CHAPTER III

REVIEW OF RELATED LITERATURE

3.1 STUDIES RELATED TO LEARNING DISABILITY

3.2 STUDIES RELATED TO DYSCALCULIA

3.3 STUDIES RELATED TO MATHEMATICAL CREATIVITY

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REVIEW OF RELATED LITERATURE

The study of the related literature implies locating, reading and evaluating reports of research as well as reports of casual observations and opinions that are related to the individual’s planned research project (Aggarwal, 1994). A systematic canvas of related literature is the means of determining whether the proposed study unnecessarily duplicate earlier investigations (Good, 1972).

Review of related literature develops in the investigator an insight which he needs to convert his tentative research problem to a specific and concise one. It helps to know the research possibilities that have been overlooked. It provides the researcher, with an opportunity for understanding the methods, measures, subjects and approaches employed by other research workers. This in turn will lead to significant improvement of his research design.

The literature and studies reviewed are arranged under the following heads.

3.1 Studies related to Learning Disability

3.2 Studies related to Dyscalculia

3.3 Studies related to Mathematical Creativity
3.4 Studies related to Ability for Fundamental Mathematical Operations

The related literature examined under each heading is given below.

3.1 STUDIES RELATED TO LEARNING DISABILITY

Ruth (2009) examined the differential efficacy of verbal self-instructional training on reflective and impulsive reading disabled tribal and non-tribal children. Results showed that verbal self-instructional training has been very effective for non-tribal children and those having reflective cognitive style failed to yield desirable results for the tribal and impulsive children.

Mehta (2006) conducted a study based on the awareness level of teachers about learning disability. The study has revealed that there is a significant difference in the awareness level of learning disabilities in students among teachers of different boards. Amongst them ICSE board teachers are more aware about learning disabilities as compared to the CBSE and SSC board.

Carlson (2005) reported that there is a vast difference between learning difficulty and learning disability; an individual with learning difficulty can learn using conventional teaching techniques while an individual with learning disability requires specialized interventions which depend on the type of disability. Learning disability can result from injury; it can be hereditary and it can come in many forms.
Saracoglu, Minden, & Wilchery (2000) found that a sample of 34 university students with learning disability reported significantly poorer self esteem, academic achievement and personal emotional achievement than a sample of 31 non-learning disabled students.

Heberling and Shaffer (1995) in their study examined the effects of school attendance on the grade point average (GPA) of 70 regular education and 17 learning disabled fifth-graders in a rural school district. It was found that school attendance had a significant positive influence on the regular education and learning disabled students GPA’s indicating that absenteeism directly affects the amount of learning at the elementary school level. The study also found that specific learning disabled students’ GPAs were significantly lower than the GPAs of regular education students. No significant difference was found in the rate of absence between specific learning disabled students and regular education students.

Olenchak (1995) in his study on effects of enrichment on gifted/learning-disabled students examined the effects of a highly structured personally tailored enrichment programme for 108 students in grade 4 through 6 who were gifted and learning disabled. Results indicate that year-long participation in programme had significant positive impact on attitude towards school, self-concept and creative production.
Bramlett (1994) conducted a comparative study on non-referred, learning disabled and mildly mentally retarded students using the Social Skills Rating System (SSRS). The study found that the students with disabilities scored significantly lower than non-referred group on social skills and significantly higher in problem behaviours.

Eshel (1994) made an attempt to find out the effects of mainstreamed or self-contained classes for students with a mild learning disability. The study compared a total of 108 elementary or high school students with mild learning disabilities placed in either self-contained or regular classes. The study found no evidence that student growth was greater in self-contained class, although these students tend to have a higher academic self-concept.

Nelson (1994) tried to find out whether the children classified as learning disabled understand the criteria dimension of different types of uncontested and contested knowledge or not. Students clearly distinguished between uncontested and contested knowledge, suggesting that they are capable of working with curriculum containing complex, controversial, intellectual and social knowledge.

Wilson and David (1994) evaluated the academic intrinsic motivation and attitudes towards schools and learning of learning disabled students. The study revealed that subjects perceived the school environment and academic tasks as two separate factors. Learning
disabled students, compared to non-disabled students, exhibited more positive attitudes towards the school environment than for academic learning tasks. School attitudes improved as grade level increased.

Berk and Landau (1993) in their study on private speech of learning disabled and normally achieving children in classroom and laboratory contexts found that learning-disabled children used more task relevant private speech than normally achieving classmates during academic seat work. This was more profound for those learning disabled children with attention deficit hyperactivity disorder.

Cancelli (1993) observed relationships between classroom behaviours and achievement among learning disabled students involved in Teacher-Directed Instruction (TDI) and independent seat work. Results found a stronger relationship between academic-type classroom behaviours and achievement during TDI. Different types of classroom behaviours are related to achievement for each type of instruction.

Carlisle and Andrews (1993) in their study tried to find out how mainstreamed learning disabled students cope up with their science classes. This study found that mainstreamed fourth and sixth grade students with learning disabilities had significant weaknesses on a science curriculum based assessment relative to non-disabled peers and they rated themselves and were rated by their teachers more negatively.
Scott (1993) in her study tried to identify the rhyming skills differentiating among mildly mentally retarded, learning disabled and normally achieving students. This study among children between ages 6-8 found that the rhyming ability of normally achieving students and students with learning disabilities was much higher than that of students with mild mental retardation. Most of the learning disability children could generate rhymes while most of the mildly mentally retarded students could not generate rhymes.

Swanson (1993) made an attempt to study individual differences in working memory of learning disabled children and skilled readers. Results suggests that learning disabled children’s working memory problems are functionally related to higher order processes and not memory alone.

Coleman (1992) compared the similarities in the social competencies of learning disabled and low achieving elementary school children. Eighty-five children with learning disabilities in grades 3-6 were compared to match low achieving peers. Results indicated that the two groups were comparable on most of the social competence measures, although learning disabled children reported themselves less lonely than low achieving children, and regular class children rated that learning disabled children were more likable than low achieving children.
Lorsbach and Frymier (1992) made a comparison of learning disabled and non-disabled students on five at-risk factors, viz. personal pain, family socio-economic status, family instability, family tragedy and academic risk. This study compared 1,356 students with learning disabilities and 17,431 non-disabled students in grades 4, 7 and 10 on risk factors and number of school interventions. The study found that learning-disabled children were significantly more at risk on personal pain, family socio-economic status, family instability, family tragedy and academic risk.

Nelson (1992) tried to assess the effect of teaching a summary skill strategy to students identified as Learning Disabled in their comprehension of science text. Effects of a summary skill learning strategy on the comprehension of science text was examined into five elementary age urban minority students with LD participating in a summer remedial programme. The strategy produced clear improvement in comprehension which was associated with similar improvement in the competencies of the written summaries.

Scott and Greenfield (1992) conducted a comparative study of normally achieving, learning disabled and mildly retarded students on a taxonomic information task. The sample consists of 100 students in the age group of 6-8. Large performance differences were found between mildly retarded and learning-disabled groups while small performance
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differences were found between normally achieving and learning-disabled students.

Vallies (1992) compared the oral and written testing of primary aged mainstreamed learning disabled students. The study compared the performance of four mainstreamed learning disabled students on oral and written tests in social studies. The study found superior test performance during oral testing.

In a study to measure the writing language abilities of learning disabled and nondisabled children, Watkinson and Lee (1992) examined the differences in written expression between learning disabled and non-disabled middle school students. All the learning-disabled students had been identified as having written language deficits. Non-disabled students showed superior written expression skills, especially on production-independent measures.

Ferre and Ferre (1991) evaluated the effects of individualized social skills training sessions with rural elementary learning disabled students. Students with poor interpersonal skills and low-esteem participated in weekly individual social skills training. After five weeks, all students showed improvements in peer acceptance and social and general self-esteem and two to three students showed improvement in attention and academic self-esteem.
John and Rattan (1991) conducted a study on Short Term Memory (STM) tests as predictors of reading achievement of learning disabled and educable mentally retarded students. They examined nine measures of short-term memory used by school psychologists with a group of learning disabled and educable mentally retarded special education students. Results indicated that not all STM tasks were significant predictors of reading. Sentence memory task was predictor for learning disabled students whereas letter sequence task was best predictor of reading for educable students.

Knee (1991) analysed the memory of specific learning disabled readers. A group of 73 normal children (ages 8 to 10) was compared to 49 age-matched developmentally dyslexic children of average intelligence to determine if reading disability was associated with impaired verbal memory. Dyslexics differed significantly from the control group on 9 of the 12 memory measures, with a 78 percent rate of overall correct classification. Results indicated that learning disabled readers and normal children had the same rate of verbal learning, forgetting and memory development and were equally able to utilize semantic categorization.

Graham (1990) explored the role of production factors in learning disabled students’ compositions. The sample of the study consisted of 24 learning disabled fourth and sixth grade students. Results of the study
indicate that learning disabled students’ writing problems are partly a result of difficulties with mechanics and sustaining production.

Courson (1989) compared the effectiveness of short and long form of guided notes on social studies performance by seventh grade learning disabled and at risk students. The results revealed high scores for both the groups.

Peterson (1989) evaluated the generally recommended concrete to abstract hierarchy for presenting new skills with three learning disabled children in grade 1, 2, and 4. Following collection of baseline data, place value concepts and skills were taught using a concrete, semi-concrete and abstract teaching sequence in a direct instruction model. Post-test results indicated significant gains by all three subjects, with retention demonstrated three weeks later in a different classroom setting. Findings showed that for all three students, the transition to abstract understanding occurred suddenly and conclusively but at varying points within the concrete to abstract sequence.

Ryan (1989) made a comparative study of 16 learning disabled and 16 non disabled children of eighth grade of similar intelligence. He compared the achievement levels, skill mastery rates, learning strategies and attitudes of these children. The course was individualized so that each subject had access to a set of materials. The results indicated that the learning disabled with reading disability could master computer
literacy skills in the regular classroom environment if they were given the opportunity to ask questions to teachers and peers.

Grevenow (1988) in his study presented teaching techniques for use of elementary learning disabled students which utilize right brain. It also describes a 15-week classroom project utilizing selected techniques with 11 learning disabled children in grades 2 to 6. It was concluded that the techniques definitely improved the academic growth, attitudes and classroom behaviors of the children.

Bhattacharya (1985) tried out a technological approach for alleviation of learning disabilities of the students in life science. Results of the study indicated that learning through audio-visual materials and techniques caused prolonged retention than by traditional methods.

3.2 STUDIES RELATED TO DYSCALCULIA

Burny and Desoete (2012) have shown that children with Mathematics difficulties (MD) have weaknesses in multiple areas of Mathematics. The study builds on this recent finding and aims at a more profound understanding of the difficulties that children with MD experience with telling time. This finding is in line with Geary's theory of subtypes in MD, which argues that children with MD have problems with mathematical procedures and semantic memory retrieval.

Compton (2012) examined the cognitive and academic profiles associated with Learning disability (LD) in reading comprehension, word
reading, applied problems and calculations. Results supported the hypothesis that unexpected under achievement is associated with LD.

Inglis and Swain (2012) explored the views of men with learning difficulties living in a secure environment. The findings suggest that the men are very positive about their lives reporting that they have many attributes and talents and views that having a learning difficulty as an advantage at times.

Schieve (2012) found that children in all developmental disabled groups also had significantly higher estimates for health care use, impact, and unmet needs than children without disability. This study provides empirical evidence that children with disability require increased pediatric and specialist services, both for their core functional deficits and concurrent medical conditions.

Shamir and Baruch (2012) found that mathematical learning difficulties can originate at an early age. The findings revealed that following the e-book intervention, children in the experimental e-book group improved both their vocabulary and early Mathematics skills as compared to the control group who engaged in their regular pre-school activities.

Mazzocco, Feigenson & Halberda (2011) reported that many children have significant mathematical learning disabilities (MLD, or Dyscalculia) despite adequate schooling. In this study, he reported that
students with MLD have significantly poorer Approximate Number System (ANS) precision than students in all other Mathematics achievement groups.

Christophe, Mejias & Noel (2010) conducted a study and found that Developmental Dyscalculia (DD) is a pervasive difficulty affecting number processing and arithmetic. It is encountered in around 6% of school-aged children. DD children showed a greater numerical distance effect than control children, irrespective of the number format. This favours a deficit in the specialised cognitive system underlying the processing of number magnitude in children with DD.

Lovett & Sparks (2010) found that increasing numbers of students are being diagnosed as simultaneously gifted and having a Learning Disability, although the identification procedures and characteristics of these students are matters of continuing debate. In this study, post secondary students with Learning Disability diagnoses were grouped according to their IQ scores, and the groups' cognitive and achievement characteristics were explored, with special attention to the proportions of each group that would meet various objective criteria for Learning Disability diagnosis. Many students in each group failed to meet any of the criteria, although higher IQ students were more likely to meet most of the criteria. In addition, the higher IQ group exhibited higher achievement
scores than did the lower IQ group, although the achievement gaps were much smaller than the IQ differences.

Piazza et al. (2010) reported that developmental Dyscalculia is a learning disability that affects the acquisition of knowledge about numbers and arithmetic.

Camos (2008) reported a close relationship between Developmental Dyscalculia and spatial working memory.

Schuchardt (2008) showed that children with Dyscalculia have deficit in visual spatial memory.

Willburger, Fussenegger, Moll, Wood & Landerl (2008) reported that dyscalculic children exhibited a domain-specific deficit in rapid naming of quantities. This finding is in line with recent assumptions that Dyscalculia is associated with a neurobiological deficit in the processing of numerosities. He also suggested that the cognitive bases of Dyslexia and Dyscalculia are independent of each other.

On comparing students with Mathematics learning disabilities and students with low Mathematics achievement in solving word problems Hartmann (2007) showed that students with low Mathematics achievement had more computational errors but fewer translation errors when compared to students with Mathematics learning disabilities who had conceptual difficulties in the areas of analyzing, reasoning and abstract thinking.
Messenger (2007) revealed that dyscalculic population has difficulty in automatically associating numerals with magnitude but no problem in associating letters with phonemes.

Michaelson (2007) suggested that for many children, Mathematics is an inherently difficult subject to learn. Between 5 and 8 percent of children between the ages of 6 and 14 have a particular type of cognitive deficiency that limits their aptitude to acquire knowledge and understanding of fundamental ideas in numeracy.

Rosselli, Matute, Pinto, & Ardila (2006) reported a close relationship between Developmental Dyscalculia and spatial working memory.

An investigation into the learning difficulties of simple fractions of Indian school children at secondary level by Maite & Mete (2006) revealed that one third of all the mistakes in division of fractions were due to the student’s negligence to invert the divisor before the process of multiplication; one fourth of all mistakes in the division of fractions were due to the student’s lack of comprehension of the process involved.

A study by Owen (2005) conducted on the comparison of mathematical problem-solving errors between third-grade students with learning disabilities and peers without disabilities indicated that students with learning disabilities made more errors in the translation of word problems than in computation.
On assessing the familial relationship between Dyscalculia and researches on Dyscalculia and Attention-Deficit Hyperactivity Disorder (ADHD) by using structured diagnostic interviews and a cognitive test battery, Monuteaux, Farone, Herzig, Narsaria & Biederman (2005) found that ADHD and Dyscalculia are independently transmitted in families. Koumoula et al. (2004) found that prevalence of Dyscalculia is more in rural than in urban area.

Landerl, Bevan & Butterworth (2004) concluded that Dyscalculia is the result of specific disabilities in basic numerical processing, rather than the consequence of deficits in other cognitive abilities.

The study of Evans (2003) showed that students with learning disabilities were satisfied with the accommodations they received in their university-related Mathematics courses. It was reported that students with learning disabilities performed better in a class that is reserved for them than students enrolled in open sections.

Kumar (2003) on studying the effectiveness of certain instructional strategies to overcome learning disabilities in arithmetic among secondary level school children, it was found that there was significant difference in the post-test performance of learners than pre-test by using various instructional strategies.

Garderen and Montague (2002) investigated student’s use of visual imagery while solving mathematical problems. Students with learning
difficulty, average achievers and gifted students in sixth grade (N=66) participated in this study. Students were assessed on measures of mathematical problem solving and visual spatial representation. Visual spatial representation was coded as either primarily pictorial representation that encodes persons, places or things described in the problem. Results indicated that gifted students used significantly more spatial representation than the other two groups. Students with learning difficulty used significant more pictorial representation that this successful mathematical problem solving was positively correlated with use of schematic representation, conversely, negatively correlated with use of pictorial representatives.

Robinson (2002) examined about number facts performance in a sample consisting of 318 children with learning disabilities of third grade in six public schools. The findings revealed that children with both phonological processing and number sense weaknesses had greater difficulty in mastering the number facts and that students with Mathematics difficulties alone were able to use their phonological processing skills to compensate for observed weakness in number sense.

The results of the study by Myers (2001) explored the relationship between perceptions of post secondary Mathematics instructors and students with learning disabilities. The results of the study showed that students had neutral attitude towards the nature of Mathematics, were
concerned with instructor’s personalities and prefer approachable, friendly and patient instructors who involve students in class and teach through examples. Instructors were found to perceive Mathematics as a way of thinking that involves logic, procedures and models. Some had negative stereotypes with learning disabilities while others describe them as conscientious and intelligent.

Rotzer et al. (2000) compared brain activity associated with spatial working memory processes in 8-10 year old children with Developmental Dyscalculia (DD) and normally achieving controls. Both groups showed significant spatial working memory related activity in a network including occipital and parietal regions. Children with DD showed weaker neural activation compared to the control group during a spatial working memory task in the right intraparietal sulcus (IPS), the right insula and the right inferior frontal lobe. These poor spatial working memory processes may inhibit the formation of spatial number representations as well as the storage and retrieval of arithmetical facts.

McLean and Hitch (1999) reported a close relationship between developmental dyscalculia and spatial working memory.

Belmarez (1998) on doing a research on the relationship between co-teaching and the Mathematics achievement of groups of students with and without learning disabilities found that: (1) students with learning disabilities do not achieve greater academic gains by receiving
Mathematics instruction in a co-taught classroom rather than in a resource classroom; (2) students with learning disabilities in the co-taught classroom attained significantly higher standardized test scores; (3) with the exception of the case significantly higher standardized test scores, the co-taught classroom in this study was not conducive to greater Mathematics achievement for students with learning disabilities and (4) no significant difference existed in Mathematics achievement for co-taught, experimental groups of students without learning disabilities when compared to that of the control groups who received Mathematics instruction in the general classrooms.

Lee-Sachse (1998) had done an investigation on the relationship between working memory and mathematical problem solving in children with and without learning disabilities. Significant correlations were obtained between problem solution accuracy and working memory in children without learning disability but not in children with learning disability.

Ostad (1997) investigated the character and extent of difference between the mathematically disabled pupil and mathematically normal pupil as reflected in the use of strategies for solving elementary addition problems as the pupil move up through primary school. Compared with the mathematically normal group, the mathematically disabled group exhibited divergent pattern of development.
Drueck (1997) on examining second-grade Average-Mathematics achievers and Low-Mathematics achievers who were at-risk for Mathematics learning disabilities on factors related to conceptual understanding and solution procedures for two-digit addition and subtraction found that Average-Mathematics learners and Low-Mathematics achievers did not differ on the accuracy of their computations but rather on their use of conceptual structure and representational methods. It was also found that the Low-Mathematics achievers used the more immature unitary conception for a longer period of time than did the Average-Mathematics learners. It was also found that the Low-Mathematics achievers used the less sophisticated concrete representational methods in solution procedures more frequently than the more advanced methods of mental strategies and standard written algorithms used by the Average-Mathematics learners. The Low-Mathematics achievers were also found to have decreased automaticity for labeling numerical information, poorer basic fact retrieval and lower performance on a composite of memory tasks.

White (1997) analysed the effects of cognitive learning strategy interventions with learning disabled students in the topical areas of Reading and Mathematics. The results showed that the interventions were effective with the learning disabled students. It was found that the interventions were most successful in the elementary and junior high
grade levels in Reading while interventions were most successful at the junior and senior high levels in Mathematics.

Toppel (1996) investigated on the effects of a labeling plus diagramming strategy and a labeling only strategy on the mathematical word problem solving ability of learning disabled community college students and their attitude towards their mathematical ability. The results of the study showed that only six students of the labeling plus diagrammatic group did not improve in their ability to solve mathematical relational word problems: however these learning disabled students labeled the numerical values in the relational word problems as compared to only two out of the seven learning disabled students in the labeling group. It was also found that the attitude towards mathematical ability of the learning disabled students in labeling plus diagramming strategy instruction group improved.

Evans and Goodman (1995) analysed the factors behind children's learning difficulties in Mathematics from three kinds of characteristics: characteristics of the child, of the teacher/teaching method and of the subject and they suggested that perceived under achievement comes mainly from poor self-image, learning style, poor language skills, dyslexic-type difficulties, lack of Mathematics experiences at home, different cultural backgrounds, gender differences and Dyscalculia.
Reysa (1995) investigated on the Mathematics computation performance associated with Attention Deficit Hyperactive Disorder (ADHD) and Learning Disability (LD) with a sample comprising of four groups of boys which included 17 boys diagnosed with ADHD, 11 boys diagnosed with Mathematics learning disability, 16 boys with both ADHD and Mathematics learning disability diagnosis, and 15 normal comparison (NC) boys. It was found that there were significant differences among the groups on several error types. LD boys made significantly more number fact errors and total errors than ADHD and NC boys. Additionally, ADHD and ADHD/LD boys made significantly more mistakes than NC boys.

Kavale (1994) claimed that students with learning disability have rather differential learning characteristics from low achievers so that they can be clearly differentiated. Understanding learner characteristics of learning disabled children also can be helpful in that the implications from the literature are conducive to develop intervention programme for low achievers in Mathematics class.

Pollock & Waller (1994) reported that children who have difficulty in literacy skills also have trouble with Mathematics. Research studies also showed that rapid retrieval of abstract knowledge from long term memory is also likely to be shared both by literacy and arithmetic
learning. It has been estimated that 40 percent of dyslexic children can also have trouble with learning Mathematics.

Shafrir (1994) in his survey found that 331 adolescents and adults with learning disabilities could be grouped into three types namely arithmetic disability, reading disability and arithmetic and reading disability. Findings showed that each group differed significantly from others on testing of reading, spelling, memory and other cognitive measures.

Geary (1992) examined the relationship between counting knowledge and computational skills of 13 mathematically disabled first graders who showed a delay in acquiring mathematical skills and 24 non-disabled ones. Results showed mathematically disabled children’s immature counting knowledge and poor computational skills.

Lee (1992) investigated the effectiveness of a novel teaching method for helping learning disabled students to solve one step Mathematics word problem. The results revealed significantly better scores in the skill of choosing correct operation in subtraction and addition word problems.

Maree (1992) in her work identified problems in Mathematics and she also discussed examples that may lead to a better understanding of Mathematics problems. She reported the importance of holistic approach towards problems in Mathematics.
Geary (1991) did a longitudinal assessment of skill development in addition to 26 normal and 12 mathematically disabled children studying in first or second grade. The study suggests that a primary factor contributing to an early learning problem in Mathematics is difficulty in the retrieval of basic information from long term memory. Mathematically disabled children appear to have relatively poor working memory, which may lead to frequent computational errors.

Vasanthi (1991) explored the incidence and content of certain mathematical learning disabilities in relation to certain psychological, social and educational factors. It was found that the mathematical disabilities were greatest among pupils in government schools affiliated to the State Board, less among pupils in Matriculation schools and least among pupils affiliated to the Central Board of Secondary Education and that these disabilities had a significant negative relation to intelligence and socio-economic status and a positive relationship to behavior problems.

Ramaa (1990) while analyzing the neuropsychological processes and the arithmetic errors committed by the students in primary schools, it was found that majority of the dyscalculics experienced difficulty in reading and writing more than two digits, in sequential reproduction, seriation of numbers and also in solving problems involving spatial and numerical relations.
Wisniewski (1990) conducted a study to assess the patterns of errors between students with learning disability and those of their non-disabled peers. The findings indicated that students with learning disability had greater difficulty in acquiring the concept of regrouping than their non-disabled peers. They were also observed to make a different pattern of errors.

Friedman (1989) conducted a study on reading and arithmetic achievement scores of learning disabled students to develop information about subtypes of learning disabilities. This study identifies subtypes of disabled learners who are relatively weak in Mathematics but strong in reading, subtypes who are weak in reading but strong in Mathematics and subtypes who demonstrate deficits in both reading and Mathematics. Several groups of disabled learners were identified who were relatively strong in academic skills requiring comprehension and weak in rote application of skills. Only two groups were identified who were relatively strong in academic rote skills, but weak in comprehension.

Siegal and Ryan (1989) observed that specific arithmetic learning disability is associated with low capacity in a type of working memory that is specialized for arithmetical operations.

Taylor (1989) in an investigation of associations between learning-disabled children's ability to repeat pseudo words and their performances on other measures of phonological processing and academic achievement
found that repetition ability was more closely related to reading and spelling skills than to Mathematics achievement, while measures of phonological skills were moderately associated with each other.

Rastogi (1983) reported that the important causes of backwardness in Mathematics were the poor command over basic mathematical skills. When basic arithmetic skills are improved, the attitude towards Mathematics became favourable and so the achievement increased. He also reported that there is no significant difference in achievement and attitude based on gender.

Bhattacharya (1982) conducted a study on diagnosing and preventing learning disabilities of primary school students in Arithmetic. He found that learning through audio-visual methods caused prolonged retention than traditional methods.

Singh (1981) conducted a study on the effects of peer tutoring in Mathematics skills of learning disabled students. Results indicated that peer tutored group of learning disabled students made significant gains in both Mathematics computation and Mathematics concepts than non-peer tutored students.

Tishler (1981) conducted a study on the factors of cognitive development in two groups of seventh-grade students evidencing dyscalculia with a sample of thirty students in each of the two groups—the dyscalculic and the control groups. It was found that students evidencing
dyscalculia were different from their mathematically achieving counterparts on two factors of cognitive style namely field dependence and independence, and spatial visualization.

Weinstein (1980) suggested that many children who have difficulty with arithmetic suffer from neurological developmental lag rather than an underlying deficit. Such people appear to favor the right hemisphere, which serves the spatial functions rather than the left analytic half of the brain.

Bhattacharya (1977a) reported that students develop more learning disabilities in the application of linear equation sums. The simplified method is more effective than the method of transposition.

Bhattacharya (1977b) conducted a study to diagnose the detailed patterns of disabilities in students in specific areas of Algebra and to try out the teaching methods which would prevent development of learning disabilities in Algebra. The preventive measure included teaching through audio-visual methods. Results revealed that teaching through audio-visual methods was effective and it helped in increased retention and motivation.

Koppitz (1968) reported that 88% of the children referred to learning disability programme in her study were one to three years below the expected grade level in arithmetic computation. The focus is largely
on reading and writing and less attention is given to quantitative aspect of thinking.

### 3.3 STUDIES RELATED TO MATHEMATICAL CREATIVITY

Bahar and Maker (2011) investigated whether the students’ score in Mathematics was correlated with students’ score in the Iowa Tests of Basic Skills (ITBS) and the Comprehensive Tests of Basic Skills (CTBS). ITBS included measures of problem solving, data interpretation, Mathematics concepts, estimation and computation. The CTBS was used as a measure of mathematical achievement in mathematical concepts, estimation and computation. They concluded that there was a strong, significant correlation of originality, fluency, flexibility, elaboration and total mathematical creativity with mathematical achievement in both ITBS and CTBS tests.

Baran, Erdogan, & Cakmak (2011) investigated the relationship between creativity and mathematical ability of 6 year old students. In this study, data for creative ability were collected using a general creativity instrument (Torrance Tests of Creative Thinking) whereas data for mathematical ability were gathered using a mathematical test, measuring aspects of informal (e.g. fewer/more, counting) and formal Mathematics (e.g. numbers, calculations). Results revealed that there was no statistically significant relationship between mathematical ability and
creativity or even between mathematical ability and creativity indicators (such as fluency, originality and elaboration).

Alam (2009) conducted a study on academic achievement in relation with creativity and achievement motivation. The study aims to find out the extent of relationship between creativity and achievement motivation of the students and academic achievement. The findings revealed a significant positive correlation between (i) creativity and academic achievement (ii) achievement motivation and achievement.

Reddy (2008) conducted a study on creativity of student teachers of colleges of teacher education. The result of the study says that male and female student teachers do not differ significantly with respect to creativity.

Leikin (2007) stressed that mathematical creativity is a prerequisite for the development of mathematical ability.

Sak and Maker (2006)) in their first study, a mathematical test was used to measure mathematical knowledge and divergent production ability (originality, flexibility, elaboration, fluency). Data analysis revealed that knowledge had a statistically significant contribution in explaining variance in originality, flexibility and elaboration in fourth and fifth graders.

Sriraman (2005) conducted a study to investigate how mathematicians create Mathematics. The results indicate that, in general,
the mathematicians' creative processes followed the four-stage Gestalt model of preparation-incubation-illumination-verification. It was found that social interaction, imagery, heuristics, intuition and proof were the common characteristics of mathematical creativity.

Hong and Aqui (2004) have suggested that content knowledge is a crucial factor for mathematical creativity. The results revealed that creative students in Mathematics were more cognitively resourceful than their peers who achieved high grades in school Mathematics.

Nakakoji, Yamamoto & Ohira (1999) have suggested that mathematical knowledge is vital for the development of mathematical creativity

Haylock (1997) found that students with similar degree of mathematical achievement have significant differences in mathematical creativity and mathematical ability. This result implies that several factors differentiate mathematical creativity from mathematical ability in general.

Silver (1997) emphasized that “mathematical creativity is closely related to deep, flexible knowledge in content domains”.

George (1994) conducted a study on a sample of 8000 secondary school students and found that the relationship between Mathematics creativity and Mathematics achievement is positive and significant.
Starko (1994) have suggested that mathematical creativity is important for the development of mathematical ability. According to him students who use the content creatively learn the content well.

Hermelin and O’connor (1986) conducted a study on comparison of mathematically and artistically gifted children and two IQ matched subgroups for their ability to carry out several types of visual-spatial tasks. It was found that mathematically gifted children were better than all the other groups in solving problems and mathematically gifted were superior to IQ matched control group in visual cognitive memory.

Haylock (1984) reported that children may show a fixation in Mathematics and the fixation may provide some self restriction that may cause them to fail to solve problems. He suggested that mathematical attainment limits the pupil’s creativity but does not determine it. Low attaining pupil who do not have sufficient mathematical knowledge and skills demonstrate creative thinking. In highest attaining group there is significant number of pupils who show very low level of these kinds of creative thinking in Mathematics.

Joshi (1981) observed that in urban areas high achievers are also high creative. In rural area there was no such relationship.

Tuli (1980) reported that mathematical creativity is significantly related to aptitude for achievement in Mathematics.
Jensen (1973) studied the relationships between mathematical creativity, numerical aptitude and mathematical achievement in relation to computation and problem solving. He found moderately high correlation among the constructs and recommended that the possibility of mathematical creativity as a supplementary evidence of a student’s Mathematics performance.

3.4 STUDIES RELATED TO ABILITY FOR FUNDAMENTAL MATHEMATICAL OPERATIONS

Louis and Mistele (2012) showed that there is significant difference in the achievement scores of males and females by subject, where females score higher in Algebra, but males score higher in other Mathematics subjects.

Sasanguie, Van & Reynvoet (2012) studied the performance on basic number processing tasks, such as number priming, number comparison and number line estimation. These tasks assess the innate "number sense," which is assumed to be the breeding ground for later Mathematics development. In this study, they examined the association between the performance of children on several basic number processing tasks and their individual mathematics achievement scores. Regression analysis showed that most of the variance in children's Mathematics achievement was predicted by non-symbolic number line estimation.
performance (i.e. estimating large quantities of dots) and to a lesser extent, the speed of comparing symbolic numbers.

Zhu, Leung & Koon (2012) showed that while the time spent on daily Mathematics homework had significantly positive effect on students' results, no effect was observed on the frequency of homework assigned. Out of three types of homework, only homework of the problem/question type demonstrated significant effect.

Duan, Depaepe & Verschaffel (2011) suggested that infants are able to recognize basic arithmetic operations across sensory modalities.

Schoppek and Tulis (2010) reported that fluency of basic arithmetic operation is a pre-condition for mathematical problem solving. The authors proposed individualization of practice as a means to improve the efficiency in arithmetic skills.

Klein, Starkey, Florio & Brown (2009) found that students from low-income and minority backgrounds demonstrate lower levels of Mathematics achievement than their peers from more advantaged backgrounds, and there is compelling evidence that this SES-related achievement gap in Mathematics emerges prior to school entry. They also suggest that children's Mathematics knowledge in kindergarten is the strongest predictor of their later school achievement--stronger than early literacy knowledge, attention skills or socio-emotional development.
The study by Ysseldyke & Algozinne (2006) investigated alternative explanations for differences in Mathematics achievement between pairs of handicapped students exhibiting comparable amounts of academic engaged time. Explanations investigated were student demographics, cognitive functioning, home and family factors, teacher stress, student cognitions (including cognitive style), student motivation, behavior, and conditions in the learning environment. Of all factors investigated, only cognitive ability served as a consistent explanation for differences in Mathematics achievement for students matched on academic engaged time.

Mathew (1998) who examined the factors affecting errors in arithmetic computation found that boys commit more errors than girls.

Mathew (1994) conducted a study on the computational ability of pupils in Std.III which indicated that there was no significant difference in the computational ability of boys and girls but the students from high SES have high computational skill than students from low SES. Another important result of the study indicates that students from urban area have more computational ability than students from rural area.

A study conducted by Ambily (1993) revealed that there was no significant difference between the computational skill test scores of boys and girls and that of urban and rural area students.
George (1992) examined the computational skills of primary school students and found that girls were superior to boys in their computational skills.

Marshal (1984) examined gender difference in Mathematics achievement. The sample for the study consisted of 30000 sixth grade children in California. It was found that the girls were more likely than boys to solve computation problems successfully whereas boys were more likely than girls to solve story problems.

Rastogi (1983) conducted a study to diagnose the difficulties in basic arithmetic skill and prepared remedial materials. The major conclusion is that one of the most important reason for backwardness is poor arithmetic skills.

Thomas (1981) revealed that urban students were superior to rural students in their numerical ability.

Thakur (1979) conducted a diagnostic test and prepared remedial materials on fractions and decimal fractions for students of Std. V. The major finding was that the students did not understand arithmetic operations of fractions.

Gupta (1972) conducted a study on backwardness in Mathematics and basic arithmetic skills. The study consisted of 180 boys and 176 girls. It was found that low achievers in Mathematics have poor
command whereas high achievers have good command over basic arithmetic skills.

Sumanan (1971) revealed that the location of school play a decisive role in numerical ability of secondary school children.

MAJOR TRENDS INDICATED BY THE REVIEW

1. There is a discrepancy between ability and achievement of learning disable students

2. The studies in Mathematical Creativity are conducted on normal students. There was no study which was intended to measure the Mathematical Creativity of learning disabled children.

3. There are many studies to measure the computational skill of normal students. Studies on Ability for Fundamental Mathematical Operations of the dyscalculic students are less.

4. No study was conducted to compare the Dyscalculic students and Normal students with respect to their Mathematical Creativity and Ability for Fundamental Mathematical Operations.

5. The review of the studies does not enable us to draw a generalized conclusion regarding the Mathematical Creativity and Ability for Fundamental Mathematical Operations of Dyscalculic and Normal students.

6. There is disagreement about the relationship between Mathematical Creativity and Ability for Fundamental Mathematical Operations.
7. These studies do not give a clear picture about the influence of gender, locality and type of management on Mathematical Creativity and Ability for Fundamental Mathematical Operations.

The review of the related studies provides supporting evidence for the present study by revealing the results of those works. Simultaneously the drawbacks observed stimulate the investigator for a more systematic and adequate study in the field.