Subtests of WMI:

i.Digit span: It is a core working memory subtest composed of two parts: Digit Span Forward and Digit Span Backward. Digit Span Forward requires the child to repeat number as same order as read allowed by the examiner, and Digit Span Backward requires the child to repeat the number in the reverse order as presented by the examiner. The sub-test is designed as a measure of auditory short-term memory, sequencing skills, attention and concentration. The digit span forward task involves rote learning and memory, attention, encoding and auditory processing. Digit Span Backward involves working memory, transformation of information, mental manipulation, and visuospatial imaging. There are eight items in Digit Span Forward and eight items in Digit Span Backward [125].

ii.Letter-Number Sequencing: It is a core working memory subtest. The child is read a sequence of numbers and recalls the numbers in ascending order and the letters in alphabetical order. The task involves sequencing, mental manipulation, attention, short-term auditory memory visuospatial imaging and processing speed. Letter-Number Sequencing consists of 10 items with 3 trials each [125].

iii.Arithmetic: It is a supplemental Working Memory subtest. The child mentally solves a series of orally presented arithmetic problems within a specified time limit. It involves mental manipulation, concentration, attention, short-term and long-term memory, numerical reasoning ability, and mental alertness. It may also involve sequencing, fluid reasoning, and logical reasoning. Arithmetic consists of 34 items [125].

Processing Speed Index (PSI): The PSI is a measure of processing speed. It assesses children's abilities to focus attention and quickly scan, discriminate between, and sequentially order visual information. It requires persistence and planning ability, but is sensitive to motivation, difficulty working under a time pressure, and motor coordination too. Cultural factors seem to have little impact on it. It is related to reading performance and development too. It is related to Working Memory in that increased processing speed can decrease the load placed on working memory, while decreased processing speed can impair the effectiveness of working memory [125].

Subtests of PSI:

i.Coding: The Coding subtest is a core Processing Speed subtest. The child copies symbol that are paired with simple geometric shapes or numbers. Using a key, the child draws each symbol in its corresponding shape or box within a specified time limit. In addition to processing speed, the subtest measures short-term memory, learning ability, visual perception, visual-motor coordination, visual scanning ability, cognitive flexibility, attention and motivation. It may also involve visual and sequential processing [125].

ii.Symbol Search: The Symbol Search subtest is a core Processing Speed subtest. The child scans a search group and indicates whether the target symbol(s) matches any of the symbols in the search group within a specified time limit. In addition to processing speed, the subtest also involves short-term visual memory, visual-motor coordination, cognitive flexibility, visual discrimination, and concentration. It may also tap auditory comprehension, perceptual organization and planning and learning ability [124].

iii.Cancellation: The Cancellation subtest is a supplemental processing speed subtest. The child scans both a random and structured arrangement of pictures and marks target pictures within a specified time limit. It is designed to measure processing speed, visual selective attention, vigilance, and visual neglect [125].

Reliability of WISC-IV: Reliability for the WISC IV was examined by computing internal consistency values (split half correlations) or test-retest reliability. Two subtests improved in reliability compared to the older version of the test, likely due to the updates to the test. All the subtest values were recomputed as well using 16 special groups (ADHD, LDs, LD/ADHD, Mild and Mod MR…) and values were comparable. Some subscales dropped below .79, but 94% maintained .79 or better, with many increasing to .90 or better [125].

Test-retest reliability was computed based on 243 children across the 11 age groups, tested twice in 32 days on average (13 to 63). Results were at minimum .76, but most were in the .80s. Of note, these reliabilities are based on the whole sample, and at specific age ranges, Sattler points out, the numbers are sometimes shakier. Thus, treat subscale scores as less stable compared to index scores and the FSIQ. Interscorer reliability by experts was generally .98, with Comprehension dipping to .95. However, carelessness can drop this number drastically. Sattler quotes studies of graduate students and master's level clinicians finding about 8 errors per protocol, and errors in 34% to 42% of all protocols [125].

Validity of WISC-IV: Validity for the WISC IV was assessed in a number of ways. **Content Validity** was established by reviewers and experts, as well as creating content similar to other, established tests to expand the evaluation base of the WISC IV. The response process was examined as well with multiple choice formats to detect common errors, having children explain their responses to highlight alternate acceptable answers, and altering stimuli as a result[125].

Convergent Validity was established by examining the subtest inter-correlations. While all subtests should tap Full Scale IQ score to some extent, and thus correlate positively to some extent, subscales on the same index should correlate most strongly with each other. After this, subtests from different scales should have stronger correlations if they both are strongly related to Full Scale IQ score [125].

Discriminant Validity was established by conducting an updated factor analysis. As reported in the technical and Interpretive Manual, each of the subtests on an index has factor loadings above .60 with their own index and far lower loadings on the others. The only exception was Picture Concepts. Picture Concepts loads .45 on PRI, with .19 being the next highest loading anywhere else, and it typically shows the weakest loadings of any subtest on an index across the age groups. Sattler generally agrees with the new factor structure [125].

2.4.2: Academic Results: Performance in Mathematics was determined by the obtrained marks in all subjects of last two consequetive exams in schools. Marks were collected from the record book maintained by the schools.

2.4.3: Personal and Demographic questionnaire: This questionnaire was designed to obtain demographic and developmental information that might have an influence on children's intelligence and academic attainment. [Appendix-2]

2.5: Data Collection Procedure

2.5.1: Preparatory Stage:

2.5.1.1: Training: At first the researcher has received intensive training for 2 weeks by an expert on administrative procedure and scoring system of WISC-IV. This training was followed by practice trial of administration and scoring under supervision. Possible variation or error has been noted and tailored to accuracy.

2.5.1.2: Preparation of measuring instrument:

a. Familiariry of items: The test was administered on 5 students of English Medium School to see the familiarity and suitability the items of the subtests of WICS-IV for our culture. No notable difficulty was found in following procedural directions. Further experts' opinion on cultural biasness, unfamiliarity, and item difficulties was obtained.

b. Translation of key instructions: The record form consisting of 10 pages were printed and a set of WISC-IV test items were reproduced to use in this research. Then the key instructions for administration of WISC-IV were translated into Bangla. The Bangla instruction of each items were written on stickers and pasted on the specific areas of reproduced manual.

c. First tryout: For first tryout the test was administered on a sample of 50 students between the age ranges of 6 to 16 years 11 months using the Bangla translated instructions. Although certain pictures, words, and concepts were identified for unfamiliarity, no notable difficulty in following procedural directions. Simple changes in Bangla translation were made according to the experts' opinion based on the results of first tryout.

d. Determining reliability of key translations: The test was administered on 30 students between the age ranges of 6 to 16 years using the modified Bangla translated instructions. Internally consistency was measured for subtests (except coding, symbol search & cancellation) of WISC-IV and was found significant and satisfactory. Alpha score of those subtests ranged from .71 to .92. Split-half reliability was also measured for subtests (except coding, symbol search & cancellation) of WISC-IV and was found significant and satisfactory. For core subtests of WISC-IV, Guttman split-half reliability coefficient was ranged from .67 to .84. But for block design it was .45 and for comprehension it was .57. For supplemental subtests of WISC-IV, Guttman split-half reliability coefficient was ranged from .60 to .79.

Test-retest reliability was computed for coding, symbol search & cancellation based on the scores of 30 students between age ranges of 6-16 years. Test-retest reliability co-efficient was ranged between .74 and .81.

e. Determining validity of key translations: Content validity of the scale was obtained from experts' opinion and through modifying the translated Bangla instructions accordingly. Significantly moderate to high correlations between scaled score of subtest and Full scale IQ score as well as between scaled score of subtest and composite score within the same index provided the evidence of convergent validity.

Convergent Validity was established by examining the correlations between scaled score of subtest and Full scale IQ score as well as between scaled score of subtest and composite score within the same index. Moderate positive correlations found between scaled score of subtest and Full scale IQ score for block design($r=.60$), coding($r=.66$) & arithmetic($r=.60$) and High positive correlations were found for rest of the subtests, which was ranged from .74 to .87.

Positive correlation was found between sum of scaled scores of subtests of each index and scaled score of subtest within the same index. For Verbal comprehension index, Perceptual reasoning index, Working memory index and Processing Speed index, ranges of correlations were from .76 to .85; from 68 to .92; from .79 to .89; and from .79 to .85 respectively.

f. Preparation of questionnaire: Personal and demographical questionnaire was prepared to collect demographical data of the students and well as data related to their developmental history which might have an influence on their performance as well as on their intellectual/cognitive functioning.

2.5.1.3: Preparation of Consent form: An informed consent letter was prepared to obtained consent and assent from the teachers/parents and from the students respectively.

2.5.2: Final Stage: Permission from the schools was taken explaining the nature and purpose of the study and permission was also obtained for using a free classroom standard for administration of WISC-IV.

After obtaining permission from schools, three groups (Math-specific, Math-general & Comparison group) of 66 students from both primary and secondary grade levels were selected purposively on the basis of their academic results in last two exams. The total marks and obtained marks in the last two exams were collected from the register maintained by the school. The three groups of students were also matched in terms of sex, school and grade level.

Cognitive ability (verbal comprehension, fluid reasoning, working memory, processing speed, and verbal working memory) of those students were assessed by using Wechsler Intelligence scale for Children –Fourth Edition (WISC-IV) and the translated Bangla instructions were used for it. The test was administered in a quiet room which was free from distraction. Rapport was built between examiner and the students (examinees) before administering it. It took one hour to one and half hour to complete administration of WISC-IV. Ten minutes of gap was given after administering half of the subtests. Permissions from class teachers were also obtained before administering WISC-IV by explaining the nature and purpose of the study.

The personal and demographic information were collected from parents of those 66 students by using the demographic questionnaire.

2.6: Scoring:

After administration of WISC-IV, scoring was obtained by using the Administration and Scoring Manual. Raw scores obtained for each of the subtests were transferred into the scaled score using the norms of Wechsler Intelligence Scale for Children –Fourth Edition (WISC-IV).

- Verbal Comprehension was obtained by adding scaled scores of Similarities, vocabulary and comprehension subtests.
- Fluid reasoning was obtained by adding scaled scores of Picture Concept and Matrix Reasoning subtests.
- Working memory was obtained by adding scaled scores of Digit Span and Letter-Number Sequencing Subtests
- Processing Speed was obtained by adding scaled scores of Coding and Symbol Search Subtests.
- Verbal working memory was obtained from the scaled score of Digit Span Backward part of Digit Span Subtests.

It is important to mention that scaled scores were used to eliminate effect of age on data since the students' groups were not matched in terms of their age level.

2.7: Data analysis:

Data were analyzed by using SPSS software. Frequency and descriptive statistics were computed to see the characteristics of sample. Pearson Product Moment Correlation was executed to see the association between cognitive factors and average marks of mathematics derived from two consecutive exams. ANOVA was computed to see the differences among three Math performance groups in terms of verbal comprehension, fluid reasoning, working memory, processing speed and verbal working memory. Logistic Regression Analysis was executed to determine the predictors for failure in mathematics.

Chapter-3

Results

3. RESULTS

The objective of the present study was to see the role of cognitive factors such as: Verbal comprehension, fluid reasoning, working memory, processing speed and verbal working memory on poor performance in Mathematics of school children.

This section deals with the results obtained from statistical analysis of data. The results have been presented in the following section under four sections. In the first section, descriptive statistics of personal and demographic data have been presented. In the second section, the associations between cognitive factors and average marks of mathematics derived from two consecutive exams have been presented by analyzing Pearson Product Moment Correlation. In the third section, results obtained from Analysis of Variance (ANOVA) have been presented. In the last section, results derived from Logistic Regression Analysis have been presented.

3.1: Descriptive Statistical Analysis of Sample:

Three groups of 66 students from primary and secondary school level took part in this study. Demogaphic characteristics of those students have been listed in Table-6.

Table-6 shows that among 66 students with age range of 8 to 16 years 59.1% were boys and 40.9% were girls. It also shows that percentage of students (63.6%) in secondary level was higher than those of primary level (36.4%). Educational qualification of majority of father and mother were in Under SSC level. And more than half of the fathers (65.2%) were holding job while majority (80.3%) of mothers were housewives. Math specific group, Math general group and comparison group were shown almost equal range of monthly income.

Table-6

Demographic characteristics of the students were given in the following table:

Variable		**Math Specific**	**Math General**	**Comparison group**	**Total (%)**
No. of students		22	22	22	100%
Sex	Boys	13	13	13	**59.1%**
	Girls	9	9	9	40.9%
Age range (years)		9-15	8-16	8-16	
Average age (in month)		151.8	142.4	145.6	
Range of Heights(inch)		38-65	37-66	34-64	
Range of Weight(kg)		20-47	25-55	25-49	
Grade level	Primary	**8**	8	8	36.4%
	Secondary	14	14	14	**63.6%**
Father's education	Under SSC	9	16	11	**54.5%**
	SSC	3	2	4	13.6%
	HSC	4	2	2	12.1%
	Higher education	6	2	5	19.7%
Mother's education	Under SSC	13	18	14	**68.2%**
	SSC	6	3	5	21.2%
	HSC	2	1	1	6.1%
	Higher education	1	0	2	4.5%
Father's occupation	Job	13	17	13	**65.2%**
	Business	9	5	9	34.8%
Mother's occupation	Job	4	**8**	1	19.7%
	Housewife	18	14	21	**80.3%**
Range of monthly income (Tk)		7,000-70,000	5,000-50,000	5,000-60,000	

3.2: Correlation between cognitive factors and average marks of Mathematics :

Correlation coefficients were computed between cognitive factors (Verbal comprehension, Fluid reasoning, Working memory, Processing speed, and Verbal working memory) and average marks of Mathematics obtained in two consecutive exams. Results have been presented in the following table no.-7.

Table-7

Correlation between cognitive factors and average marks of Mathematics

Variables	N	Mean	Std. Deviation	r
Average marks	66	42.81	28.75	
Verbal comprehension	66	15.86	6.5	.63**
Fluid Reasoning	66	12.16	4.59	.42**
Working memory	66	14.19	6.76	.61**
Processing Speed	66	12.39	4.64	.47**
Verbal working memory	66	8.73	2.86	.48**

$^{**}P<.01$

Table-7 shows that correlation coefficient between verbal comprehension and obtained marks in Mathematics was r=.63 and it was significant at 0.01 levels. This indicates moderate positive correlation between verbal comprehension ability and Math performance. This means that performance in Mathematics improves with increase in the ability of verbal comprehension.

The correlation coefficient between fluid reasoning and obtained marks in Mathematics was r=.42 and it was significant at 0.01 levels. This indicates moderate positive correlation between fluid reasoning ability and Math performance. This means that performance in Mathematics improves with increase in the ability of fluid reasoning.

The correlation coefficient between working memory and obtained marks in Mathematics was r=.61 and it was significant at 0.01 levels. This indicates moderate positive correlation between working memory ability and Math performance. This means that performance in Mathematics improves with increasing the ability of working memory. The correlation coefficient between processing speed and obtained marks in Mathematics was r=.47 and it was significant at 0.01 levels. This indicates moderate positive correlation between processing speed ability and Math performance. This means that performance in Mathematics improves with increasing the ability of processing speed.

The correlation coefficient between verbal working memory and obtained marks in Mathematics was r=.48 and it was significant at 0.01 levels. This indicates moderate positive correlation between verbal working memory and Math performance. This means that performance in Mathematics improves with increasing the ability of verbal working memory.

3.3: Analysis of variance of Math performance groups

ANOVA was computed to see whether Math specific, Math general and comparison groups differ in terms of verbal comprehension, fluid reasoning, working memory, processing speed and verbal working memory. Results have been presented in the tables (12 to 21) below:

Table-8

Analysis of variance of verbal comprehension scores according to grade level and Math performance groups for grade levels:

	Math specific	Math general	Comparison group	Total
Primary	$\bar{X}$= 13.87 SD = 4.05	$\bar{X}$ = 11.00 SD = 4.50	$\bar{X}$ = 23.75 SD = 6.51	$\bar{X}$ = 16.20 SD = 7.43
Secondary	$\bar{X}$= 13.28 SD = 5.02	$\bar{X}$= 12.92 SD = 5.81	$\bar{X}$ = 20.92 SD = 4.19	$\bar{X}$ = 15.66 SD = 6.14
Total	$\bar{X}$ = 13.50 SD= 4.60	$\bar{X}$ = 12.22 SD= 5.34	$\bar{X}$ =21.86 SD =5.21	$\bar{X}$ = 15.86 SD = 6.58

Note: *Math performance groups, F value= 24.19* is significant at .01 level; df=2*

Grade levels, F value=.17 is not significant

Math performance groups vs grade level, F value= 1.17, is not significant

Table-8 showed that the average verbal comprehension score of comparison group ($\bar{X}$ =21.86) was higher than Math specific group ($\bar{X}$ =13.50) and Math general group ($\bar{X}$ =12.22). It showed that the Math performance groups were differ significantly (*F value= 24.19, df=2; p<.01*) in terms of their verbal comprehension ability.

Table-9

Mean differences on Verbal Comprehension scores among different performance groups of Mathematics

(I)Math Performance Groups	(J) Math Performance Groups	Mean Differences	Std. Error
Math Specific	Math General	1.2727	1.53273
	Comparison Group	-8.3636(*)	1.53273
Math General	Math Specific	-1.2727	1.53273
	Comparison Group	-9.6364(*)	1.53273

*$P < .05$

Table-9 shows that in case of verbal comprehension, mean differences of Math specific group and comparison group as well as mean differences of Math general group and comparison group were significant at .05 levels.

Table-10

Analysis of variance of fluid reasoning scores according to grade level and Math performance groups:

	Math specific	**Math general**	**Comparison group**	**Total**
Primary	$\bar{X}$ = 11.37 SD = 2.32	$\bar{X}$ = 8.87 SD = 4.22	$\bar{X}$ = 17.50 SD = 6.27	$\bar{X}$ = 12.58 SD = 5.72
Secondary	$\bar{X}$ = 11.21 SD = 4.04	$\bar{X}$ = 11.00 SD = 3.86	$\bar{X}$ = 13.57 SD = 3.36	$\bar{X}$ = 11.92 SD = 3.85
Total	$\bar{X}$= 11.27 SD=3.45	$\bar{X}$ =10.22 SD= 4.03	$\bar{X}$ =15.00 SD=4.88	$\bar{X}$ = 12.59 SD = 4.59

Note: Variables: *Math performance groups, F value= 10.49* is significant at .01 level; df=2*

Grade levels, F value=.39 is not significant

Math performance groups vs grade level, F value= 2.87, is not significant

Table-10 showed that the average fluid reasoning score of comparison group ($\bar{X}$ =15.00) was higher than Math specific group ($\bar{X}$ =11.27) and Math general group ($\bar{X}$ =10.22). It showed that the Math performance groups were differ significantly (*F value= 10.49, df=2; p<.01*) in terms of their ability of fluid reasoning.

Table-11

Mean differences on Fluid Reasoning scores among different performance groups of Mathematics

(I)Math Performance Groups	(J) Math Performance Groups	Mean Differences	Std. Error
Math Specific	Math General	1.0455	.22631
	Comparison Group	-3.7273(*)	1.22631
Math General	Math Specific	-1.0455	1.22631
	Comparison Group	-4.7727(*)	1.22631

**P*< .05*

Table 11 shows that in case of fluid reasoning, mean differences of Math specific group and comparison group as well as mean differences of Math general group and comparison group were significant at .05 levels.

Table-12

Analysis of variance of working memory scores according to grade level and Math performance groups:

	Math specific	**Math general**	**Comparison group**	**Total**
Primary	$\bar{X}$ = 12.50 SD = 3.77	$\bar{X}$ = 11.00 SD = 3.74	$\bar{X}$ = 22.75 SD = 6.27	$\bar{X}$ = 15.41 SD = 7.00
Secondary	$\bar{X}$ = 13.64 SD = 5.67	$\bar{X}$ = 9.35 SD = 4.10	$\bar{X}$ = 17.50 SD = 7.26	$\bar{X}$ = 13.50 SD = 6.60
Total	$\bar{X}$= 13.22 SD= 5.00	$\bar{X}$ = 9.95 SD= 3.96	$\bar{X}$=19.40 SD=7.24	$\bar{X}$ = 14.19 SD = 6.76

Note: Variables: *Math performance groups, F value= 17.79* is significant at .01 level; df=2*

Grade levels, F value=1.87 is not significant

Math performance groups vs grade level, F value= 1.74, is not significant

Table-12 showed that the average working memory score of comparison group ($\bar{X}$ =19.40) was higher than Math specific group ($\bar{X}$ =13.22) and Math general group ($\bar{X}$=9.95). It showed that the Math performance groups were differ significantly (*F value= 17.79, df=2; p<.01*) in their ability of working memory.

Table-13

Mean differences on Working memory scores among different performance groups of Mathematics

(I)Math Performance Groups	(J) Math Performance Group	Mean Differences	Std. Error
Math Specific	Math General	3.2727	1.65027
	Comparison Group	-6.1818(*)	1.65027
Math General	Math Specific	-3.2727	1.65027
	Comparison Group	-9.4545(*)	1.65027

$*P < .05$

Table 13 shows that in case of working memory, mean differences of Math specific group and comparison group as well as mean differences of Math general group and comparison group were significant at .05 levels.

Table-14

Analysis of variance of processing speed scores according to grade level and Math performance groups:

	Math specific	**Math general**	**Comparison group**	**Total**
Primary	$\bar{X}$ = 12.75 SD = 3.01	$\bar{X}$ = 11.00 SD = 3.66	$\bar{X}$ = 17.25 SD = 6.43	$\bar{X}$ = 13.66 SD = 5.16
Secondary	$\bar{X}$ = 10.92 SD = 2.81	$\bar{X}$ = 9.42 SD = 4.56	$\bar{X}$ = 14.64 SD = 3.38	$\bar{X}$ = 11.66 SD = 4.20
Total	$\bar{X}$ = 11.59 SD= 2.95	$\bar{X}$ = 10.00 SD= 4.24	$\bar{X}$ =15.59 SD=4.74	$\bar{X}$ = 12.39 SD = 4.64

Note: *Math performance groups, F value= 10.98* is significant at .01 level; df=2*

Grade levels, F value=3.77 is not significant

Math performance groups vs grade level, F value= .092, is not significant

Table-14 showed that the average processing speed score of comparison group ($\bar{X}$ =15.59) was higher than Math specific group ($\bar{X}$ =11.59) and Math general group ($\bar{X}$=10.00). It showed that the Math performance groups were differ significantly (*F value= 10.98, df=2; p<.01*) in terms of their ability of processing speed.

Table-15

Mean differences on Processing Speed scores among different performance groups of Mathematics

(I)Math Performance Groups	(J) Math Performance Groups	Mean Differences	Std. Error
Math Specific	Math General	1.5909	1.21267
	Comparison Group	-4.0000(*)	1.21267
Math General	Math Specific	-1.5909	1.21267
	Comparison Group	-5.5909(*)	1.21267

$*P< .05$

Table 15 shows that in case of processing speed, mean differences of Math specific group and comparison group as well as mean differences of Math general group and comparison group were significant at .05 levels.

Table-16

Analysis of variance of verbal working memory scores according to grade level and Math performance groups:

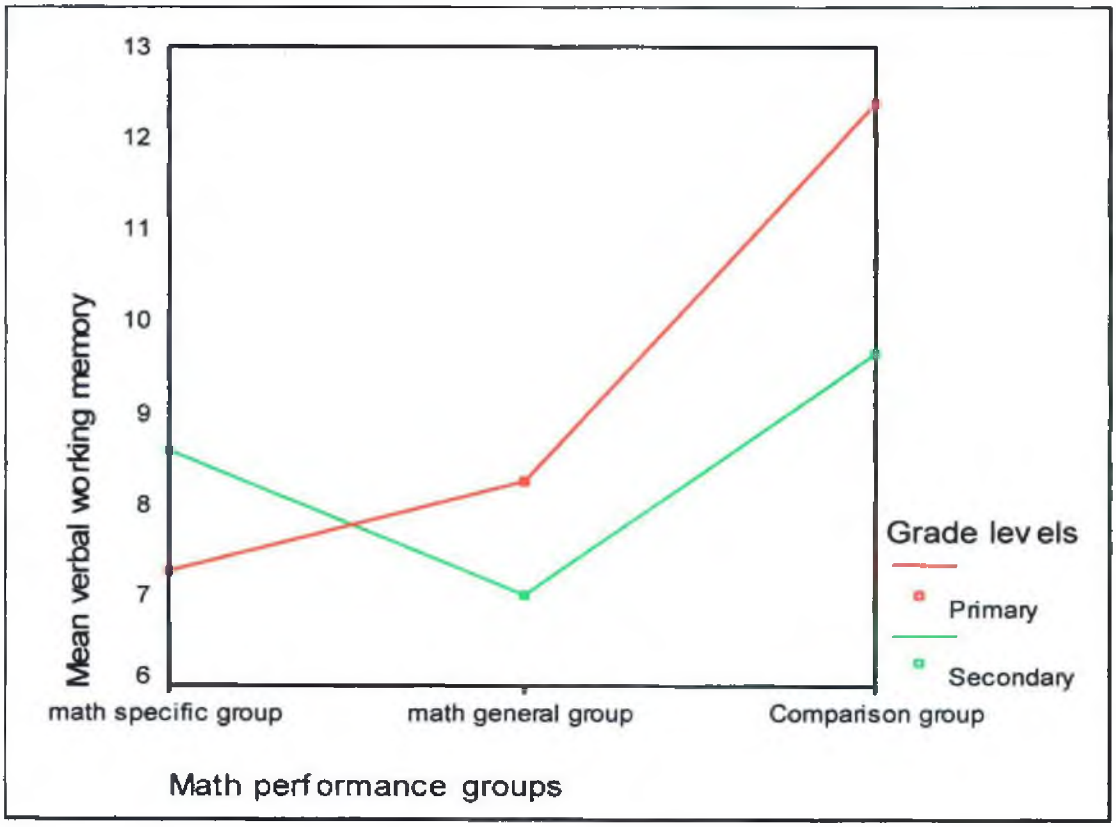
	Math specific	Math general	Comparison group	Total
Primary	$\bar{X}$ = 7.25 SD = 1.75	$\bar{X}$ = 8.25 SD = 2.12	$\bar{X}$ = 12.38 SD = 1.50	$\bar{X}$ = 9.29 SD = 2.85
Secondary	$\bar{X}$ = 8.57 SD = 2.84	$\bar{X}$ = 7.00 SD = 1.75	$\bar{X}$ = 9.64 SD = 3.27	$\bar{X}$ = 8.80 SD = 2.85
Total	$\bar{X}$ = 8.09 SD = 2.54	$\bar{X}$ = 7.45 SD = 1.94	$\bar{X}$ =10.64 SD=3.03	$\bar{X}$ = 8.73 SD = 2.86

Note: Variables: *Math performance groups, F value= 12.17* is significant at .01 level; df=2*

Grade levels, F value=2.03 is not significant

Math performance groups vs grade level, F value= 3.63 is significant at .05 level; df=2*

Table-16 showed that the average verbal working memory score of comparison group ($\bar{X}$ =10.64) was higher than Math specific group ($\bar{X}$ =8.09) and Math general group ($\bar{X}$ =7.45).



Graph-1: Mean verbal working memory scores of Math performance groups.

It showed that the Math performance groups (*F value* $= 12.17$, $df=2$; $p<.01$) and interaction of Math performance groups vs grade levels (*F value* $= 3.63$, $df=2$; $p<.05$) had significant effect on verbal working memory. This implies that whether students of comparison group are higher in their ability of verbal working memory than students in Math specific and students in Math general group depends on grade levels.

Table-17

Mean differences on Verbal working memory scores among different performance groups of Mathematics

(I)Math Performance Groups	(J) Math Performance Groups	Mean Difference	Std. Error
Math Specific	Math General	64	.732
	Comparison Group	-2.55(*)	.732
Math General	Math Specific	-64	.732
	Comparison Group	-3.18(*)	.732

**P< .05*

Table -17 shows that in case of verbal working memory, mean differences of Math specific group and comparison group as well as mean differences of Math general group and comparison group were significant at .05 levels.

3.2: Logistic Regression Analysis:

Logistic Regression Analysis was executed to explain contribution of cognitive factors (verbal comprehension, fluid reasoning, working memory and processing speed) in failure of Mathematics and estimated changes with the changes in corresponding variables. Results have been presented in tables-18 & 19.

Table-18

Logistic Regression Analysis for failure in Math in terms of cognitive factors

Predictors	**Cox & Snell R Square**
Cognitive factors (Verbal comprehension, Fluid reasoning, Working memory and Processing speed)	.523

From table-18, it has shown that Cox & Snell R square is .523. This implies that student's ability in Verbal comprehension, Fluid reasoning, Working memory and Processing speed together account for 52% the explanation of why student's attainment was poor in Mathematics at primary and secondary level.

Table-19

Summary of Logistic Regression Analysis of cognitive factors explaining failure in Mathematics

Predictors	**B**	**S.E.**	**Exp(B)**
Verbal Comprehension	-.516**	.172	.597
Fluid Reasoning	.085	.141	1.089
Working Memory	-.171**	.084	.843
Processing Speed	-.414**	.184	.661
Constant	16.213	5.116	10997834.040
df	*1*		

**Note: **** $p<.o5$

The above table shows the coefficients (B), their standard errors, and odds ratio (Exp (B)). It has shown that verbal comprehension, working memory and processing speed were statistically significant at 0.05 levels, while fluid reasoning was statistically insignificant. Exp(B)=.597 implies that controlling for the ability of working memory and processing speed, being a student of Math failure of either primary or secondary grade, the likelihood of being failed (versus nor being achieved) decreased .597 times with one unit increase in scaled scores of verbal comprehension index.

Exp(B)=.843 implies that controlling for the ability of verbal comprehension and processing speed, being a student of Math failure of either primary or secondary grade, the likelihood of being failed (versus nor being achieved) decreased .843 times with one unit increase in scaled scores of working memory index.

Similarly, Exp(B)=.661 implies that controlling for the ability of verbal comprehension and working memory, being a student of Math failure of either primary or secondary grade, the likelihood of being failed (versus nor being achieved) decreased .661 times with one unit increase in scaled scores of processing speed index.

Logistic regression analysis has been executed to explain contribution of Verbal working memory on failure in Mathematics and estimated changes with the changes in corresponding variables suvh as grade levels. As bilateral interactions has been demonstrated among Math performance groups and grade levels in terms of verbal working memory (see table-16), logistic regression analysis has been executed separately for primary and secondary levels. Results obtained from this analysis have been presented in Table-20 & 21.

Table-20

Logistic regression for Math failure in terms of verbal working memory

Predictors	**Cox & Snell R Square**	
	Primary	**Secondary**
Verbal working memory	.451	.093

From table-20, it has shown that Cox & Snell R square is .451 for primary level. This implies that for primary grade, student's ability in Verbal working memory was account for 45% the explanation of why student's attainment was poor in Mathematics.

But in case of secondary level, Cox & Snell R square is .093. This implies that for secondary grade, student's ability in Verbal working memory was account for 9% the explanation of why student's attainment was poor in Mathematics.

Table-21

Summary of Logistic Regression Analysis of verbal working memory explaining failure in Mathematics

Predictors	**Primary**			**Secondary**		
	B	**S.E.**	**Exp(B)**	**B**	**S.E.**	**Exp(B)**
Verbal working memory	-.891**	.362	.410	-.246	.129	.782
Constant	9.306			2.831		
df	*1*			*1*		

Note: ** *p<.o5*

Table -21 shows that the coefficients (B), their standard errors, and odds ratio (Exp (B)). It has shown that verbal working memory for Primary level is statistically significant at 0.05 levels while it is not for secondary level. Exp(B)=.410 implies that being a student of Math failure of Primary grade, the likelihood of being failed reduced by .410 times with one unit increase of scaled score of digit span backward(verbal working memory).

Chapter-4

Discussion

4. DISCUSION

The objective of the present study was to see the role of cognitive factors such as: verbal comprehension, fluid reasoning, working memory, processing speed and verbal working memory on poor performance in Mathematics of school children. To meet this objective, 66 students (59.1% boys and 40.9% girls) between the age ranges of 8 to 16 years were taken from 4 schools of Dhaka city. Among those 36.4% students were in primary grade level and 63.6% students were in secondary grade level.

The findings of the present study are discussed below under three sections. In the first section, summary and interpretation of the main findings are presented. The second section deals with the implications of the study. And the third and final section mentions limitations of the study and suggestions for future research.

The results of the present study showed positive relationship between the cognitive factors and attainment in Mathematics. Students' ability in verbal comprehension, fluid reasoning, working memory, processing speed, and verbal working memory were positively correlated with the average marks obtained in Mathematics in two consecutive exams and the relationships were significant at .05 levels [see table-7]. This finding is supported by many researches where established and strong link was found between Comprehension-Knowledge (Gc) and Mathematics achievement (e.g., Hale et al., 2001; Keith, 1999; McGrew et al., 1997; Williams et al., 1996). It seems to be consistent with the study conducted by Floyd (2003). He found that fluid reasoning demonstrated moderate relationship with Math calculation skills and moderate to strongest relation with Math reasoning throughout childhood and adolescence. The findings of the study corroborated with research that has included instruments that appear to measure Gf abilities (e.g., the Wisconsin Card Sort Test and the Halstead Category Test) has indicated that such abilities are significant correlates of Mathematics achievement (Bull, Johnston, & Roy, 1999; Rourke, 1993; Shute & Huertas, 1990; Strang & Rourke, 1983). Passolunghi, Cordnoldi and De Liberto (1999) found that children who were poor Mathematical problem solvers had low scores on working memory tasks that required the inhibition of irrelevant information. This finding is also consistent with the results of a number of studies that have demonstrated Processing Speed (Gs) had strong to moderate relations with Basic Mathematics Skills throughout the lifespan and moderate relations with Mathematics Reasoning through young adulthood (McGrew, Flanagan, Keith, and Vanderwood (1997). Keith (1999) also found that measures of Mathematics achievement were strongly influenced by Full Scale IQ and a number of other CHC broad cognitive abilities, such as Gc, Gf, and Gs. Similarly, the present study demonstrated processing speed as a contributing factor for failure in Mathematics. The results of the present study supported by Passolunghi & Cornoldi (2008) and Passolunghi & Siegel (2001, 2004). The findings of those studies revealed that verbal working memory measures those involving number (e.g., digit span backward) distinguish children with difficulties in Math.

Math performance groups were significantly varied in their ability of verbal comprehension ($F = 24.19$, $df= p<.01$), fluid reasoning (F $value= 10.49, df=2; p<.01$), working memory ($F$ $value= 17.79$, $df=2$;; $p<.01$), processing speed (F $value= 10.98$, $df=2$; $p<.01$) (see table- 8, 10, 12, & 14). Students who failed only in Mathematics as well as who failed in Mathematics with other subjects differ significantly from students who achieved in Mathematics including other subjects in terms of their ability in verbal comprehension fluid reasoning, working memory, and processing speed (see table-9, 11, 13, 15). Students who failed in Mathematics in both primary and secondary level had lower level of verbal comprehension fluid reasoning, working memory, and processing speed ability than students who had achieved in Mathematics (see table- - 8, 10, 12, & 14).

An advance exploration revealed that cognitive factors such as: verbal comprehension, working memory and processing speed are the predictors of failure in

Mathematics. In logistic regression it was found that verbal comprehension, fluid reasoning, working memory and processing speed together account for 52% the explanation of why student's attainment was poor in Mathematics at primary and secondary level. Among those explanatory variables, verbal comprehension, working memory and processing speed were found to be statistically significant at 0.05 levels, while fluid reasoning was statistically insignificant (see table-22 (b)). So it can be concluded that students' verbal comprehension ability, working memory ability, and processing speed ability demonstrated the important contributing factors for poor performance in Mathematics for both primary and secondary grade levels. These findings seem to be consistent with the findings obtained by Floyd, 2003 where it was also revealed that the Gc cluster which was composed of verbal comprehension and general information was generally the strongest predictor of Mathematics achievement throughout the school-age years. It also corroborated with research which indicates that Gs was one of the strong predictors of Mathematics Reasoning (McGrew, Flanagan, Keith, and Vanderwood (1997). Andersson (2008), found that measures of working memory predicted accuracy in children's performances on Mathematical word problems (Grades 2 to 4) even after variation attributable to intelligence, reading ability and age differences were controlled. Swanson (2004) showed that working memory measures predicted accuracy on a Mathematical problem solving task in 8- and 11-year-olds even after differences in age, Mathematical knowledge, fluid intelligence, and reading abilities were statistically controlled. He found that working memory contributed about 5% of the unique variance in solution accuracy. Bull and Scerif (2001) found that working memory span accounted for 3% more variance in Mathematics performance in 7-year-olds than did measures of intelligence and reading ability.

Although fluid reasoning did not seemed as a predictor of attainment in Mathematics, moderate positive relationship demonstrated some extent of association of fluid reasoning on attainment in Mathematics. This finding has been partially consistent with Floyd (2003); Bull, Johnston, & Roy, 1999; Rourke, 1993; Shute & Huertas, 1990; Strang & Rourke, 1983. It seemed to be inconsistent with the studies conducted by McGrew et al., 1997; Keith, 1999 as they found that Fluid Reasoning had statistically significant influences on Mathematics achievement.

Table-17 showed that whether Math performance groups varied in their ability of verbal working memory depends on their grade level. Since bilateral interaction of Math performance groups and grade level for verbal working memory was found significant, logistic regression was executed separately for students in primary level as well as secondary level. Student's ability in Verbal working memory was account for 45% the explanation of why student's attainment was poor in Mathematics at primary level while it was only 9% for secondary level. As Coefficient (B) was not significant for secondary level, verbal working memory can be considered as an important contributing factor for poor attainment in Mathematics of students at primary level (see tables- 20, & 21). In the present study, digit span backward was considered as a measure of verbal working memory. The results of the present study supported by Passolunghi & Cornoldi(2008) and Passolunghi & Siegel (2001, 2004). The findings of those studies revealed that verbal working memory measures those involving number (e.g., digit span backward) distinguish children with difficulties in Math. Mabbot & Bisanz (2008) also found that digit span backward specifically distinguishes children with severe Math difficulties from both children with less severe Math difficulties, and children with typical achievement in Math.

Lee et al., (2004); & Lee, Ng, & Ng, (2009) found that the central executive measure uniquely predicted 2.6% of the variance in 10-year-olds' performance on Mathematical word problem solving. Similarly, the present study revealed that verbal working memory which involves both central executive and phonological loop was an important contributing factor for poor attainment in Mathematics of students in primary level as students of this level are mostly required to solve arithmetic problem (word related task). It also consistent with the study by Holmes et. al (2008), where it was found that the central executive, and to a lesser extent the visual–spatial sketchpad, contributed to performance on both the pure and applied areas of Math of younger children. In adolescents, relations between visual–spatial working memory and Math have been found [76,98] with some differences reported for static and dynamic measures of visual– spatial working memory, depending on the particular Math skill being measured (e.g., static related to mental arithmetic and dynamic related to geometry and word problem solving). Visual-spatial skills and visual-spatial working memory have been found to be related to Mathematics ability in children aged 10 years (Maybery & Do, 2003), 11 years, and 14 years (Jarvis & Gathercole, 2003). From the above findings it can be concluded that the differences in contribution of verbal working memory in Mathematics attainment of students in primary and secondary level might result from the variation in the content of Mathematics in two grade levels which could be explored from the further studies.

Finally, it can be concluded that for students in primary grade verbal comprehension, working memory, processing speed, and verbal working memory and for students in secondary grade verbal comprehension, working memory, and processing speed are important contributing factors for poor attainment in Mathematics. Findings of this study give us an indication that more emphasis has been given on cognitive domain in the primary and secondary shool curriculum of Mathematics. So, the assessment of the content of Mathematics reflects the assessment of cognitive abilities of students in the broad sense.

The findings of this study can play a vital role in the professional field of educational psychology and some other fields related to education. The findings from this study can be considered as the baseline for early identification of students with poor performance in Mathematics due to cognitive factors. It can help educational psychologists and other professionals in the field of education to develop intervention programme based on the role of associated cognitive factors for difficulties in Mathematics and thereby ensuring quality education by improving National pass rate of students in Bangladesh.

Limitations of the Study

Several limitations of this study need to be considered. The limitations of the present study have been presented below:

1. A small sample size was used in this study.
2. Second, although research has focused on the importance of reading ability in predicting Mathematics achievement, these abilities were not included as factor of failure in Math.
3. The reliability and validity of the scale was measured using a small sample size.
4. Since the performance groups of Math were not matched on age, the scaled scores were used to analyze data which required using the norms from original WISC-IV.
5. Only a limited number of studies were included for verbal comprehension and fluid reasoning.

Recommendations

The followings are some recommendations based on the present study:

1. This study could be replicated in large scale for different age groups.
2. In-depth studies need to be designed for better understanding regarding both cognitive and non-cognitive contributing factors of Math failure.
3. Cognitive factors and their association with specific difficulties in solving math problems need to be investigated.
4. It is necessary to investigate the effectiveness of interventions related to verbal comprehension, working memory and processing speed and verbal working memory for improving the performance in Mathematics.

Although the study has some limitations, it incorporates knowledge base and works as a basis for hunting knowledge in the field of education. This study also suggests applications which might have a great impact in the life of students in schools and thereby helpful for teachers, parents, educators and professionals. This study comes up with some innovative ideas for future research which might be helpful for researchers, scholars, and experts in this arena.

Chapter-5

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5.REFERENCES

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Chapter-6

APPENDIX

APPENDIX-1: CONSENT LETTER

গবেষণার শিরোনাম: **Cognitive Factors in Determining the Causes of Poor performance in Mathematics of school Children.**

গবেষণার উদ্দেশ্য:

শিশুদের গণিতে খারাপ ফলাফলের কারণ হিসেবে স্থানীয় ও অন্যান্য যেসব বিষয় ভূমিকা পালন করছে সে সম্পর্কে ধারনা লাভ করা।
এই গবেষণাটি ঢাকা বিশ্ববিদ্যালয়ের মনোবিজ্ঞান বিভাগের অধীনে শিক্ষা মনোবিজ্ঞানের এম.ফিল পর্বের গবেষনার জন্য পরিচালিত হচ্ছে। এ গবেষনাটির অংশ হিসেবে "Wechsler Intelligence Scale for Children-fourth edition (WISC-IV)" নামক অভীক্ষাটি ৬ থেকে ১৬ বছর বয়সী শিশুদের উপর প্রয়োগ করা হবে। তার পরীক্ষার রেকর্ড আপনার সন্তানকে এই গবেষণায় অংশগ্রহণ করার জন্য নির্বাচিত করা হয়েছে।

কার্যপ্রনালী:

এই গবেষণাটিতে আপনার সন্তানকে অংশগ্রহণ করার অনুমতি দিলে আমরা তার উপর "Wechsler Intelligence Scale for Children-fourth edition (WISC-IV)" নামক অভীক্ষাটিকে প্রয়োগ করব।

ঝুঁকি:

এই গবেষণায় আপনার অংশগ্রহনের ঝুঁকির সম্ভবনা খুবই কম। আপনার এবং আপনার সন্তানের কাছ থেকে যেসব তথ্য নেয়া হবে তা গোপন রাখা হবে এবং একমাত্র গবেষণার কাজেই ব্যবহার করা হবে।

সুবিধা:

আপনার সন্তানকে এই গবেষনায় অংশগ্রহণ করানোর মাধ্যমে শিশুদের গনিতে খারাপ ফলাফলের জন্য যেসব বিষয় দায়ী সে সম্পর্কে ধারণা লাভ করা সম্ভব। এই গবেষনার ফলাফলের ভিত্তিতে শিক্ষার সাথে সংশি-ষ্ট বিভিন্ন পেশাজীবীরা গণিতে সন্তোষজনক ফলাফলের অর্জনের জন্য প্রয়োজনীয় ব্যবস্থা গ্রহণ করতে পারবেন।

গোপনীয়তা

আপনার এবং আপনার সন্তানের কাছ থেকে যেসব তথ্য নেয়া হবে তা গোপন রাখা হবে। গবেষণার গবেষকরা ছাড়া অন্য কেউই আপনাদের দেয়া তথ্য ও অভীক্ষাটির ফলাফল জানতে পারবেন না এবং এগুলো শুধুমাত্র গবেষণার কাজেইব্যবহার করা হবে। ভবিষ্যতে গবেষণাটি প্রকাশ করা হলে আপনাদের নাম ব্যবহার করা হবে না।

স্বতঃস্ফূর্ত অংশগ্রহণ

এই গবেষনার আপনার সন্তানের অংশগ্রহন হবে সম্পূর্ণ স্বতঃস্ফূর্ত। আপনি ইচ্ছা করলে যেকোন সময় আপনার সন্তানকে গবেষনায় অংশগ্রহন করা থেকে বিরত রাখতে পারবেন। আপনি যদি কোন প্রশ্নের উত্তর দিতে না চান তাও পারবেন।

অংশগ্রহণকারীর অধিকার:

এই গবেষনা সম্পর্কে আপনার যদি কোন প্রশ্ন থাকে তাহলে আপনি তা যেকোন সময় জানতে চাইতে পারেন।

গবেষকের স্বাক্ষর **তারিখ**

CONSENT FORM

অভিভাবকের সম্মতির বিষয়াবলী ঃ

আমি এই গবেষণার উদ্দেশ্য ও ধরণ সম্পর্কে বিস্তারিত জেনেছি।

আমি আমার গবেষণা সম্পর্কিত প্রশ্নের সন্তোষজনক উত্তর পেয়েছি।

আমি স্বতঃস্ফূর্তভাবে আমার সন্তানকে গবেষণায় অংশগ্রহন করার সিদ্ধান্ত নিয়েছি এবং আমি চাইলে যেকোন সময় গবেষনায় অংশগ্রহণ করা থেকে আমার সন্তানকে বিরত রাখতে পারি।

আমি গবেষণার অংশগ্রহনের জন্য সম্মতি দিয়েছি।

আমি ইতিমধ্যে আমার সন্তানের সাথে এই গবেষণা সম্পর্কে আলোচনা করেছি।

নামঃ...

স্বাক্ষরঃ...

তারিখঃ...

শিশুর সম্মতির বিষয়াবলীঃ

এই গবেষণায় অংশগ্রহণের জন্য তোমার অভিভাব তোমাকে অনুমতি দিয়েছে। এখানে স্বাক্ষর প্রদানের মাধ্যমে তোমার সম্মতি পাওয়া যাবে।

নামঃ...

স্বাক্ষরঃ...

তারিখঃ...

APPENDIX-2: DEMOGRAPHIC QUESTIONNAIRE

ID No.:

Name:

Age: Sex: □ Male □ Female

Height: Weight:

Class:

Name of the School:

Medium of School: □ Bengali □ English □ Madrasha

Father's Education: □ Under SSC □ SSC □ HSC □ Higher Education

Father's Occupation:

Mother's Education: □ Under SSC □ SSC □ HSC □ Higher Education

Mother's Occupation:

Family Income (Monthly):

Consanguinity: □Yes □ No

Family history of mental illness: □ Mental retardation □ Physical disability □ Other impairments

Complications during pregnancy: □Yes □ No

Birth complication: □Yes □ No

Type of complication during delivery: □ Oxygen deprivation □ Forceps delivery □ Others (please mention).......................................

Any hazards immediately after birth:

Birth Order: No. of siblings:

Residence: □ Rural □ Urban □ Slum

Family Structure: □ Joint □ Nuclear

Presence of serious Disease: □ Yes □ No

Name of disease:

Onset of disease:

Scores obtained in all subjects (last two exams):

i)Mathematics (Total score:...................... Obtained Score: ....)

ii)Bengali (Total score:...................... Obtained Score: ....)

iii) English (Total score:...................... Obtained Score: ....)

iv) Science (Total score:...................... Obtained Score: ....)

v) Social Science (Total score:...................... Obtained Score: ....)

vi) Religion (Total score:...................... Obtained Score: ....)

Contact no. :

APPENDIX-3: TRANSLATED BANGLA KEY INSTRUCTIONS OF WISC_IV

Subtest-1. Block design (ব্লক ডিজাইন)

Age: 6-7: এই ব্লকগুলি দেখো ? ব্লকগুলি সব দেখতে একই রকম। এর কোন দিকে পুরোটাই লাল, কোনদিকে দিকে পুরোটাই সাদা এবং কোনদিকে অর্ধেক লাল ও অর্ধেক সাদা।

Item-1 (Trial-1): দেখ, আমি এই ব্লকগুলি একসাথে করে একটা কিছু তৈরী করছি। এখন তুমি ঠিক আমারটার মত করে একটা তৈরী কর। শুরু কর।

Item-1(Trial-2): আমারটা আবার দেখ। এখন তুমি আবার আমারটার মত করে তৈরি করতে চেষ্টা কর। শুরু কর।

Item-2 (Trial-1): দেখ আমি ৪টি ব্লক একসাথে করে অন্যকিছু তৈরী করছি।এখন তুমি ঠিক আমারটার মত করে একটা তৈরী কর। যত তাড়াতাড়ি সম্ভব তুমি কাজটি করবে এবং কাজটি শেষ হলে আমাকে বলবে।

Item-2 (Trial-2): আমারটা আবার দেখ।এখন তুমি আবার আমারটার মত করে তৈরি করতে চেষ্টা কর। শুরু কর।

Age: 8-16 : এই ব্লকগুলি দেখো ? ব্লক গুলি সব দেখতে একই রকম। এর কোন দিকে পুরোটাই লাল, কোনদিকে দিকে পুরোটাই সাদা এবং কোনদিকে অর্ধেক লাল ও অর্ধেক সাদা।

Item-3 (Trial-1): দেখ আমি ব্লকগুলোকে দিয়ে এই ছবিটির মত তৈরী করছি। দেখেছ ব্লক গুলির উপরের দিকটা দেখতে ঠিক এই ছবিটার মতই।

এখন তুমি এই ছবিটার মত করেই একটি তৈরী কর। যত তাড়াতাড়ি সম্ভব তুমি কাজটি করবে এবং তোমার শেষ হলে আমাকে বলবে।

(Trial-2): আমারটা দেখ। দেখেছ, এই ব্লকগুলির উপরের দিকটা দেখতে ঠিক এই ছবিটার মতই। এখন তুমি এই ছবিটার মত করে একটা তৈরি করতে চেষ্টা কর। শুরু কর।

Item-4: এখন এটার মত করে একটি তৈরী কর। তুমি যত তাড়াতাড়ি সম্ভব কাজটি করবে এবং শেষ হলে আমাকে বলবে।

Item-5-10 : এখন এটার মত করে একটি তৈরী কর। তুমি যত তাড়াতাড়ি সম্ভব কাজটি করবে এবং শেষ হলে আমাকে বলবে।

Item-11-14: এখন তুমি ৯টি ব্লক ব্যবহার করে এটার মত তৈরী কর। তুমি যত তাড়াতাড়ি সম্ভব কাজটি করবে এবং শেষ হলে আমাকে বলবে। শুরু কর।

Subtest-2. Similarities

Age: 6-16 : এখন আমি তোমাকে ২টি করে শব্দ বলবো এবং তোমাকে জিজ্ঞেস করবো শব্দ দুটির মধ্যে কী মিল আছে বা তারা কি ভাবে একরকম।

Sample: লাল ও নীল শব্দ দুটি কোন দিক থেকে একরকম ? তাদের মধ্যে মিল কোথায় ?

লাল ও নীল দু'টোই রং এর নাম। চল অন্যটা চেষ্টা করি।

Item-1: কলম ও পেন্সিল কোন দিক থেকে একরকম ? চল অন্যটা চেষ্টা করি।

কলম ও পেন্সিল দুটোর সাহায্যে তুমি লিখতে পার অথবা আঁকতে পার ।
Item-2: দুধ ও পানি কোনদিক থেকে একরকম ? দুধ ও পানি দুটোই হল তরল পদার্থ এবং তুমি এগুলি পান কর ।
Item:3. একটি আপেল এবং একটি কলা কোনদিক থেকে একরকম ?
Item4. জামা এবং জুতা কোনদিক থেকে একরকম ?
Item5. প্রজাপতি এবং মৌমাছি কোনদিক থেকে একরকম ?
Item6. বিড়াল এবং ইঁদুর কোনদিক থেকে একরকম ?
Item7. গ্রীষ্মকাল এবং শীতকাল কোনদিক থেকে একরকম ?
Item8. রাগ এবং আনন্দ কোনদিক থেকে একরকম ?
Item9. হাটু এবং কনুই কোনদিক থেকে একরকম ?
Item10. ভ্রুকুটি এবং হাসি কোনদিক থেকে একরকম ?
Item11. চিত্রশিল্প এবং ভাস্কর্য্য কোনদিক থেকে একরকম ?
Item12. কাঠের তক্তা এবং ইট কোনদিক থেকে একরকম ?
Item13. কবি এবং চিত্রশিল্পি কোনদিক থেকে একরকম ?
Item14. পর্বত এবং হ্রদ কোনদিক থেকে একরকম ?
Item15. বরফ এবং বাস্প কোনদিক থেকে একরকম ?
Item16. প্রথম এবং শেষ কোনদিক থেকে একরকম ?
Item17. বন্যা এবং খরা কোনদিক থেকে একরকম ?
Item18. রাবার এবং কাগজ কোনদিক থেকে একরকম ?
Item19. লবন এবং পানি কোনদিক থেকে একরকম ?
Item20. প্রতিশোধ নেয়া এবং ক্ষমা করা কোনদিক থেকে একরকম ?
Item21. অনুমতি নেয়া এবং নিয়ন্ত্রণ করা কোনদিক থেকে একরকম ?
Item22. বাস্তবতা এবং স্বপ্ন কোনদিক থেকে একরকম ?
Item23. মহাশুন্য এবং সময় কোনদিক থেকে একরকম ?

<u>Subtest-3. Digit Span</u>

Digit Span Forward

Age: 6-16: আমি এখন কিছু সংখ্যা বলবো, তুমি সেগুলো মনোযোগ দিয়ে শুনবে । আমার বলা শেষ হওয়া মাত্রই আমি যা বলেছি, তুমি তা বলবে ।

Digit Span Backword

Age: 6-16: (Trial-1): এখন আমি আরো কিছু সংখ্যা বলবো, কিন্তু এক্ষেত্রে আমার বলা শেষ হওয়া মাত্রই তুমি সেগুলো উল্টোদিক থেকে বলবে ।

Correct response: ঠিক হয়েছে ।

Incorrect Response: না, এটা পুরোপুরি ঠিক নয় । আমি বলেছিলাম 8-2, সুতরাং এটাকে উল্টোভাবে বলতে হলে তোমাকে বলতে হবে, 2-8 । চল, আমরা আবার চেষ্টা করি ।

(Trial-2): এখন আমি আরো কিছু সংখ্যা চেষ্টা করি, মনে রাখবে তোমাকে উল্টোভাবে বলতে হবে ?
Correct response: ঠিক হয়েছে।
Incorrect Response: না, এটা পুরোপুরি ঠিক নয়। আমি বলেছিলাম 6-5 , সুতরাং এটাকে উল্টোভাবে বলতে হলে তোমাকে বলতে হবে, 5-6। চল, আমরা আবার চেষ্টা করি।

Subtest-4. Picture Concepts

Sample A : উপরের ছবিগুলোর দিকে তাকাও; এবং নিচের ছবিগুলোর দিকে তাকাও। এখান থেকে একটি নাও যার সাথে এখানকার একটির মিল আছে।

Correct response: এদের মধ্যে মিল আছে কেন?

Incorrect Response: এদের মধ্যে মিল আছে কারণ তারা উভয়েই গাছ। এই ছায়াতরু গাছটির সাথে পাইন গাছটির মিল আছে কারণ তারা উভয়েই গাছ।চল অন্যটি চেষ্টা করি।

Sample B : এখান থেকে একটি নাও যার সাথে এখানকার একটির মিল আছে।

Correct response: এদের মধ্যে মিল আছে কেন?

Incorrect Response: কাঠবিড়ালীর সাথে পাখির মিল আছে, কারণ তারা উভয়েই প্রাণী। চল, অন্য একটা চেষ্টা করি।

Items 1-12 (Two-Row Items): এখান থেকে একটা নাও যার সাথে এখানকার একটার মিল আছে।

Items 13-28 (Three-Row Items): এখান থেকে একটা নাও যার সাথে এখানকার (2st row) একটার এবং এখানকার (3rd row) একটার মিল আছে।

Subtest-5. Coding

Age: 6-7 Coding-A
Sample items:এখানে চিহ্নযুক্ত কতগুলো আকৃতি আছে। প্রতিটি আকৃতির একটি নিজস্ব চিহ্ন আছে।
নিচে কতগুলি ফাকা আকৃতি আছে। তুমি এগুলো উপরের মত করে পূরণ করবে।
আমাকে দেখ। এখানে একটি বৃত্ত আছে। উপরের এই বৃত্তটিতে ২টি লাইন এভাবে দেয়া আছে। তাই বৃত্তটিতে আমিএইরকম ২টি লাইন আকব।
আবার আমারটা দেখ। এখানে একটা তারা আছে। উপরের এই তারাটিতে একটা খাড়া লাইন আছে। তাই এখানে আমি খাড়া লাইন আকব।
এখন তুমি এইগুলি কর। এই লাইন পর্যন্ত করা হলে তুমি থামবে।
Correct response: হ্যাঁ, ঠিক আছে। এখন তুমি জান কিভাবে এগুলো করতে হয়।

Test items: যখন আমি শুরু করতে বলবো, তখন একইভাবে এগুলো করবে। এখান থেকে শুরু করবে, একটার পর একটা করবে এবং একটি বাদ দিয়ে অন্যটি করবে না। আমি যতক্ষন না থামতে বলবো ততক্ষন পর্যন্ত কোন ভুল না করে যত দ্রুত সম্ভব কাজটি করবে।

তুমি কি প্রস্তুত ?

শুরু কর।

থাম।

Age: 8-16: Coding B

Sample items: এই বাক্সগুলোর দিকে তাকাও। প্রতিটি বাক্সের উপরের অংশে একটি সংখ্যা আছে এবং নীচের অংশে একটি বিশেষ চিহ্ন আছে। প্রতিটি সংখ্যার একটি নিজস্ব চিহ্ন আছে। এখানে নীচে বাক্সগুলোর উপরের অংশে সংখ্যা আছে কিন্তু নিচের অংশটি খালি। তুমি খালি বাক্সগুলিতে এগুলোর মত চিহ্ন আঁকবে।

এখানে একটি 2 আছে। 2 তে এই চিহ্নটি আছে। সুতরাং, আমি খালি বাক্সটিতে এইভাবে এই চিহ্নটি আঁকলাম।

এখানে একটি 1 আছে। 1-এ এই চিহ্নটি আছে সুতরাং, আমি বাক্সটিতে এই চিহ্নটি আঁকলাম।

এটি একটি 4, 4 এর জন্য এই চিহ্নটি আছে। সুতরাং আমি বাক্সটিতে এই চিহ্নটি আঁকলাম।

এখন তুমি এইগুলি কর। যখন এইপর্যন্ত করা হলে থামবে।

হ্যাঁ বা ঠিক আছে। এখন তুমি জান কিভাবে এগুলো করতে হয়।

Test items: যখন আমি শুরু করতে বলবো, তখন একইভাবে এগুলো করবে। এখান থেকে শুরু করবে, একটার পর একটা করবে এবং একটি বাদ দিয়ে অন্যটি করবে না। আমি যতক্ষন না থামতে বলবো ততক্ষন পর্যন্ত কোন ভুল না করে যত দ্রুত সম্ভব কাজটি করবে।

তুমি কি প্রস্তুত ?

শুরু কর।

থাম।

Subtest-6. Vocabulary

Picture items: Items 1-4: এটা কি ?

Verbal items: আমি কিছু শব্দ বলতে যাচ্ছি। মনোযোগ দিয়ে শুনবে এবং প্রতিটি শব্দ দ্বারা কি বুঝায় তা আমাকে বলবে।

Item: 5. ঘড়ি কি ?

একটি ঘড়ি হলো এমন জিনিস যা থেকে আমরা সময় জানতে পারি।

Item: 6.টুপি কি ?

টুপি হল এমন জিনিস যা তুমি তোমার মাথায় পড়।

Item: 7. ছাতা কি?

Item: 8. গরু কি?

Item: 9. সাইকেল কি?

Item: 10. বর্ণমালা কি?

Item: 11. প্রস্থান করা বলতেকি বুঝ?

Item: 12. সাহসী বলতেকি বুঝ?

Item: 13. চোর কি?

Item: 14. মান্য করা বলতেকি বুঝ?

Item: 15. দ্বীপপুঞ্জ বলতেকি বুঝ?

Item: 16. ক্ষতিকারক প্রাণী বলতেকি বুঝ?

Item: 17. নির্বোধ বলতেকি বুঝ?

Item: 18. প্রাচীন বলতেকি বুঝ?

Item: 19. অণুকরণ করা বলতেকি বুঝ?

Item: 20. শুষে নেয়া বলতেকি বুঝ?

Item: 21. পৌরাণিক কাহিণী বলতেকি বুঝ?

Item: 22. অভিবাসন বলতেকি বুঝ?

Item: 23. যথাযথ বলতেকি বুঝ?

Item: 24. স্বচ্ছ বলতেকি বুঝ?

Item: 25.কদাচিৎ বলতেকি বুঝ?

Item: 26 প্রতিদ্বন্দিতা বলতেকি বুঝ?

Item: 27.তেজঃপূর্ণ বলতেকি বুঝ?

Item: 28. দুরদর্শিতা বলতেকি বুঝ?

Item: 29.ঐকামত্য বলতেকি বুঝ?

Item: 30. সংশোধন করা বলতেকি বুঝ?

Item: 31. বাধ্য বলতেকি বুঝ?

Item: 32. যন্ত্রণাদায়ক বলতেকি বুঝ?

Item: 33.আসন্ন বলতেকি বুঝ?

Item: 34.বিচ্যুতি বলতেকি বুঝ?

Item: 35.বাক্যবাগীতা বলতেকি বুঝ?

Item: 36. ধীরুজ বলতেকি বুঝ?

<u>Subtest-7. Letter-Number Sequencing</u>

6-7: Qualifying Items

Counting: চল এখন অন্যরকম কিছু করি। তুমি ৫ পর্যন্ত জোরে জোরে বল যেন আমি শুনতে পাই।

বল - এক --- দুই -----। এখন তুমি বল।

Alphabet: এখন বর্ণমালার অক্ষরগুলি আমাকে বল।

এভাবে বল A ----- B --------

এখন তুমি চেষ্টা কর।

Sample item : Trial 1: এখন আমি তোমাকে কিছু সংখ্যা এবং কিছু অক্ষর বলব। আমার বলার পর, তুমি প্রথমে সংখ্যাগুলো ছোট থেকে বড় অনুসারে সাজিয়ে বলবে এবং এরপর অক্ষরগুলোকে বর্ণমালা অনুসারে সাজিয়ে বলবে। যেমন, আমি যদি বলি A-1, তুমি বলবে 1-A সংখ্যাটি আগে আসবে, তারপর অক্ষর। চল এবার চেষ্টা করি। A- 2.

Incorrecet response : এটি পুরোপুরি ঠিক নয়। আমি বলেছিলাম A- 2; তোমাকে বলতে হবে 2- A; প্রথমে সংখ্যাটি আসবে, তারপর অক্ষর।

Trial 2: চল আবার চেষ্টা করি। B-3

Incorrecet response :আমি বলেছিলাম B-3। তোমাকে বলতে হবে 3-B. প্রথমে সংখ্যাটি আসবে, তারপর অক্ষর। চল আবার চেষ্টা করি। B-3.

Items 1-2: এতক্ষণ আমরা অনুশীলন করেছি। চল এবার করতে চেষ্টা করি। মনে রেখ, প্রথমে সংখ্যাগুলো ক্রমানুসারে বলবে তারপর অক্ষরগুলি বর্ণমালা অনুসারে বলবে।

Items 3-10: চল, এখন বেশি সংখ্যা ও অক্ষরযুক্ত কিছু চেষ্টা করি। যদি আমি বলি 2-C-3 তখন তুমি বলবে 2-3-C. প্রথমে সংখ্যাগুলো ক্রমানুসারে সাজিয়ে বলবে তারপর অক্ষরগুলো বর্ণমালা অনুসারে সাজিয়ে বলবে।

Subtest-8. Matrix Reasoning

Sample A : এই ছবিগুলি দেখ, এখানকার কোন ছবিটি এখানে বসবে ?

Correcet response: ঠিক হয়েছে, চল অন্যটি চেষ্টা করি।

Incorrecet response: চল আবার দেখি। সবগুলো প্রজাপতি নীল রংয়ের। এই প্রজাপতিটিও নীল রংয়ের। তাই, এটা এখানে বসবে। চল অন্য একটি চেষ্টা করি।

Sample B : এখানকার কোনটি এখানে বসবে।

Correcet response: ঠিক হয়েছে। এখন চল অন্যএকটি চেষ্টা করি।

Incorrecet response: চল আবার দেখি। এই বাক্স দুইটি হলুদ রংয়ের। এখানে একটি সবুজ রংয়ের বাক্স আছে। আমাদেও এটার মত সবুজ রংয়ের বাক্স দরকার। তাই, এটা এখানে বসবে। চল অন্য একটি চেষ্টা করি।

Sample C : এখানকার কোনটি এখানে বসবে ?

Correcet response: ঠিক হয়েছে এখন চল অন্য একটি চেষ্টা করি ।

Incorrecet response: আবার দেখ । এই সবগুলি বাক্সই হল নীল এবং এরমধ্যে এইরকম একটি লাইন আছে । এই বাক্সটিও নীল এবং এরমধ্যে/এর ভেতরেও একইরকম লাইন আছে । তাই, এটি এখানে বসবে । চল এখন অন্যটা চেষ্টা করি ।

Items 1-35: এখানকার কোনটি এখানে বসবে ?

Subtest-9. Comprehension

এখন আমি তোমাকে কিছু প্রশ্ন করব । আমি চাই তুমি আমাকে এগুলোর উত্তর বলবে ।

১ । মানুষ দাঁত মাজে কেন?

দাঁত পরিস্কার রাখার জন্য এবং ক্ষয়রোধ করার জন্য মানুষ দাঁত মাজে । দাঁত ব্রাশের ফলে তোমার হাসি যেমন সুন্দর দেখায় তেমনি তোমার নিঃশ্বাসকে সজীব ও সতেজ রাখে ।

২ । মানুষ শাক-সবজি খায়কেন ?

৩ । গাড়ীতে সীট বেল্ট থাকে কেন?

৪ ।তুমি যদি দেখ তোমার পাশের বাড়ির জানালা দিয়ে কালো ধোঁয়া আসছে, তখন তোমার কি করা উচিত?

৫ ।যদি তুমি দোকানে কারো মানিব্যাগ পড়ে থাকতে দেখ, তখন তুমি কি করবে ?

৬ । পুলিশকে পুলিশের পোশাক পড়তে হয় কেন?

৭ । তোমার চেয়ে ছোট ছেলে /মেয়ে যদি তোমার সাথে মারামারি শুরু করে তখন তুমি কি করবে ?

৮ । যদি তুমি বুঝতে পার তুমি কাউকে কষ্ট দিয়েছ তখন তার কাছে ক্ষমা চাইতে হবে কেন?

৯ । কেউ লাইট ব্যবহার না করলে তাহলে তা বন্ধ করে রাখর কিছু কারন বল ।

১০ । ব্যায়াম করার ও কর্মঠ হবার সুবিধাগুলো কি কি ?

১১ । পাবলিক লাইব্রেরী থাকার সুবিধাগুলো কি কি ।

১২ । মাংস বিক্রির আগে সরকারকে তা পরিদর্শন করতে হয় কেন ?

১৩ । টেলিভিশন থেকে পাওয়া খবরের চেয়ে সংবাদপত্র থেকে পাওয়া খবরের কিছু সুবিধা বল ।

১৪ । চিকিৎসকরা তাদের পেশায় কিছুদিন কাজ করার পর আরো উচ্চতর শিক্ষা গ্রহণ করে কেন?

১৫ । কোন লেখকের বইয়ের কপিরাইট এবং কোন আবিষ্কারকের আবিষ্কারের পেটেন্ট থাকার প্রয়োজনীয়তা কি?

১৬ । প্রতিশ্রুতি রক্ষা করতে হয় কেন?

১৭ । আমরা চিঠিকে ডাকটিকেট লাগাই কেন ?

১৮ ।একই শহরে একই মালিকের অধীনে পত্রিকা, রেডিও ও টেলিভিশন না থাকার প্রয়োজন কেন?

১৯ । গনতন্ত্রে বাক স্বাধীনতা থাকা প্রয়োজন কেন ?

২০ । বিজ্ঞান এবং প্রযুক্তির দ্রুত পরিবর্তনের অসুবিধাগুলো কি কি ?

২১ । যোগাযোগের মাধ্যম যেমনঃ টেলিভিশন, রেডিও, ইন্টারনেট একনায়কতন্ত্রের জন্য হুমকী স্বরূপ কেন?

Subtest-10. Symbol Search

Symbol Search A

এই আকৃতিগুলোর দিকে তাকাও। এখানকার এই আকৃতিটা এখানকার এই আকৃতিটার মত, তাই আমি Yes বক্সে এভাবে দাগ দিব।

এই আকৃতিগুলোর দিকে তাকাও। এখানকার এই আকৃতির মত এখানে কোন আকৃতি নেই, তাই আমি No বক্সে এভাবে দাগ দিব।

যদি এই আকৃতিটার মত এখানে কোন আকৃতি থাকে তাহলে Yes বক্সে দাগ দিব, আর যদি এই আকৃতির মত না থাকে তাহলে No বক্সে দাগ দিব। তুমি কি বুঝেছ?

Practice items: এখন তুমি এগুলি কর। শুরু কর।

Correcet response: হ্যাঁ, ঠিক হয়েছে। এখন তুমি জান কিভাবে এগুলো করতে হয়।

Incorrecet response: এটা পুরোপুরি ঠিক হয়নি।এখানে দেখ, এখানে একটি আকৃতি আছে। এখন এখানে দেখ। এখানে একইরকম দেখতে একটি আকৃতি আছে। তাই তুমি Yes বক্সে দাগ দিবে।

এটা পুরোপুরি ঠিক হয়নি।এখানে দেখ, এখানে একটি আকৃতি আছে। এখন এখানে দেখ। এখানকার কোনটাই এই আকৃতির মত নয়। তাই তুমি No বক্সে দাগ দিবে।

Test items: যখন আমি শুরু করতে বলবো, তখন তুমি একইভাবে এগুলো করবে। এখান থেকে শুরু করবে, একটার পর একটা করবে এবং একটি বাদ দিয়ে অন্যটি করবেনা। কোন ভুল না করে যত তাড়াতাড়ি সম্ভব তুমি কাজটি করবে। প্রথম পৃষ্ঠা করা শেষ হলে ২য় পৃষ্ঠায় যাবে এবং তারপর পরের পৃষ্ঠায় যাবে। তুমি কি প্রস্তুত ?

শুরু কর।

করতে থাক যত দ্রুত সম্ভব।

থাম।

Symbol Search B

Sample items

এই আকৃতিগুলোর দিকে তাকাও। এখানকার এই আকৃতিটা এখানকার এই আকৃতিটার মত, তাই আমি Yes বক্সে এভাবে দাগ দিব।

এই আকৃতিগুলোর দিকে তাকাও। এখানকার আকৃতিগুলোর কোনটাই এখানকার মত নয়, তাই আমি No বক্সে এভাবে দাগ দিব।

এখানকার আকৃতিগুলোর যেকোন একটি যদি এখানে থাকে তাহলে Yes বক্সে দাগ দিব, আর যদি এখানকার আকৃতিগুলোর কোনটাই এখানকার মত না হয় তাহলে No বক্সে দাগ দিব। তুমি কি বুঝেছ?

Practice items : এখন তুমি এগুলি কর। শুরু কর।
Correcet response: হ্যাঁ, ঠিক হয়েছে। এখন তুমি জান কিভাবে এগুলো করতে হয়।
Incorrecet response: এটা পুরোপুরি ঠিক হয়নি। এখানে দেখ, এখানকার এই আকৃতিটির মত দেখতে এখানে একটি আকৃতি আছে। তাই তুমি Yes বক্সে দাগ দিবে।

এটা পুরোপুরি ঠিক হয়নি। এখানকার আকৃতিগুলোর কোনটাই এখানকার মত নয়। তাই তুমি No বক্সে দাগ দিবে।

Subtest-11. Picture Completion

আমি এখন তোমাকে কিছু ছবি দেখাবো। প্রতিটি ছবিরই একটা অংশ নেই। তুমি মনোযোগ দিয়ে ছবিগুলো দেখবে এবং আমাকে বলবে সেখানে কোন অংশটি নেই।

Sample : এই ছবিটির দিকে তাকাও, এখানে কোন অংশটি নেই ?
Correcet response: হ্যাঁ, ঠিক হয়েছে। এখানে সীস নেই।
Incorrecet response: দেখ, এখানে সীস নেই।

Item 1 : এই ছবিটির দিকে তাকাও, এখানে কোন অংশটি নেই ?
Correcet response: হ্যাঁ, ঠিক হয়েছে।
Incorrecet response: দেখ, এখানে জামার হাতা নেই।

Item 2 : এই ছবিটির দিকে তাকাও, এখানে কোন অংশটি নেই ?
Correcet response: হ্যাঁ, ঠিক হয়েছে।
Incorrecet response: দেখ, এখানে কান নেই।

Item 3-38: এই ছবিটির দিকে তাকাও, এখানে কোন অংশটি নেই ?

Subtest-12. Cancellation

Sample: এই সারিটির দিকে তাকাও। এখানে সবই প্রাণী। এই সারিটির দিকে তাকাও। এখানে প্রানী আছে আবার অন্য বস্তুও আছে। আমি প্রতিটি প্রাণীর মধ্য দিয়ে একটি করে দাগ টানছি। আমি আর অন্য কিছুর মধ্য দিয়ে দাগ টানছি না।

Practice : এখন তুমি কর। প্রতিটি প্রাণীর মধ্য দিয়ে একটি করে দাগ দাও। অন্য কোন কিছুর মধ্য দিয়ে দাগ দিও না।

Correcet response: হ্যাঁ বা ঠিক আছে। এখন তুমি জান কিভাবে এগুলো করতে হয়।
Incorrecet response: [যদি ৪ টার কম প্রানী বা অপ্রানীতে দাগ দেয়]এখানে একটি প্রানী আছে। প্রতিটি প্রাণীর মধ্য দিয়ে একটি করে দাগ দাও।

[অপ্রানী দাগ দেয়ার ক্ষেত্রে] এটা পুরোপুরি ঠিক নয়।

এখানে দেখ এট প্রাণী নয়। তোমাকে শুধুমাত্র প্রাণীতে দাগ দিতে হবে। অন্য কোন কিছুর মধ্য দিয়ে দাগ দিবে না।

Item - 1: Random: আমি যখন শুরু করতে বলবো, তখন প্রতিটি প্রাণীর মধ্য দিয়ে দাগ টানবে। কোন ভুল না করে যত দ্রুত সম্ভব কাজটি করবে। তোমার শেষ হয়ে গেলে আমাকে বলবে। তুমি কি প্রস্তুত?

শুরু কর।

থাম।

Item - 2: Structured: আমি যখন শুরু করতে বলবো, তখন প্রতিটি প্রাণীর মধ্য দিয়ে দাগ টানবে। কোন ভুল না করে যত দ্রুত সম্ভব কাজটি করবে। তোমার শেষ হয়ে গেলে আমাকে বলবে। তুমি কি প্রস্তুত?

শুরু কর।

থাম।

Subtest-13. Information

আমি তোমাকে কিছু প্রশ্ন করতে যাচ্ছি এবং আমি চাই তুমি প্রশ্নগুলোর উত্তর দিবে।
১। তোমার পায়ের পাতা দেখাও।
Incorrecet response: এটা হল তোমার পায়ের পাতা
২। তুমি এটাকে কি বল ?
Incorrecet response: এটাকে বলে নাক।
৩। তুমি খাও এমন কয়েকটি খাবারের নাম বল।
৪। তোমার কয়টি কান আছে ?
৫। তোমার বয়স কত ?
৬। একটি কুকুরের কয়টি পা আছে ?
৭। বৃহঃস্পতিবারের পরে কি বার হয় ?
৮। দুইটি মুদ্রার নাম বল।
৯। মার্চ মাসের পরে কোন মাস আসে ?
১০। পানি ফুটাতে হলে তোমাকে কি করতে হবে ?
১১। কয়দিনে এক সপ্তাহ হয়?
১২। বছরের ৬টি ঋতুর নাম বল।
১৩। কয়টিতে এক ডজন হয় ?
১৪। পাকস্থলির কাজ কি ?
১৫। জীবাশ্ম কি ?
১৬। ক্রিষ্টোফার কলম্বাস কে ছিলেন ?
১৭। ৪ বছর পরপর কোন মাসে ১ দিন বেশি হয় ?
১৮। কতদিনে এক বছর ?
১৯। অক্সিজেন কিভাবে বাতাসে ফিরে আসে ?
২০। লোহায় মরিচা পড়ে কেন ?
২১ ।হায়ারোগ্লাফিক্স কি ?
২২ ।বিশ্বের কোন দেশে জনসংখ্যা সবচেয়ে বেশি ?
২৩। ওজোন স্তর কি ?
২৪। পাতার রং সবুজ হয় কেন ?

২৫ । গ্রীসের রাজধানীর নাম কি ?
২৬ । ব্যারো মিটার কি ?
২৭ । চার্লস ডারউইন কে ছিলেন ?
২৮ ।কনফুসিয়াস কে ছিলেন ?
২৯ । আয়নাস্ত কি ?
৩০ । হীরা কি দিয়ে তৈরী হয় ?
৩১ । লন্ডন থেকে নিউইয়র্কের মধ্যে দূরত্ব কত ?
৩২ । পারমানবিক বিভাজন কি ?
৩৩ । তার্পিন কি দিয়ে তৈরী হয় ?

Subtest-14. Arithmetic

এখন আমি তোমাকে কিছু সমস্যা সমাধান করতে বলবো ।
Item 1 : তোমার আঙ্গুল দিয়ে এই পাখিগুলো গুনবে । একটু জোরে শব্দ করে গুনবে যাতে আমি শুনতে পাই ।

Correcet response:চল এখন অন্য একটা চেষ্টা করি ।
Incorrecet response: এটা পুরোপুরি ঠিক নয় । আমারটা দেখ এবং মনোযোগ সহকারে শোন । এখানে ৩টি পাখি আছে । এখন চল অন্য একটি চেষ্টা করি ।

Item 2 : তোমার আঙ্গুল দিয়ে এই মুরগীর বাচ্চাগুলো গুনবে । একটু জোরে শব্দ করে গুনবে যাতে আমি শুনতে পাই ।

Correcet response: চল এখন অন্য একটা চেষ্টা করি ।

Incorrecet response: এটা পুরোপুরি ঠিক নয় । আমারটা দেখ এবং মনোযোগ সহকারে শোন । এখানে মুরগীর ৫টি ছানা আছে । চল এখন অন্য একটা চেষ্টা করি ।

Item 3- তোমার আঙ্গুল দিয়ে এই গাছগুলি গুনবে । একটু জোরে শব্দ করে গুনবে যাতে আমি শুনতে পাই ।

Correcet response: চল এখন অন্য একটা চেষ্টা করি ।

এটা সম্পূর্নভাবে/পুরোপুরিবাবে ঠিক হয়নি ।

Incorrecet response: এটা পুরোপুরি ঠিক নয় । আমারটা দেখ এবং মনোযোগ সহকারে শোন । এখানে ১০টি গাছ আছে । চল এখন অন্য একটা চেষ্টা করি ।
Item 4-এখানে প্রজাপতি ও ঘাস ফড়িং মিলে মোট কতগুলো আছে ।
Item 5: প্রতিটি কাঠবিড়ালী যদি ১টি করে বাদাম খায় তাহলে কতগুলি বাদাম থাকবে?
Item 6. সুমনের ৫টি বই আছে । সে একটি বই হারিয়ে ফেললো । এখন তার কাছে কয়টি বই থাকলো ?
Item 7. ২টি রংপেনসিল ও ৩টি রংপেনসিল মিলে কতটি হয় ?
Item 8. আরিফের ৫টি বিস্কিট ছিল । সে সুমনকে ১টি দিল ও জাহিদকে ১টি দিল, তারকাছে আর কতটি বিস্কিট থাকলো ।
Item 9. একটি আপেলকে আমি যদি অর্ধেক করে কাটি তাহলে আমার কাছে কয়টি টুকরা থাকবে ?
Item 10. রতনের ৪ পয়সা ছিল এবং তার মা তাকে আরো ২ পয়সা দিল । সব মিলে তার কত পয়সা হলো ।
Item 11. যদি তোমার প্রত্যেক হাতে ৩টি করে পেন্সিল থাকে তাহলে সব মিলিয়ে তোমার কতটি পেন্সিল হলো ?
Item 12. তোমার কাছে যদি ১০টি চকলেট থাকে এবং ৩টি খেয়ে ফেল তাহলে তোমার কাছে আর কতটি চকলেট থাকবে ?

Item 13. একটি জায়গায় ৩টি গাড়ী পার্ক করা হল, সেখানে আগে থেকেই আরো ১২টি গাড়ী পার্ক করা ছিল। সব মিলিয়ে কতগুলি গাড়ী হল?

Item 14. মিলির ৪টি কলম আছে এবং সে আরো ৬টি কলম কিনলো। সবগুলো মিলে তার কতগুলি কলম হলো ?

Item 15. সেলিম একটি দোকান থেকে ৪টি আপেল কিনলো এবং অন্য আরেকটি দোকান থেকে ২টি আপেল কিনলো। তার মা তাকে আরো ১০টি আপেল দিল। সবগুলো মিলে তার কতটি আপেল হল ?

Item 16. একটি মাঠে ৩টি গরু আছে। মাঠে আরো ৪টি গরু মাঠে আসলো এবং পরে ২টি গরু মাঠ থেকে চলে গেল। মাঠে আর কয়টি গরু থাকলো ?

Item 17. ফারুক সোমবারে ১০টি স্টিকার পেল এবং মঙ্গলবারে ১৫টি স্টিকার পেল। সবমিলিয়ে তার কতগুলো স্টিকার হলো ?

Item 18. কনার কাছে ১২টি বেলুন আছে এবং সে ৫টি বিক্রি করলো। তার কাছে আর কতটি বেলুন থাকলো?

Item 19. করিম মাটিতে ৮টি পাখি দেখছে। ৪টি পাখি উড়ে গেল। আবার ২টি পাখি এসে বসলো। এখন সে কতটি পাখি দেখছে?

Item 20. টুটুল একটি খেলায় ১৭ পয়েন্ট পেল এবং অন্য একটি খেলায় ১৫ পয়েন্ট পেল। সবমিলিয়ে তার কত পয়েন্ট হল ?

Item 21. একটি খেলায় ৮ ধরনের প্রতিযোগীতা ছিল। প্রতিটি প্রতিযোগীতায় যদি ৩টি করে ফিতা দেয়া হয়, তাহলে ঐ মেলাতে মোট কতগুলো ফিতা লাগবে?

Item 22. তুমি যদি ৪০ পয়সা করে ২টি কলম কিনে দোকানদারকে ১টাকা দাও, তাহলে তুমি কত ফেরত পাবে?

Item 23. একটি গানের ক্লাশে ৩০ জন ছাত্রছাত্রী ভর্তি হল। এক সপ্তাহ পর ১১ জন ছাত্র-ছাত্রী চলে গেল। তাহলে শ্রেণীতে আর কতজন থাকল ?

Item 24. সুমন ৩০ টাকা আয় করল এবং এর অর্ধেক ব্যয় করলো। প্রতিটি পত্রিকার দাম যদি ৫ টাকা। অবশিষ্ট টাকা দিয়ে সে আর কতগুলি পত্রিকা কিনতে পারবে ?

Item 25. রত্না ২ টাকা করে ৩টি কৌতুকের বই কিনলো এবং ৭ টাকা দিয়েএকটি খেলনা কিনল। সে দোকানদারকে ২০ টাকা দিলে, দোকানদার তাকে কত টাকা ফেরত দেবে ?

Item 26. একটি স্কুলের প্রতিটি শ্রেণীকক্ষে ২৫ জন করে ছাত্র-ছাত্রী আছে। যদি ঐ স্কুলে মোট ৫০০ ছাত্র-ছাত্রী থাকে তাহলে স্কুলটিতে কতগুলি শ্রেণীকক্ষ আছে ?

Item 27. সুমনের টাকা আছে, রতনের টাকার দ্বিগুন। সুমনের ১৭ টাকা আছে, তাহলে রতনের কত টাকা আছে ?

Item 28. একটি পরিবার ৩ ঘন্টা গাড়ি চালিয়ে বিশ্রামের জন্য থেমেছিল এবং পরবর্তীতে তারা আরো ২ ঘন্টা চালিয়েছিল। তারা মোট ৩০০ মাইল গাড়ী চালিয়েছিল। গড়ে তাদের গাড়ীর গতিবেগ কত ছিল ?

Item 29. বাবুল একটি নতুন সাইকেলের দুই-তৃতীয়াংশ দামে একটি পুরাতন সাইকেল কিনেছিল। সে ২০ টাকা দিয়েছিল নতুন সাইকেলের দাম কত হবে ?

Item 30. ভোর ৪টা থেকে সকাল ৮টার পর্যন্ত তাপমাত্রা ওঠে ১২ ডিগ্রী। আবার, সকাল ৮টা থেকে বেলা ১১টার পর্যন্ত তাপমাত্রা ওঠে ৯ ডিগ্রী। প্রতি ঘন্টায় তাপমাত্রা গড়ে কত ডিগ্রী ওঠে ?

Item 31. একটি খেলনা সাধারনত ৪০ টাকায় বিক্রি করা হয়। বিক্রয়ের সময় ১৫% মূল্যহ্রাস করা হলে খেলাটির বিক্রয় মূল্য কত হবে ?

Item 32. ৬ জন লোক ৪ দিনে ৪০টি গাড়ী পরিষ্কার করতে পারে। তাহলে একদিনের অর্ধেক সময়ে ৪০টি গাড়ী পরিষ্কার করতে কতজন লোক লাগবে ?

Item 33. শাওন প্লেনে করে বাড়ি ফিরছে, তার যাত্রার সময় ২ ঘন্টা। রাজিব এয়ারপোর্ট থেকে ১৫০ মাইল দূরে থাকে। যদি শাওনের প্লেন ৩ টায় ছাড়ে এবং রাজিব যদি ৬০ মাইল বেগে গাড়ি চালিয়ে আধাঘন্টা আগে এয়ারপোর্টে পৌঁছতে চায়, তাহলে রাজিবের কয়টায় রওনা করতে হবে?

Item 34. রহিম করিমের চেয়ে একঘন্টা আগে অফিস থেকে বাড়ির উদ্দেশ্যে রওনা হল। যদি রহিম ৪০ মাইল বেগে এবং করিম ৬০ মাইল বেগে একই দিকে গাড়ি চালায়, তাহলে রহিমের যাত্রা শুরুর ৫ ঘন্টা পর, করিম তার থেকে কতমাইল সামনে থাকবে?

Subtest-15. Word Reasoning

Sample A : চল আমরা অনুমান ভিত্তিক একটি খেলা করি। বলতো আমি কি ভাবছি- এটা একটা প্রাণী যা কিনা ঘেউ ঘেউ করে। বলতো এটি কি ?

Correcet response: ঠিক বলেছো। কুকুর এমন একটি প্রাণী যা ঘেউ ঘেউ করে। এখন অন্য একটা চেষ্টা কর।

Incorrecet response: এটা হল কুকুর। কুকুর এমন একটি প্রাণী যা ঘেউ ঘেউ করে। এখন অন্য একটি চেষ্টা কর।

Sample B : Mop

I. এটার একটা লম্বা হ্যান্ডেল/হাতল আছে- বলতো এটা কি ?

Correcet response: ঠিক বলেছ। ন্যাকড়া ঝাড়ুর লম্বা হ্যান্ডেল আছে। এখন অন্য একটা চেষ্টা কর।

II. এটির একটা লম্বা হ্যান্ডেল/হাতল আছে এবং এটা পানি দিয়ে ঘর/ফ্লোর পরিষ্কার করার কাজে ব্যবহৃত হয়। বলতো এটা কি ?

Correcet response: ঠিক বলেছ। নেকড়ার ঝাড়ুর একটি লম্বা হ্যান্ডেল বা হাতল আছে এবং পানি দিয়ে ঘর/ফ্লোর পরিস্কার করার কাজে এটি ব্যবহৃত হয়। এখন চল অন্য একটি চেষ্টা করি।

Incorrecet response: এটা একটা ন্যাকড়ার ঝাড়ু। ন্যাকড়ার ঝাড়ুর লম্বা হাতল/হ্যান্ডেল আছে এবং পানি দিয়ে ঘর/ফ্লোর পরিস্কার করার কাজে এটি ব্যবহৃত হয়। চল অন্য একটি চেষ্টা করি।

Item 1: এটা এমন একটা জিনিস যা তুমি গোসলের পর শরীর শুকানোর জন্য ব্যবহার কর।

Item 2. এটা এমন একটা জিনিস যার একটি গোল হাতল আছে এবং মানুষ এটিকে খুলতে পারে এবং তারপর এর ভেতর দিয়ে যেতে পারে।

Item 3. এটা তোমার মুখমন্ডলের একটি অংশ যা দিয়ে কোন কিছুর ঘ্রান নাও।

Item 4. এটা একটা প্রানী যার একটি লম্বা শুঁড় আছে এবং বড় বড় কান আছে।

Item 5. এটি এমন একটি জিনিষ যা তুমি মাথা ঢাকার জন্য পর।

Item 6. এটি একটি ঘর যেখানে মানুষ ঘুমায়।

Item 7.I. এটা বৃষ্টির পর মাটিতে থাকে।

II. এবং এটা তোমার কাপড়কে নোংরা করতে পারে।

Item 8.I. এটা অনেক রংয়ের হয়।

II. এবং এটা দেয়ালে ব্যবহার করা হয়।

Item 9.I. এটা শিক্ষনের/শেখার জায়গা।

II. এবং অতীতের অনেক জিনিস এর মধ্যে থাকতে পারে।

Item 10.I. এটা আকাশে থাকে ।

II. এবং তুমি এগুলো শুধুমাত্র রাতের বেলায় দেখতে পাও ।

Item 11.I. এটা এমন একটা কাজ যা মানুষ কোন কিছুকে নতুনের মত করার জন্য করে ।

II. এবং ভেঙ্গে গেছে এমন জিনিসের জন্য মানুষ এটা করে ।

Item 12.I. এটা খাবারকে সুস্বাদু করে

II. এবং এটা সমুদ্রে পাওয়া যায় ।

Item 13.I. এটা প্রকৃতিতে দেখা যায় ।

II. এবং এর মধ্য দিয়ে পানি প্রবাহিত হয় ।

Item14.I. এগুলো চামড়া ও হাড় দিয়ে সুরক্ষিত থাকে ।

II. এবং এগুলো মাঝে মাঝে বদলানো যায় ।

Item 15.I. এটা ভাঙ্গা যেতে পারে

II. এবং এটা মানুষকে সুরক্ষা দেয়ার জন্য লেখা হয় ।

Item 16.I. এটা নতুন কিছু আবিস্কার করে

II. এবং এটি ধাপে ধাপে করা হয় ।

III. এবং এটা পরীক্ষণের সাহায্যে করা হয় ।

Item 17.I. এটা মানুষকে কোন কিছু করতে বা পেতে দেয় ।

II. এবং এটা সরকার দেয় ।

III. এবং এটা পাওয়ার জন্য মানুষকে পরীক্ষা দিতে হতে পারে ।

Item 18.I. এটা এমন একটি জিনিস যা বেশির ভাগ লোকই চায় ।

II.এবং এটা দ্বন্দ্ব প্রতিরোধ করে

III. এবং সরকার এটাকে ধরে রাখতে চেষ্টা করে ।

Item 19.I. এটা এমন কিছু যা প্রত্যেকেরই আছে ।

II. এবং এটা প্রতিবছর পরিবর্তন হয় ।

III. এবং এটা কখনোই কমে না ।

Item 20.I. এটাকে ছোঁয়া যায় না ।

II. এবং এটা পেছনে যেতে পারে না ।

III. এবং এটাকে থামানো যায় না ।

Item 21.I. এটা একটি জায়গা ।

II. এবং এটা আবহাওয়া থেকে রক্ষা করে

III. এবং এটা কোনকিছুর ভিতরে থাকে ।

Item 22.I. এটা একটি নদী হতে পারে।

II. এবং যুদ্ধ এটাকে পরিবর্তন করতে পারে।

III. এবং দুইটি দেশ এটা ভাগাভাগি করে।

Item 23.I. এটা মানুষের দ্বারা তৈরি।

II. এবং এটাকে ছোঁয়া যায় না।

III. এবং এটা ইতিমধ্যেই ঘটে গেছে।

Item 24.I. এটা আগে কখনো দেখা যায়নি বা করা হয়নি।

II. এবং এটা আমাদের জীবনকে উন্নত বা সহজতর করতে পারে।

III. এবং এটা মন দিয়ে সৃষ্টি।