CHAPTER III

REVIEW OF RELATED LITERATURE

3.1 Studies related to Learning Disability
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REVIEW OF RELATED LITERATURE

Literature review is the process of locating, obtaining, reading and evaluating the research literature in the area of interest (Bordens and Abbott, 2002). One of the most important preliminary steps in the research process is thorough reviewing of the scientific literature on the topic identified for the study. There are several reasons for conducting a literature review. Certainly the most important reason is to avoid needless duplication of effort. Acquaintance with that area through a literature review helps to avoid “reinventing the wheel”. Becoming familiar with a body of research on topic is perhaps the best way to generate ideas for new research. From the results of published literature, researchers can use the knowledge from past literature on a topic to continually refine and expand ones’ knowledge. In addition, familiarity of research literature on a topic will help to identify the inconsistencies in research results that need to be investigated. Also the knowledge of one research area often can be successfully applied to another research area (Cozby, 1997).

Another advantage to reviewing the literature applies to the design phase of the research. Designing a study includes several decisions as to what variables to involve and how to measure them, what apparatus to use, what procedures to use and so on. Review of related literature provides a rich resource for addressing these important design questions. Yet another
advantage is that a review of the literature keeps the researcher up to date on current empirical or theoretical controversies in a particular research area. As science progresses, new ideas develop concerning age-old behavioural issues. Thus review of related literature not only provides a rich source of research but also give direction to specific research hypotheses and designs.

The research studies thus reviewed for the present study are classified as follows.

- Studies related to Learning Disability
- Studies related to Dyslexia
- Studies related to Dysgraphia
- Studies related to Dyscalculia
- Studies related to Instructional Strategies
- Studies related to Achievement

3.1 Studies related to Learning Disability

Callinan, Theiler, and Cunningham (2015) analysed a Cognitive Deficit Framework used to identify Learning Disability. They also examined whether verbal memory deficits explain similarities between learning disabled and low achieving students. A sample of 172 students were administered cognitive processing tests to ascertain whether scores in these tests could accurately allocate students into discrepancy-defined groups using discriminant function analysis. Results showed that 77% to 82% of students could be correctly allocated into LD, low achievement, and regular achievement
groups using only measures of phonological processing, rapid naming, and verbal memory. The study concluded that Learning Disability could be identified via cognitive deficits.

Kennedy, Deshler, and Lloyd (2015) explored the effects of Multimedia Vocabulary Instruction on adolescents with Learning Disabilities. The purpose of the experimental study was to investigate the effects of using Content Acquisition Podcasts (CAPs) to provide vocabulary instruction to adolescents with and without Learning Disabilities (LD). 30 urban high school students with LD in an area related to reading were randomly assigned to one of four experimental conditions with instruction occurring at individual computer terminals over a 3-week period. Each of the four conditions contained different configurations of multimedia-based instruction and evidence-based vocabulary instruction. Dependent measures of vocabulary knowledge indicated that students with LD who received vocabulary instruction using CAPs through an explicit instructional methodology and the keyword mnemonic strategy significantly outperformed other students with LD who were taught using the same content, but with multimedia instruction that did not adhere to a specific theoretical design framework.

Mattingly (2014) investigated the effect of Response to Intervention (RTI) on elementary school academic achievement and Learning Disability identification. The study aimed to find out whether RTI affect student achievement and the effect of RTI implementation on the proportion of
elementary school students identified as learning disabled. The results indicated an increase in reading achievement for RTI schools, but no effect on math. In addition, RTI had no effect on the proportion of students identified with a Specific Learning Disability (SLD). The findings suggest that RTI can increase student achievement when instruction and interventions target students' areas of need.

Sideridis and Padeliadu (2013) created a brief rating scale for the assessment of learning disabilities using reliability and true score estimates of the scale's items based on the Rasch model. The purpose of the study was to provide the means to create brief versions of instruments that can aid the diagnosis and classification of students with learning disabilities and comorbid disorders (e.g., attention-deficit/hyperactivity disorder). A sample of 1,108 students with and without a diagnosis of learning disabilities took part in Study 1. Using information from modern theory methods (i.e., the Rasch model), a scale was created that included less than one third of the original battery items designed to assess reading skills. This best item synthesis was then evaluated for its predictive and criterion validity with a valid external reading battery (Study 2). Using a sample of 232 students with and without learning disabilities, results indicated that the brief version of the scale was equally effective as the original scale in predicting reading achievement. Analysis of the content of the brief scale indicated that the best item synthesis involved items from cognition, motivation, strategy use, and
advanced reading skills. The study suggested that multiple psychometric criteria be employed in evaluating the psychometric adequacy of scales used for the assessment and identification of learning disabilities and co-morbid disorders.

**Westreich (2013)** compared the Specific Learning Disability (SLD) identification methods using the WJ (Woodcock-Johnson) III assessment tool. The sample of the study consisted of 122 students referred to their district's Child Study Team (CST). The study aimed to determine whether in addition to being SLD eligible according to their district's CST, they also met criteria according to two "third method" models, better known as strengths and weaknesses approaches and a simple difference discrepancy model. The results of the study indicated that the model identified a statistically greater amount of children than the school district. Most noteworthy was that a similar number of children were identified regardless of the model utilized; however, they were different children. These results were concerning, as they indicate that there is still a lot of work to be done in the area of SLD identification.

**Aydeniz, Cihak, Graham and Retinger (2012)** examined the use of Inquiry-Based Instruction for teaching science to students with Learning Disabilities. The purpose of the study was to examine the effects of inquiry-based science instruction for five elementary students with learning disabilities (LD). Students participated in a series of inquiry-based activities
targeting conceptual and application-based understanding of simple electric circuits, conductors and insulators, parallel circuits, and electricity and magnetism. Students' conceptual understanding of these concepts was measured through a test designed by the investigators. The students' attitudes towards science were measured through scientific attitudes inventory (SAI-II). The results indicated that all students acquired the science content covered during the intervention and maintained their performance six weeks later. In addition, students improved their attitudes towards science. The findings also revealed that students with learning disabilities can access science learning by making changes in curriculum, instruction and assessment.

**Laffitte (2012)** conducted a study on comparison of Pull-Out and Co-Teaching models on the reading performance of third through fifth grade elementary students with a diagnosed Specific Learning Disability in reading. The purpose of the mixed methods study was to compare the student reading performance of 56 students who participated in one of the two models- Pull-Out and Co-Teaching models and to determine which model was associated with higher levels of student success and under what circumstances. The study revealed no significance between the Co-Teaching and Pull-Out instructional models on the reading achievement of elementary students identified with a specific learning disability in reading.

**Nielsen (2012)** conducted an investigation on cognitive measures of elementary students identified as having a specific learning disability. The
purpose of the study was to determine if students who identified using a pattern of strengths and weaknesses with a deficit in reading, displayed a specific pattern of cognitive abilities. The sample consisted of 55 students who had been identified with a learning disability through interpretation of a pattern of cognitive strengths and weaknesses. The students were assessed for learning disability using WJ-III COG (Woodcock-Johnson III Tests of Cognitive Abilities) with seven subtests- Comprehension-Knowledge (Gc), Long-Term Retrieval (Glr), Visual-Spatial Thinking (Gv), Auditory Processing (Ga), Fluid Reasoning (Gf), Processing Speed (Gs), and Short-Term Memory (Gsm). The percentage of students making scores less than 85 on a cluster was the greatest for Gsm (70%), Glr (69%), and Gc (50%), indicating that most students were identified with at least one of these scores as a normative deficit. Results of independent sample t tests indicated that there were no differences in gender among scores of cognitive abilities. The study demonstrated that Gf may be predictive of reading ability in the area of reading comprehension, but Gsm, Glr and Gc may be the most important factors to consider when determining the student's needs for instruction and remediation.

Polat, Adiguzel, and Akgun (2012) conducted a need analysis in order to prepare an adaptive, web-assisted learning system according to variables determined by the extent of learning disabilities. The scope of the study was limited to dyslexia, dyscalculia and dysgraphia. Data were
collected from five subject area experts (psychologist and special education specialists) using semi-structured interview forms including open-ended questions from 15 parents, at least one of whose children has a specific learning disability and six classroom teachers via surveys including open-ended questions. The study revealed three main findings: a lack of information/interest about specific learning disabilities, the inadequacy of the Turkish Ministry of Education Specific Learning Disabilities Support Education Program, and the inadequacy of applications, both within and outside the classroom. The findings also showed that the students with specific learning disabilities need a web-assisted system that should be adaptive and which can be used both in school and at home.

Chaharsooghi, Mohammadi and Hoshyar (2011) studied the effect of study of miniature on concentration of Iranian children with nonverbal learning disability (NLD). A sample of 20 children (8-10 years) was randomly assigned to experimental and control groups. The experimental group took part in twelve sessions of miniature with 45-60 min, while the control group was put on a waiting list. Both groups received the Toulouse-Pieron test three times (pre-test, mid-test, and past-test). The results of ANCOVA based on repeated measure revealed that Persian miniature had a significant effect on concentration.

Mashal and Kasirer (2011) explored the relationship between visual metaphor comprehension and recognition of similarities in children with
learning disabilities. In the study visual and verbal metaphor understanding was assessed in 20 children with learning disabilities (LD) and 20 typically developed (TD) children. Results showed that LD children scored significantly lower than TD children in the comprehension of conventional metaphors, and idioms. Furthermore, the results suggested that higher analogical thinking facilitates visual metaphor comprehension in the LD group.

Westendorp, Hartman, Houwen, Smith and Visscher (2011) examined the relationship between gross motor skills and academic achievement in children with learning disabilities. The study was carried out in 7 to 12 year old children with learning disabilities (n = 104) with those of age-matched typically developing children (n = 104) using the Test of Gross Motor Development-2. The findings revealed that the children with learning disabilities scored poorer on both the locomotor and object-control subtests than their typically developing peers. Furthermore, in children with learning disabilities a specific relationship was observed between reading and locomotor skills and a trend was found for a relationship between mathematics and object-control skills: the larger children’s learning lag, the poorer their motor skill scores. The study stresses the importance of specific interventions facilitating both motor and academic abilities.

Al Zyoudi (2010) examined the differences in self-concept among Jordanian students with and without learning disabilities. The sample
consisted of 124 students including 50 students with learning disabilities and 74 of their peers without learning disabilities. To achieve the objective of the study, the Jordanian adaptation of the Piers-Harris Children's Self-Concept Scale (PHCSCS) was used. Differences were found between the groups on the intellectual and school status and behaviour subscales, students without learning disability scoring higher on both scales. There was also a significant difference between boys and girls.

Filippatou and Kaldi (2010) examined the effectiveness of project-based learning on primary school pupils with learning difficulties regarding their academic performance and attitudes towards self efficacy, task value, group work and teaching methods applied. The sample consisted of six Greek fourth-grade primary school mainstream classrooms with ninety-four pupils of mixed learning abilities. An eight-week project was implemented within the curriculum area of environmental studies with a topic of "sea animals". The methodology applied in the study was a combination of a pre-experimental design (the one group pre-post-test design) and the case study research design. The findings revealed that pupils with learning difficulties can gain benefits through project based learning in academic performance, motivation (self-efficacy and task value in terms of environmental studies) and group work (acceptance in the group and engagement in the learning process). The students also preferred experiential learning to traditional teaching.
Vandenberg and Emery (2009) conducted a three year longitudinal study to examine the effects of IQ, age of diagnosis, school socioeconomic status (SES) and participation in desegregation programmes on the remediation of learning disabilities. Participants included 176 children who were diagnosed with a learning disability, 44 of whom were participants in a voluntary transfer program. The effect of remediation was measured at a three-year re-evaluation period. Results indicated that IQ and age at diagnosis were significant predictors of remedial success, while school SES and transfer status were not. Students with higher IQ scores, who were identified at an earlier age, showed greater remedial gains. The results revealed the importance of early identification and suggested more intensive services and follow-up be given to children with lower IQ.

Berninger, Nielsen, Abbott, Wijsman, and Raskind (2008) examined the gender differences in severity of writing and reading disabilities. The sample of the study consisted of 122 children (80 boys and 42 girls) and 200 adults (115 fathers and 85 mothers) who showed behavioural markers of dyslexia. Gender differences were found in writing and replicated prior results for typically developing children. Boys and men were more impaired in handwriting and composing than girls and women, but men, who were more impaired in those writing skills, were also more impaired in spelling than women. Men were more impaired than women in accuracy and rate of reading passages orally, but boys were not more
impaired than girls on any of the reading measures. Males were consistently more impaired than females in orthographic skills, which may be the source of gender differences in writing, but not motor skills.

Shipp (2008) examined the Disability documentation criteria for students with learning disabilities in higher education. The investigator surveyed disability support services programmes at institutions of postsecondary education and collected information about their criteria for documentation for students with learning disabilities. The sample consisted of one hundred and sixty two respondents for the online survey. The results of the survey confirmed the researcher's hypothesis that there is a great deal of incongruence between schools regarding their documentation requirements for students with learning disabilities. These results could be devastating to students who need and expect to obtain academic accommodations at the post-secondary level.

Heiman (2006) examined the learning styles among students with and without Learning Disabilities (LD) at a Distance-Learning University. Two hundred and twelve students answered self-report questionnaires on their learning styles. Results revealed that students with LD preferred to use more stepwise processing, including memorizing and drilling, than Non LD students. In addition, students with LD reported a higher need for self-regulation strategies than their Non LD peers, including controlling their
learning process, self-orientation, planning, monitoring, and continuous evaluation of their learning process and results.

Kohli, Kaur, Mohanty, and Malhotra (2006) examined neuropsychological functioning in specific learning disorders--reading, writing and mixed groups. The study compared the pattern of deficits, intelligence and neuropsychological functioning in subcategories of learning disorders. Forty-six children (16 with reading disorders, 11 with writing disorders and 19 with both reading and writing disorders--mixed group) in the age range of 7-14 years were assessed using the NIMHANS (National Institute of Mental Health and Neuroscience, Bangalore, India) Index of Specific Learning Disabilities, Malin's Intelligence Scale for Indian Children, and the PGI Memory Scale (A battery of simple tests of memory by Pershad D and Wig N. N). The findings were (1) the mixed group had greater dysfunction than the reading and writing groups in alphabet sequencing and graded division, and the mixed group had greater dysfunction than the writing group in capital letters, division and graded subtraction (2) the mixed and reading groups had greater dysfunction than the writing group in speech and language (3) intellectual functions and mental balance (on PGI memory scale) were more affected in the mixed group in comparison to the writing group. The study revealed that subtypes of learning disorders differ in terms of their neuropsychological profile with the mixed group having greater dysfunction.
McCloskey (2005) used ethnographic longitudinal case study methods to uncover the ramifications of labeling a student ‘learning disabled’ because of an inability to read as expected and educating him in a self-contained special education context. The study focused on the settings that bring disability in and out of focus and the positions people inhabit that maintain these positions. The data was collected over a three-year period through the student's middle school years. The findings indicated that literacy learning did not occur in a self-contained special education context despite numerous Individualised Educational Programmes developed for this student. Additionally, placement in this context hindered growth in mathematics and led to the school's determination that the student possessed a disability in mathematics despite that the curriculum that was tested was not covered. The findings also indicated that learning to read was possible for this middle school student.

Gitanjali (2004) conducted a comparative study of the personality characteristics of primary-school students with Learning Disabilities and their Non Learning Disabled peers. The study examined the personality characteristics of 180 boys and girls of ages 8, 9, and 10 with learning disabilities (LD) in 3rd, 4th, and 5th grade in urban and rural primary schools of Andhra Pradesh, India. The subjects were identified based on their scholastic achievement on a spelling dictation test, an oral reading test, a reading comprehension test and an arithmetic test developed specifically for
the purpose, along with mental ability tests--Raven's Standard Progressive Matrices and Draw-A-Man. An adapted version of the Children's Personality Questionnaire (CPQ) was administered to the subjects with LD and a comparison group of children without learning disabilities (NLD). The findings revealed that the LD child have problems in social and emotional adjustment. Further, the older LD children tended to show a more maladaptive behavioural disposition than the younger, and there was a significant gender effect among LD children.

Martinez (2002) compared the learning disability subtypes in middle school: self-concept, perceived social support, and emotional functioning. The goal of the study was to compare young adolescents in middle school with different types of learning disabilities and a group with no learning disability and examine their self-perceptions of worth, perceived social and emotional functioning. Multivariate analyses of group differences revealed that the groups did not differ on global self-worth, although girls reported lower global self-worth than boys, regardless of group membership. Students in the LD group (disability in reading and mathematics) rated their intellectual and academic self-worth lower than students in the other groups (RD-reading disability, MD-math disability, NA-normally achieving). Girls, regardless of group, also reported lower intellectual self-concept than boys. There were no group or gender differences on non-academic self-concept.
Pandey (2002) explored the effect of single parenting on severity of learning disabilities. The study was carried to identify and measure the severity of reading, writing, and arithmetic disability among children in relation to single parent family conditions. 60 learning disabled children aged 6-10 years were taken from primary schools (Classes II to IV) of Srinagar-Garhwal, Uttaranchal, of whom 30 had couple parents and 30 had only single parents. Non-Verbal Group Test, Arithmetic Diagnostic Test and Reading/Writing Disability Test were conducted to collect data. Results showed that the mother figure was much more important in single parenting for learning disabled children. Children having mother figure and children having couple parents showed hardly any difference in level of learning disability. Mother figure was fully capable of taking care of emotional as well as academic needs of the child, and providing the required support. It was found that learning disabled children having single parent had more arithmetic disability than those children who had couple parenting. As far as reading and writing disability was concerned, there was no significant difference between both groups.

Dadario (2001) explored the impact of Non Verbal Learning Disability (NVLD) upon cognitive triad variables of Exner's comprehensive scoring system of the Rorschach Inkblot Technique. The purpose of the study was to investigate the effect of the neuropsychological characteristics of nonverbal learning disabled children on their performance on the Rorschach.
The participants for the study included twelve nonverbal learning disabled individuals (9 male and 3 female; mean age = 14.88). The results suggested that individuals with NVLD disabilities are prone to significantly more difficulties in information-processing and cognitive mediation than the normal population which negatively affects their performance on the Rorschach.

Bentum (2000) examined the long term effects of learning disability instruction and resource room placement on reading achievement. The study also examined the level of cognitive functioning (IQ) of students identified as having reading disability who had been placed in resource rooms over periods of three and six years. Two groups of elementary grade children were used as subjects of investigation. The first group included 237 children who had been diagnosed as having reading disability and had been re-evaluated after receiving learning disability instruction for three years; the second group consisted of 170 children with the same diagnosis but had been re-evaluated after having received learning disability instruction for six years. Two-way analysis of variance (ANOVA) procedures, with repeated measures were used to analyze the data. Results of the study indicated that Learning Disability resource room instruction does not improve word recognition or reading comprehension.

four different instructional strategies - Programmed learning material, supervised learning module, guided inductive inquiry model and lecture demonstration method on the achievement in Biology was examined in a sample of 204 Learning Disabled (LD) and 204 Non Disabled (ND) students. The study revealed that self-instructional materials and modern instructional strategies are more effective than the conventional lecture demonstration method in the achievement in Biology of LD and ND students.

**Shaheen (2000)** examined the effects of computer-based instruction in the development of study skills on junior high students with learning disabilities. The dependent variables measured were the students' mastery of study strategies as measured by gain scores pre and post tests of the ten subtests of the LASSI-HS (Learning and Study Strategies Inventory - High School Version), as well as, students' mastery of content area in Humanities as measured by gain scores on pre and post tests designed by the classroom teacher. Statistical methods used to evaluate the effectiveness of an intervention included ANOVA, t tests, correlations (using Pearson's R), and other inferential statistical methods. The findings revealed that hypermedia increased student motivation towards the study guide creation and retention of content information.

**Frederick (1997)** studied the relationship among acceptance of a learning disability, grade level at diagnosis, and achievement of students with learning disabilities. The study determined whether acceptance of a learning
disability, as measured by the administration of the Acceptance of Learning Disability Scale (ALDS), relates to the grade level at time of diagnosis and to high-school seniors' achievement as measured by grade-point average. The study population consisted of fifty (N = 50) high-school seniors, ages 17 and 18, representing three urban high-schools. The results indicated that the lower the student's grade level, when a diagnosis of a learning disability is determined, the greater the student's self-acceptance of his or her learning disability.

Acker (1994) examined the influence of group guidance on the self-esteem, acceptance of disability, and academic achievement of children with learning disabilities. The study was designed to determine whether or not differences existed between pre and post treatment with acceptance of learning disability scores, self-esteem scores, and academic achievement scores for students with learning disabilities. The study used the Peabody Individual Achievement Test (PIAT) to determine the specific level of academic achievement. The Coopersmith Self-Esteem Inventory (SEI) Form B, was utilized to assess the level of self-esteem. The Acceptance of Learning Disability Scale (ALDS) was used to assess levels of self-acceptance of learning disability and the impact of counseling. The PIAT, the SEI, and the ALDS were administered to 28 children between the ages of seven and twelve in special class placements. To assess the impact of counseling, the 28 subjects were administered group guidance intervention. The ALDS and the
SEI were administered after group counseling. The dependent t-test and Pearson correlations were used to test the hypotheses. The results provided evidence that the subjects scored significantly higher in post-treatment than in pre-treatment with respect to acceptance of learning disability, self-esteem, and academic achievement. The results concluded that group counseling can influence the areas of learning disability, self-esteem, and academic achievement.

3.2 Studies related to Dyslexia

Richardson (2015) explored the academic success in postsecondary students who have Dyslexia. The sample consisted of 30 college students. They were interviewed in order to examine personal postsecondary experiences resulting from dyslexia, and to identify those strengths (inherent drivers) and assets (systematic supports) that assisted them in succeeding academically. Findings revealed that reading, distraction, and/or switching characters were key academic challenges for participants. These participants attributed their postsecondary academic successes to two significant factors: internal strengths (inclusive of learning strategies) and environmental assets (governmental and/or institutional resources). Findings also showed that participants' non-linear thinking processes were major strengths in their academic successes.

Youman (2015) explored the value of Phonological Awareness (PA), Rapid Automatized Naming (RAN), and Processing Speed (PS) as predictors
of basic reading skills in Spanish speaking English Language Learners (ELLs). The study also aimed to investigate a model that combined tasks of PA, RAN and PS that had the highest correlations to aspects of reading. It explored the role of Vocabulary (V) in both English and Spanish in the development of reading skills in ELLs. Findings suggested that RAN, PA, and PS, as measured in the study, are highly correlated to basic reading skills in Spanish speaking ELLs, and that these can be used for the assessment of reading and dyslexia in the population. The study also demonstrated that a model that included RAN numbers and phoneme deletion in English can accurately predict reading performance. Findings also indicated that Vocabulary in English is highly correlated to basic reading skills in English.

Chiarenza et al. (2014) analysed reading and writing performances of children with dyslexia before and after treatment with sublexical method. The purpose of the study was to confirm the efficacy of a rehabilitation programme for children with dyslexia based on automation and lexical and sublexical recognition through specific software to improve the accuracy and fluency in reading. The treatment was divided in 3 periods of 3 months each, spaced with a rest of 3 months. The sample of the study consisted of 73 students of age group 6-13 years. The findings revealed that the sublexical method shows a significant improvement in reading performance. With regard to the writing test, the improvement was significant in both known (p < 0.001, \( z = -3.934 \)) and unknown correctly written words (p < 0.01, \( z = -2.420 \)).
Cullen, Alber-Morgan, Schnell, and Wheaton (2014) examined the use of Headsprout Comprehension to improving reading skills of students with disabilities. The purpose of the study was to examine the effects of Headsprout Comprehension, a computer-assisted reading program, on the reading comprehension of six elementary students with high-incidence disabilities (i.e., learning disabilities, emotional disturbance, and other health impairment–attention deficit hyperactivity disorder (OHI-ADHD)). A multiple baseline across participants’ design demonstrated that Headsprout Comprehension was functionally related to substantial increase in reading comprehension for all six participants as measured by Ohio Achievement Assessment (OAA) passage comprehension questions and AIMS web Maze assessments.

Macchi, Schelstraete and Casalis (2014) conducted a study on word and pseudo word reading in children with specific speech and language impairment. The study was set out to determine the precise impact of language impairment on word reading skills. They investigated single-word reading in 27 French children with specific Speech and Language Impairment (SLI). Precise quantification of reading levels in the SLI group showed an average delay of 3.5 years. Approximately 90% of these children were affected by a reading disorder, whereas for the remaining 10%, reading performance was within normal limits. Word reading procedures were analyzed using the so-called 'dual route model', which proposes that reading is
achieved through two processes, the phonological and the orthographic procedures. The findings revealed that approximately 60% of these children reached the standard levels expected of younger children with identical reading levels (delayed reading profile) in both procedures.

Wai, Chan, and Zhang (2014) examined the effectiveness of five spelling strategies used to teach junior secondary school students with dyslexia. Participants were 30 secondary school teachers in Hong Kong. The teachers commented on five spelling strategies: the phonological strategy, an integration of phonological and orthographical strategies, the rule-based strategy, the visual-imagery strategy and teaching spelling with other skills. The study compared teachers’ opinions. Results indicated that the five strategies have both strengths and weaknesses.

Ecalle, Kleinsz and Magnan (2013) examined the effects of two computer-based interventions, one with Grapho-Syllabic Training (GST) and another with Grapho-Phonemic Training (GPT) on the development of word recognition and reading comprehension in French children during Grade 1 and Grade 2. In experiment 1, poor readers (N = 27) in second grade were selected and divided into three equal groups, one GST group, one GPT group and a control group. After the session training (10 hour), the children from the grapho-syllabic training group outperformed their counterparts in word reading. In experiment 2, poor readers in first grade (N = 18) were divided in two groups, a GST group and a GPT group. The results revealed an effect of
Grapho-Syllabic Training on silent word recognition, word reading aloud and reading comprehension.

**Moll, Loff, and Snowling (2013)** investigated cognitive deficits associated with dyslexia and familial risk of dyslexia (endophenotypes) by comparing children from families with and without a history of dyslexia. Eighty-eight school-aged children were assessed on measures of phonology, language and rapid automatized naming. A series of regression analyses with family risk and dyslexia status as predictors indicated that word recall, morphology, and rapid automatized naming were associated with the deficit, whereas the two phonological measures (phoneme awareness and nonword repetition) were associated with both literacy deficits and family risk, suggesting that the phonological deficit is an endophenotype of dyslexia. Whereas the association with familial risk was similar for the two phonological measures, they differed in their relation to dyslexia status. Phoneme awareness showed a stronger association with dyslexia than risk status, whereas nonword repetition was more strongly related to the risk. The data were interpreted within the framework of multiple deficit models of dyslexia.

**Krishnan (2012)** conducted a study which focused on the development of a Multi Media Package (MMP) for primary school students with special reference to Dyslexia. The effectiveness of the developed Multimedia Package was assessed using a Reading Miscue Inventory (RMI) and a
standardised Reading Assessment Test (RAT). The analysis of the data revealed the need of training for the upper primary school students with Dyslexia to minimise their reading miscues for the enhancement in reading. The findings of the study revealed that the developed MMP is effective in reducing the reading miscues. Significant enhancement was seen in the reading attainment scores and retention capacity of Dyslexic students after the intervention of the Multimedia Package.

Taghvayi, Vaziri and Kashani (2012) examined the effectiveness of an integrative approach, Fernald multi-sensory technique on decreasing reading disability. The purpose of the study was to compare the effectiveness of an Integration approach with Fernald multi-sensory method for decreasing Reading disabilities in elementary male students. In a quasi-experimental study, 30 students were chosen among 139 reading disability students. Research results showed that the Integration approach was more effective from Fernald method for reducing Reading disabilities in reading, understanding, phonemics, and correct reading areas.

Geeta (2011) examined the impact of an intervention programme on the development of life skills among children with dyslexia. The purpose of the study was to identify Life Skills deficits among children with Dyslexia and to evaluate the efficacy of intervention programme for developing essential Life Skills among children with Dyslexia. The sample comprised of 30 students in the age range 8 through 11 years, manifesting traits of dyslexic
children and having deficits in the Life Skills (social competence, perseverance and self esteem). Experimental method was used by the investigator with pre-test post-test control group design. The findings revealed that the prevalence rate of Dyslexia among IV and V class students is 3.9 percent in Karnal district, Haryana. As far as Life Skills deficits among dyslexic children are concerned, the prevalence rate of Life Skills deficits among Dyslexics has been found to be 3.7 percent. The intervention strategies were found to be effective in developing Life Skills among dyslexic children.

Wochos (2010) evaluated the effectiveness of supplemental computer-assisted instruction with second-grade students at-risk for developmental dyslexia. The study investigated the effectiveness of a supplemental computer-assisted reading program, Headsprout Early Reading, with nine second-grade students at-risk for developmental dyslexia. A single-case multiple baseline design within participants was utilized using the Dynamic Indicators of Basic Early Literacy Skills (DIBELS) to assess weekly oral reading fluency (ORF) performance. Multiple data analysis procedures were used to evaluate the effectiveness of the program. Results of the study revealed that Headsprout Early Reading was effective at improving ORF performance in seven of the nine participants. Responses from the parent satisfaction survey indicated that parents were highly satisfied with the Headsprout Early Reading program.
Ecalle, Magnan, Bouchafa and Gombert (2009) conducted a study on the effectiveness of a computer-based training with ortho-phonological units in Dyslexic children. The study aimed to show that training using a computer game incorporating an audio-visual phoneme discrimination task with phonological units, presented simultaneously with orthographic units, might improve literacy skills. Two experiments were conducted, one in secondary schools with dyslexic children (Experiment 1) and the other in a speech-therapy clinic with individual case studies (Experiment 2). A classical pre-test, training, post-test design was used. The main findings indicated an improvement in reading scores after short intensive training (10 h) in Experiment 1 and progress in the reading and spelling scores obtained by the dyslexic children (training for 8 h) in Experiment 2.

Gaddy, Bakken, and Fulk (2008) explored the effects of teaching text-structure strategies to postsecondary students with Learning Disabilities to improve their reading comprehension on expository science text passages. The main objective of the study was to determine the relative efficacy of text-structure strategy instruction compared to traditional instruction on the reading comprehension of 40 postsecondary students with Learning Disabilities. Data analyzed with repeated-measures ANOVAs indicated that students in the text-structure strategy condition outperformed students in the traditional instruction condition on both immediate- and delayed-retell measures.
Kirby, Silvestri, Allingham, Parrila, and La Fave (2008) explored the learning strategies and study approaches of postsecondary students with Dyslexia. The objective of the study was to describe the self-reported learning strategies and study approaches of college and university students with and without dyslexia and examined the relationship of those characteristics with reading ability. Students with (n = 36) and without (n = 66) dyslexia completed tests measuring reading rate, reading comprehension, reading history, learning strategies, and learning approaches. The results indicated that students without dyslexia obtained significantly higher scores than students with dyslexia in their reported use of selecting main ideas and test taking strategies. Students with dyslexia reported significantly greater use of study aids and time management strategies in comparison to students without dyslexia. Moreover, university students with dyslexia were significantly more likely to report a deep approach to learning in comparison to university students without dyslexia. Reading ability correlated positively with selecting main ideas and test taking strategies and negatively with use of study aids.

Kast, Meyer, Vogeli, Gross, and Jancke (2007) examined the effect of Computer-based multisensory learning in children with developmental dyslexia. Students within the study were placed in one of four groups: a group of students with and without developmental dyslexia received writing training in the first three month period. The control group consisted of students with and without developmental dyslexia who did not receive writing training.
During the training period, students completed computerized writing training four days a week for fifteen to twenty minutes. The training program had three games that incorporated all the senses. For instance, students learned associations between a letter and a particular color. This game was meant to help students with dyslexia associate letters that are easily confused, such as “t” and “d”, with different colors. Students would then use the colors to segment words and manipulate phonemes. Finally, in the last game, students would hear words dictated to them and a song associated with the word. The study found that targeting multiple senses during a writing training program helped students with and without developmental dyslexia to improve writing skills.

Stetter (2007) explored Computer assisted instruction to promote comprehension strategies in students with learning disabilities. The purpose of the study was to investigate if comprehension strategy instruction, specifically story grammar (such as plot, character, setting, and theme), conducted through the use of a computer could improve the reading comprehension of students with learning disabilities. The population included nine students with learning disabilities in the ninth grade. The results showed that students made little progress in the area of reading comprehension by participating in the intervention. The findings suggest that working with students on the computer has a lot of potential, but needs to incorporate much more extensive teacher instruction.
Wenher, Ahlfors and Mody (2007) examined the effects of phonological contrast on auditory word discrimination in children with and without reading disability. The purpose of the study was to compare the brain activation patterns of normal and impaired readers on speech perception to understand better the phonological basis in reading disability. The result of the study showed that compared to good readers, poor readers had reduced left-hemisphere activation to the most demanding phonological condition reflecting their difficulties with phonological processing. Furthermore, unlike good readers, poor readers did not show differences in activation as a function of the degree of phonological contrast.

Nelson and Williamson (2006) examined the impact of explicit, self-regulatory reading comprehension strategy instruction on the reading-specific self-efficacy, attributions, and affect of students with reading disabilities. The objective of the study was to compare a reading intervention that consisted of explicit, self-regulatory strategy instruction to a strategy intervention that was less explicit to determine the impact on the reading-specific self-efficacy, attributions, and affect of students with Reading Disabilities (RD). Participants included 20 students with RD who were entering grades 4-8. The interventions were delivered on a one-to-one basis over five weeks, four days per week, for one hour per day. The study concluded that those receiving the explicit, self-regulatory strategy intervention showed greater gains in their attributions to incorrect strategy usage for reading failure than participants in
the less explicit intervention. Group differences approached statistical significance on the reading self-efficacy measure, with the less explicit intervention showing higher reading self-efficacy at post test than the explicit, self-regulatory intervention.

Swanson and Jerman (2006) conducted a study to examine the influence of working memory on reading growth in subgroups of children with reading disabilities. It was a 3-year longitudinal study to determine whether (a) subgroups of children with reading disabilities (RD) (children with RD only, children with both reading and arithmetic deficits, and low verbal IQ readers) and skilled readers varied in working memory (WM) and short-term memory (STM) growth and (b) whether growth in an executive system and/or a phonological storage system mediated growth in reading performance. A battery of memory and reading measures was administered to 84 children (11–17 years of age) across three testing waves spaced 1 year apart. The results showed that skilled readers yielded higher WM growth estimates than did the RD groups. No significant differentiation among subgroups of children with RD on growth measures emerged. Hierarchical linear modeling showed that WM (controlled attention), rather than STM (phonological loop), was related to growth in reading comprehension and reading fluency.

Faught (2005) analyzed the effects of a dyslexia intervention program on the instruction of identified dyslexic students. The study examined the
effects of the Orton-Gillingham intervention training program on the preparedness of teachers working with identified dyslexic students. The study considered differences between training groups across four scales: teacher preparedness, quality intervention programs, assessment related factors, and the effects of specialized instruction for dyslexic students. Using the original questionnaire items, the Likert-type questions were computed into four scale items. The first four questions were combined to make up the scale item "Effects of Specialized Training." The next group of four questions made up the second scale item, "Factors of Quality Intervention." The third group of questions made up the scale item "Assessment Related Factors" and the final four questions made up the scale item called "Teacher Preparedness." The GLM one-way ANOVA procedure was utilized to test for significant difference between the training groups on the average responses to the four scales. Significant differences were found for all four areas at the 0.01 level of significance.

Giess (2005) examined the effectiveness of a multisensory; Orton-Gillingham influenced approach to reading intervention for high school students with reading disability. The purpose of the study was to determine the effects of a multisensory reading intervention approach on the reading skills of students with reading disability. A quasi-experimental design was used in which the control and reading-intervention groups were systematically assigned. Participants were assigned to the reading-intervention group based
on low pre-test scores. Students who achieved higher pre-test scores were assigned to the control group and did not receive the treatment. Analysis of covariance (ANCOVA), $t$ test for independent samples, $t$ test for non independent (matched) samples, and correlation were used to analyze the data. The study revealed that participants in the reading intervention group did improve their reading skills. The descriptive analysis of the data revealed that on four of the six reading subskill tests, participants in the reading-intervention group out-gained the participants in the control group on grade-equivalent scores.

Chenault (2004) conducted a study to examine the effects of prior attention training and a composition curriculum with attention bridges for students with dyslexia and/or dysgraphia. The research investigated the proposition that attention process training, coupled with attention bridging activities in a literacy context, would enable dyslexic writers in grades 4-6 to make significant progress in subsequent writing composition instruction compared to a peer control group that received reading fluency training with the Read Naturally program. Twenty students in grades 4-6 identified as low functioning in reading or writing were randomly assigned to an intervention containing either the reading fluency or attention process training component. The findings revealed that students who received attention process training prior to composition lessons demonstrated significantly improved scores in composition compared to their peers who received prior reading fluency
training. The study demonstrated that attention process training can enhance later academic instruction by improving cognitive efficiency.

**Magnan and Ecalle (2004)** conducted a study on audio-visual training in children with reading disabilities. The study tested the effectiveness of audio-visual training in the discrimination of the phonetic feature of voicing on the recognition of written words by young children deemed to at risk of dyslexia (experiment 1) as well as on dyslexic children’s phonological skills (experiment 2). In addition, the third experiment studied the effectiveness of the word recognition training in dyslexic children who regularly used a computer at home. A traditional pre-test, training, post-test design including comparison groups (experimental vs. control) provided a base-line for assessing the training effects. In the three experiments, the intervention groups showed higher increase in performances in phonological skills and phonological recoding than the control group. The results revealed the impact of the audio-visual training about voicing on performances of reading-disabled children.

**Gang and Siegel (2002)** evaluated the effect of sound-symbol association training on visual and phonological memory in children with a history of dyslexia. Pre tests of phonological and visual memory, a sound-symbol training procedure, and phonological and visual memory post tests were administered to children with dyslexia, to children whose dyslexia had been compensated through remedial training, and to age- and reading level-
matched comparison groups. Deficits in visual and phonological memory and memory for sound-symbol associations were demonstrated in the dyslexia group. For children with dyslexia and children whose dyslexia had been remediated, the sound-symbol training scores were significantly associated with word and pseudo word reading scores and were significantly lower than those of the comparison groups. Children with dyslexia and children whose dyslexia had been compensated showed significantly less facilitation of phonological memory following the training. Children with dyslexia or whose dyslexia had been compensated demonstrated a variety of visual and phonological memory deficits, although children with compensated dyslexia exhibited higher scores than children in the dyslexia group.

3.3 Studies related to Dysgraphia

**Berninger, Nagy, Tanimoto, Thompson and Abbott (2014)** examined the effectiveness of iPad computerized writing instruction on children with diagnosed Specific Learning Disabilities (SLDs) affecting writing: dysgraphia (impaired handwriting), dyslexia (impaired spelling), and Oral and Written Language Learning Disability (OWL LD) (impaired syntax composing). Each of the 18 two-hour lessons had multiple learning activities aimed at improving subword- (handwriting), word- (spelling), and syntax- (sentence composing) level language skills by engaging all four language systems (listening, speaking, reading, and writing) to create a functional writing system. Results showed that the sample (n=35) as a whole improved
significantly from pretest to posttest in three handwriting measures, four spelling measures, and both written and oral syntax construction measures.

**Narang and Gupta (2014)** examined the effect of multimodal remedial techniques on the spelling ability of Learning Disabled children. The purpose of the study was to examine the effectiveness of three remedial techniques to improve the spelling ability of students with learning disability. The three techniques, namely, TAKV (tactile, auditory, kinesthetic, visual), visual orthographic method and LSRW (listen, speak, read and write) method were administered to three experimental groups, each having 13 students with learning disability. The students in the three groups differed in the kind of errors they made in spelling. TAKV, group, visual orthographic group and LSRW group comprised of dyseidetic spellers, dysphonic spellers and spellers with mixed errors respectively. The students in the sample had at least average intelligence, manifested specified traits of learning disability, had significant deficits in spelling skills and had no sensorial problems. The results indicated that all the three remedial techniques were significantly effective in ameliorating spelling deficits among students.

**Anilakumari (2012)** developed a multimedia remedial tracking package for dysgraphia among primary school students with Specific Learning Disabilities (SLD). The study aimed at developing and experimenting a specially designed study material in the form of Multimedia Package based on the learning style and remediation for children who exhibit
symptoms of Dysgraphia and closely related Dysgraphia characteristics. The study was survey cum experimental in nature. For the purpose, one group pre-test post-test design was adopted. The study concluded that MRTP (Multimedia Remedial Tracking Package) is more effective on the performance of PSS (Primary School Students) with SLD having different learning styles with respect to different aspects of Dysgraphia, and with respect to different aspects of Dysgraphia characteristics.

Barkhordar, Moghtadaie and Jafari (2012) examined the effectiveness of meta cognition strategies on children with spelling learning disabilities. The purpose of the research was to determine the efficacy of meta cognitive strategies on improvement in Spelling learning ability among male students with spelling learning disabilities in grade 3 elementary schools. The sample consisted of 40 third grade male students with spelling disabilities. The results suggested that meta cognitive strategies training improved the spelling performance of students with learning disabilities.

Mohanty (2012) examined the impact of intervention programme on the development of writing skills of students with Dysgraphia. The purpose of the study was to find out the prevalence rate of writing skill deficits (Dysgraphia) in children with Learning Disabilities and to evaluate the efficacy of the intervention programme in the development of writing skills viz, handwriting, spelling performance, writing expression and note taking, of students with Dysgraphia. The study employed pre-test, post-test control
group experimental design involving groups of students with Dysgraphia of
Grade VII in the age group 11 to 13 years drawn from public school. The
prevalence of writing disabilities among Learning disabled students in public
school was found to be 14.26 percentage. The findings revealed that the
intervention programme had a significant positive effect on development
writing skills of students with dysgraphia.

Akhondi (2011) conducted a study on the effectiveness of multimedia
instruction on the remediation of spelling disability students’ specific learning
in Iran. The purpose of the research was to consider the effectiveness of
multimedia instruction on the remedy of spelling disability students. The
population of the research consisted of all the boy and girl students with
spelling disorder in the third-grade elementary in Kermanshah city. In the
research quasi- experimental pre-post test with control group design was used.
The tools of the research were Wechsler’s intelligent test, spelling check list
and a research-made spelling test and multimedia instruction. The data was
analyzed with independent t test. The findings indicated that multimedia
instruction had a significant effect on remediation of spelling disability.

Overvelde and Hulstijn (2011) explored handwriting development in
grade 2 and grade 3 primary school children with normal, at risk, or
Dysgraphic characteristics. The study aimed to map the development and
improvement in handwriting during the early grades to differentiate between
temporary and consistent dysgraphic handwriting. In the longitudinal and
cross-sectional study, children in grade 2 (age 7-8 years, n = 169) and grade 3 (8-9 years, n = 70) took handwriting and visual motor integration screening tests twice within one school year. Result showed that Dysgraphia decreased strongly from 37% to 17% in grade 2 and diminished further to a low and stable rate of 6% in grade 3.

Rosenblum, Aloni and Josman (2010) explored the relationship between handwriting performance and organizational ability in school-aged children. The sample of the study consisted of 58 males, aged 7-8 years, 30 with dysgraphia and 28 with proficient handwriting. Group allocation was based on children's scores in the Handwriting Proficiency Screening Questionnaire (HPSQ). They performed the Hebrew Handwriting Evaluation (HHE), and their parents completed the Questionnaire for Assessing Students' Organizational Abilities- for Parents (QASOA-P). Significant differences were found between the groups for handwriting performance (HHE) and organizational abilities (QASOA-P). Significant correlations were found in the dysgraphic group between handwriting spatial arrangement and the QASOA-P mean score. The study strongly recommended assessing organizational difficulties in children referred for therapy due to handwriting deficiency.

Hooten (2009) examined the relationship of holistic scoring with handwriting legibility, spelling accuracy and number of T-units (shortest grammatically allowable sentences or minimally terminable unit) within
compositions written by children in grades 3 through 6 using path analysis. A sample of 223 compositions was rated for handwriting legibility and composition quality, and coded for number of T-units and percentage of accurately spelled words. Number of T-units was consistently the strongest predictor of holistic scoring across the four grade levels. Handwriting legibility and spelling accuracy yielded varying results in different grade levels.

Garcia, and de Caso (2004) examined the effect of a motivational intervention for improving the writing of children with Learning Disabilities. 66 fifth- and six-grade students with learning disabilities were assessed on a series of measures prior to and following the motivational intervention. Compared with a control group (n=61), trained students showed significant improvements in the quality of their writing (measured in terms of text structure and coherence) and in their attitudes towards writing. They did not, however, show significant changes in productivity (quantity of text produced), self-esteem, beliefs and expectations, or in writing-related attributions.

Rosenblum, Weiss, and Parush (2004) compared the abilities of digitizer-based evaluation of the handwriting process and conventional evaluation of the handwriting product to discriminate between children with proficient and dysgraphic handwriting. Copied and dictated writing samples were collected from 3rd grade students, 50 with proficient and 50 with
dysgraphic handwriting. Results indicated that both digitizer-based and conventional evaluations differentiated between children with proficient and dysgraphic handwriting, and that together they provided an improved understanding of writing difficulties. Moreover, copying and dictated writing task results differed significantly. The results demonstrated the advantages of combining both handwriting process and product testing, and utilizing both copying and dictation tasks, in order to achieve a more comprehensive understanding and superior evaluation of developmental dysgraphia.

Sovik (1984) examined the effects of a remedial tracking program on writing performance of Dysgraphic children. An experiment designed as a combined laboratory and classroom study was done with 12 male Norwegian third graders with dysgraphic problems. The remedial program was based on cybernetic principles and individualized. Results favoured the experimental program but were only significant with regard to accuracy scores; speed writing exercises were not included.

3.4 Studies related to Dyscalculia

Hunt (2015) examined the strategy usage and multiplicative thinking of three third grade students with learning disabilities specific to mathematics. Constant comparison analysis indicated that children increased their use of viable strategies, with notable differences in the sophistication of the strategies as well as the level of multiplicative thinking utilized before and after the ratio-based tutoring sessions.
Kohli, Sullivan, Sadeh and Zopluoglu (2015) examined longitudinal mathematics development of students with learning disabilities and students without disabilities. In the study linear, quadratic, and piecewise linear mixed-effect models were used to identify the best-fitting model for mathematics development over elementary and middle school and to ascertain differences in growth trajectories of children with learning disabilities relative to their typically developing peers. The sample of 2150 students was used for the study. Results indicated that the piecewise linear mixed-effects model captured best the functional form of students' mathematics trajectories.

De Castro, Bissaco, Panccioni, Rodrigues and Domingues (2014) examined the effect of a virtual environment on the development of mathematical skills in children with Dyscalculia. The sample consisted of 300 children between 7 and 10 years old, including 162 males and 138 females, in the second grade of primary school. They were randomly divided into the control (CG) and experimental (EG) groups. The EG participated in the virtual environment and the CG participated in reinforcement using traditional teaching methods. Scholastic Performance Test (SPT) was given as pre-test and post-test. A statistical analysis of the results using the t-test showed a significant learning improvement for the EG and no improvement for the CG. The study concluded that virtual environment allows the students to integrate thought, feeling and action, thus motivating the children to learn and contributing to their intellectual development.
Faramarzi and Sadri (2014) investigated the effectiveness of basic neuropsychological interventions in improving mathematics performance of girl students (8-9 years old) with dyscalculia. The research method was experimental with pre test, post test and a control group. The sample comprised of 30 second grade girl students (8-9 years old) of elementary school. The Wechsler Intelligence Scale for children (WISC-III-R), Keymath test, math academic performance test and clinical interview were used to gather data. The obtained data were analyzed by covariance analysis. The results revealed a significant difference between the mathematics performance of the experimental and control groups, girl students with dyscalculia. The study suggested that neuropsychological interventions can improve mathematics performance of students with dyscalculia and this method can be used for curing and assisting this group of students.

Re, Pedron, Tressoldi, and Lucangeli (2014) examined the response to specific training for students with different levels of mathematical difficulties. The purpose of the study was to determine the efficacy of specific, individualized training for students with different levels of mathematical difficulties. Fifty-four students, with either severe or mild math difficulties, were assigned to individualized training under controlled condition. Ten students with severe math difficulties ("dyscalculia") and 17 with mild math difficulties in the individualized training conditions were trained to improve their accuracy and fluency in math, compared to 9 students.
with severe math difficulties and 18 with mild math difficulties that were in the general training group. Students in the individualized training condition (both with dyscalculia and with mild math difficulties) outperformed the control groups after the training and at a later follow-up in almost all math components. Overall, the study supported the feasibility of treating both severe and mild mathematical accuracy and fluency difficulties with specific, customized training.

Wong, Ho and Tang (2014) conducted a study on identification of children with Mathematics Learning Disabilities (MLDs) using latent class growth analysis. The study attempted to identify children with MLD using the latent growth modeling approach. 210 Chinese-speaking children were classified into five classes based on their arithmetic performance over 3 years. A potential MLD class was identified, which demonstrated poor achievement over the 3 years and showed smaller improvement over time compared with the average-achieving class. On the other hand, another low-achieving class, which showed little improvement in arithmetic skills over time, was also identified. This class had an average cognitive profile but a low SES.

Betty (2013) explored the Mathematical creativity and ability for fundamental mathematical operations of primary school students with dyscalculia. The purpose of the study was to identify Dyscalculic students among primary school students and to compare Dyscalculic students and Normal students with respect to their Mathematical Creativity and Ability for
Fundamental Mathematical operations. The normative survey method was adopted for the study. Sample consists of 2024 students selected from 50 schools of Ernakulam district. The findings revealed among the selected primary school students, an average of 6% is Dyscalculic students. Dyscalculic students and Normal students (total sample) differ significantly with respect to Mathematical Creativity, Ability for Fundamental Mathematical Operations and all their components.

**Cai, Li and Deng (2013)** explored the cognitive processing characteristics of 6th to 8th grade Chinese students with mathematics learning disability. The aim of the study was to investigate the cognitive processing characteristics of Mathematics Learning Disability (MLD) students. A sample of 111 Chinese students (48 boys, 63 girls, Mean age = 11.97 years old) from 6th to 8th grades participated in the study, including 55 students who have MLD and 56, age and IQ-matched, students who are performing good at mathematics. The results showed that the MLD students have deficits in central executive of working memory, visual–spatial sketchpad and phonological loop. Among all the cognitive processing, simultaneous processing, planning, and visual–spatial sketchpad were significant predictors to MLD.

**Narimani, Abbasi, Abolghasemi and Ahadi (2013)** investigated the effectiveness of Acceptance and Commitment, and Emotional Regulation training in high-risk behaviours of students with dyscalculia. The research
followed a pre-test, post-test experimental design. The sample of the study consisted of 60 students with dyscalculia. The results of Multivariate Analysis of Variance (MANOVA) showed that "Acceptance / Commitment and Emotion Regulation" treatment trainings were effective in reducing high-risk behaviours, in a manner that they led to a reduction in negative emotions, self-destructive and impulsive behaviours of students with math disorder (dyscalculia).

Osisanya, Lazarus and Adewunmi (2013) examined the prevalence of dyslexia and dyscalculia among persons with academic deficits in English Language and Mathematics in public primary schools in Ibadan metropolis. A correlational survey study, sampling 477 pupils who were between the ages of 8 and 12 years, and in 4th and 5th grades with the use of four research instruments--the Myklebust Pupil Rating Scale (MPRS), the Slosson Intelligence Test--Revised Third Edition (SIT-R3), the Test of Pupil Reading Abilities Test (TPRA) and the Mathematical Abilities Test (MAT) was adopted. It was discovered that dyslexia and dyscalculia were prevalent among pupils with academic deficits in English Language and Mathematics, and that pupils with both dyslexia and dyscalculia were in the larger percentage. It was also discovered that learning disabilities, dyslexia and dyscalculia were not peculiar to any gender. The study suggested that persons with academic deficits in English language and mathematics should be
screened for either dyslexia or dyscalculia, even both. Also, they should be taught according to a carefully developed Individualized Education Plan.

**Tajrishi, Abkenar and Ashoori (2013)** conducted a study to determine the effectiveness of life skills training on the social self-competency of boy students with dyscalculia. The sample of 40 students chosen randomly from the population, consisted of students with dyscalculia aged 13-15 years old who were studying in learning disabilities centres in Tehran province. They were allocated to experimental and control group equally. Experimental group participated in 9 sessions (each session lasts for 50 minutes) weekly and received life skills training, but control group did not. All subjects completed social self-competency questionnaire before and after intervention. Data were collected from pre-test and post-test situations and analyzed by multiple analysis of variance (MANOVA). The findings of the study revealed that life skills training have significant effect on social self-competency of students with dyscalculia. The results revealed that life skills training have positive and significant effect on cognitive and behavioural skills, emotional competency and motivational set in students.

**Khodami and Hariri (2012)** compared the efficacy of planning training with meta-cognitive training on improving the educational performance of the Iranian elementary third-graders with math learning disability. 20 child participants with math learning disability were selected based on cluster random sampling technique. To collect the relevant data, the
researchers drew on some instruments including the relative Nerve psychology test (NEPSY), Wechsler intelligence scale for children, KEY MATH test, and academic performance test. The data analysis was carried out using the analysis of covariance. The findings of study suggested that meta cognitive training with the frequency of 52.32 (F=52.32, p, <=0.01) was more effective than planning training for the elementary third-graders with math learning disability.

Malekian and Nadi (2012) examined the effect of program learning on learning and retention of mathematics among the fifth step students affected with learning disabilities in Kermanshah city. The study followed a quasi-experimental with pre test-post test and control group design. Sample of the study consisted of 42 students including both girls and boys of fifth step of primary school affected with learning disabilities in Kermanshah city. The results showed that learning of the students affected with disabilities on mathematics with liner program instruction (p < 0.001) and branching program instruction method (p < 0.013) is better than the common training method. There is no important difference in learning (p > 0.346) and the retention (p >0.801), in liner and branching program instruction for the students affected with learning disabilities.

Pieters, Desoete, Roeyers, Vanderswalmen and Waelvelde (2012) examined the role of visual perception and motor skills in mathematical learning disabilities. In a sample of 39 children with Mathematical Learning
Disabilities (MLD) and 106 typically developing controls belonging to three control groups of three different ages, found that visual perception, motor skills and visual-motor integration explained a substantial proportion of the variance in either number fact retrieval or procedural calculation. Furthermore, children with MLD performed significantly worse on visual perception, motor skills and visual-motor integration in comparison with age-matched control children.

Sahebjamei and Mokhles (2012) studied the influence of educational designing based on assignment-process approach and investigation of its role on reduction of disabilities of student learning having mathematics disorder at elementary school. In the study, experiment group was treated with the method following educational designing based on assignment-process and control group with traditional method of educating mathematics. Results showed that experimental group after using assignment-process factor in the form of educational designing, in reduction of mathematics evolutorial disabilities including disability of comparison of number sets, logical and reasonable counting of numbers, reading numbers, arithmetic operations and narrative affairs relative to the control group have sensible growth.

Seo and Woo (2010) conducted a study titled the identification, implementation, and evaluation of critical user interface design features of computer-assisted instruction programs in mathematics for students with learning disabilities. A multimedia computer-assisted instruction program,
‘Math Explorer’, which delivers addition and subtraction word problem-solving instruction for students with learning disabilities at the early elementary level, was designed and developed. Usability testing was conducted to assess whether Math Explorer was well-designed in terms of the interface for students with learning disabilities. The results of the usability testing, the study corroborated the fact that the critical user interface design features and guidelines in mathematics computer-assisted instruction programs would be essential for facilitating the mathematical learning of students with learning disabilities.

**Stultz (2008)** studied the effectiveness of computer-assisted instruction for teaching mathematics to students with specific learning disability. An experimental research study was conducted to determine if computer-assisted instruction was as effective as other methods of instruction that do not use computers for teaching mathematics to these students. The results of the study indicated that a statistically significant difference between the two methods of instruction did not exist. However, the data also indicated that individual student characteristics or other factors may interact with the method of instruction utilized when teaching students with specific learning disability.

**Zunker (2008)** explored Computer-based instruction and mathematics skills of elementary students with learning disabilities. A pretest-posttest control group study assessed the effectiveness of a computer-based math intervention targeting the numbering skills, computation skills, and
motivational levels for elementary students with a learning disability. The researcher conducted a one-way analysis of covariance (ANCOVA) to determine if there was a statistically significant difference in mathematics ability and/or motivation for learning mathematics between the students within the control group versus the treatment group. Findings suggested that learning disabled students demonstrated an improvement in mathematics ability and motivational levels after utilizing the intervention.

**Elbaum (2007)** compared the performance of students with and without learning disabilities (LD) on a mathematics test using a standard administration procedure and a read-aloud accommodation. Analyses were conducted on the test scores of 625 middle and high school students (n = 388 with LD) on two equivalent 30-item multiple-choice tests. Whereas mean scores for students both with and without LD were higher in the accommodated condition, students without disabilities benefited significantly more from the accommodation ("ES" = 0.44) than students with LD ("ES" = 0.20). In addition, effect sizes from the study were combined meta-analytically with those of previous studies. Results of the meta-analysis revealed that for elementary students, oral accommodations on a mathematics test yielded greater gains for students with LD than for students without disabilities; for secondary students, the converse was true.

**Rousselle and Noe (2006)** conducted a study titled ‘Basic numerical skills in children with mathematics learning disabilities: A comparison of
symbolic vs non-symbolic number magnitude processing’. In the study 45 children with mathematics learning disabilities, with and without co-morbid reading disabilities, were compared to 45 normally achieving peers in tasks assessing basic numerical skills. The findings suggested that children with mathematics learning disabilities have difficulty in accessing number magnitude from symbols rather than in processing numerosity per se.

**Xin, Jitendra, and Buchman (2005)** investigated the differential effects of two problem-solving instructional approaches--Schema-Based Instruction (SBI) and General Strategy Instruction (GSI)--on the mathematical word problem-solving performance of 22 middle school students who had learning disabilities or were at risk for mathematics failure. Results indicated that the SBI group significantly outperformed the GSI group on immediate and delayed post tests as well as the transfer test.

**Koumoula et al. (2004)** conducted a study to validate and standardize an instrument for the diagnosis of developmental dyscalculia (mathematics disorder) in a Greek population and to obtain relevant epidemiological data. They used the "Neuropsychological Test Battery for Number Processing and Calculation in Children" (NUCALC) in a community sample of two hundred and forty students of age group 7 to 11 years from urban and rural schools. The study revealed no differences between genders in arithmetical performance; however, the effects of grade and socioeconomic level were significant. Prevalence was higher in the rural than in the urban area.
Landerl, Bevan and Butterworth (2004) explored the relation between Developmental Dyscalculia and basic numerical capacities. Thirty-one children of age group 8-9 years were selected for dyscalculia, reading difficulties or both, were compared to controls on a range of basic number processing tasks. Children with dyscalculia only had impaired performance on the tasks despite high-average performance on tests of IQ, vocabulary and working memory tasks. Children with reading disability were mildly impaired only on tasks that involved articulation, while children with both disorders showed a pattern of numerical disability similar to that of the dyscalculic group, with no special features consequent on their reading or language deficits. The study concluded that dyscalculia is the result of specific disabilities in basic numerical processing, rather than the consequence of deficits in other cognitive abilities.

Shalev et al. (2001) conducted a study to find whether developmental dyscalculia is a familial Learning Disability. Siblings and parents of 39 children with dyscalculia were assessed for arithmetic, reading, and attention disorders. Findings indicated a familial prevalence of dyscalculia almost ten fold higher than expected for the general population and suggested that dyscalculia, like other learning disabilities, has a significant familial aggregation, pointing a role for genetics in this disorder.

Swanson and Lee (2001) explored mathematical problem solving and working memory in children with Learning Disabilities. The purpose of the
investigation was to study the relationship between Working Memory (WM) and mathematical problem solving in children with Learning Disabilities (LD). Children with LD (age 11.5 years) were compared to Chronologically Age-Matched (CA-M). The results showed that children with LD were inferior on measures of word solution accuracy, components of problem solving, phonological processing, domain-general WM, and verbal WM when compared to children who were CA-M.

Gilbert (1992) conducted a status study of dyscalculia for the primary grades. The purpose of the study was to present general guidelines and global approaches to instruct children with dyscalculia. Each of the six types of dyscalculia was paired with the 22 characteristics of dyscalculia in order to select instructional approaches. The study concluded that to date there are no instructional programs to conclusively remediate dyscalculia. It also concluded that the general guidelines presented in the study and previously used to instruct children with mathematical learning disabilities should be used in conjunction with the four global approaches identified in the study--the direct instructional approach, the cognitive approach, problem solving strategies, and technology--in order to deal with children with dyscalculia.

Tishler (1982) compared cognitive development as measured by the ability to conserve length, area, and volume in two groups of seventh-grade students. The groups consisted of students of average or above average intelligence who (1) evidenced learning disability in mathematics but who
performed well in reading (N=30) and (2) those who performed well in both subjects (N=30). Samples were selected from seventh-graders in the Shelby County, Alabama, school system. A comparison of selected factors indicated different maturation levels between the dyscalculic and control groups. Results indicated that the proportion of students who could conserve volume in the dyscalculic group was significantly less than the proportion of conservers in the control group. Further, sex differences were found among control pupils with nearly 89 percent of the males but only 50 percent of the females capable of conserving volume.

3.5 Studies related to Instructional Strategies

Calcut (2015) examined the effects of Success Makers Math as an intervention for students. The purpose of the quasi-experimental, single subject, pre/posttest design study was to determine the impact of a Tier II intervention using Success Makers Math, a learning system that adapts to the unique needs of the individual student. The sample consisted of 10 students in Grade 5 who were identified as at risk for math failure. They completed 4 weeks of intervention daily for 30 minutes using Success Makers Math. A paired t test was conducted using pre/post-test Star Math scores and revealed a significant increase in math scores for participants (t (9) = 4.690, p = .001) before and after the RtI (Response to Intervention) model.

Gray (2015) investigated the effects of two kinds of word study on the literacy skills of 34 adult struggling readers. Young adults seeking high
school equivalency diplomas were randomly assigned to intensive individual tutoring, two hours once a week for four weeks, in either morpho-phonemic or whole word study to learn academic vocabulary from a civics curriculum. Those given morpho-phonemic instruction analyzed Latin and Greek word origins, parsed morpheme and syllable structures, and extracted base words in morphologically related words. Those taught whole word study focused on spelling the words, reading additional sentence contexts with target words, and generating meaningful related words. The findings revealed that the group who received morpho-phonemic tutoring transferred their learning from the vocabulary lessons to the reading of unfamiliar words, whereas the group who received whole word tutoring did not.

**Guzman (2015)** examined the impact of Sheltered Observational Protocol Model (SIOP) on academic success of English Language Learners (ELLs). The study included two, randomly chosen, third grade homogeneous groups with 113 ELLs in each group from two different elementary schools. The results effectively communicated a significance and positive impact of implementing the SIOP model, and support the claim that the model increases English language proficiency and reading scores as well as college and career readiness among ELLs.

**Heishman (2015)** conducted a study to find out the effectiveness of computerized working memory training on math achievement and other transfer effects in children with ADHD and math difficulties. Twenty-three
(including 11 females) school-aged children with co-occurring math difficulties and ADHD participated in a quasi-experimental, repeated-measures study to investigate transfer effects of working memory training (Cogmed RM) on math achievement, fluid reasoning and memory and learning tasks. As part of a pilot, the Cogmed Progress Indicator (CPI) was used to measure transfer effects. Standardized instruments were administered at baseline and at 4-weeks and 4-months post-intervention. The results revealed significant improvement on the CPI indices measuring verbal memory, visual memory, verbal working memory, symbolic working memory, attention/concentration, working memory, general memory, and fluid reasoning 4-weeks post-intervention.

Leonard (2015) conducted a comparative study to determine the effectiveness of accelerated cohort technical programs on student success, defined by grade point average, for both traditional and adult learners compared to traditional technical programs at the community college level. The study was conducted within the Industrial Process Control Program (IPCT) at a community college satellite campus located in a predominately rural county in middle Tennessee. The sample included 138 students who had successfully completed all remediation requirements and a minimum of one first semester IPCT course. The research was conducted utilizing a 2X2 factorial design with testing for significance achieved through the use of a two-way ANOVA with an alpha level of 0.05. The study found no significant
effect or interaction when considering the grade point averages of students regardless of delivery method or age. The study concluded that accelerated cohort programs were a viable alternative to traditional delivery methods.

Manrique (2015) examined three different instructional delivery modalities in order to identify the best practices for training and education of military personnel. The quantitative research sought to identify the best practices for military education recognizing the instructional delivery that results in the highest student academic performance and the highest level of personal learning satisfaction in order to identify program effectiveness. The population for the research study consisted of nine hundred students (n=900), divided into three groups of 300 students. Each group was composed of five courses of 60 students each who have completed the Defence Support to Civilian Authorities (DSCA) program via one of the three instructional delivery methods: face-to-face instruction, n=300; digital instruction, n=300; or web-based instruction, n=300. The findings after conducting all statistical analyses revealed that in fact the overall, type of instruction significantly affected participants' reported course satisfaction and course success, even when controlling for educational level, branch of service, gender, and instructor teaching experience. Based upon the findings, participants who received face to face instruction had higher course success (final grades) than did participants who had web-based and digital instruction. Participants who had face-to-face instruction also reported higher course satisfaction than
participants who had web-based and digital instruction.

**Odeyemi and Akinsola (2015)** examined the effects of Mnemonics and Prior Knowledge Instructional Strategies on Students’ Attitude to Mathematics. The study adopted the pre-test-post test control group, quasi experimental design with 3x2x3 factorial matrix. The sample consisted of 288 students. Data collected was analyzed using Analysis of Covariance, Multiple Classification Analysis (MCA) and Scheffe Post hoc test. The findings revealed that treatment has significant effect on students’ attitude to mathematics.

**Shalette (2015)** examined the effect of Computerized Cognitive Training on the working memory and mathematics achievement of low achievers. The goal of the study was to examine the interactions among working memory, computerized cognitive training and academic achievement. A random pre-test post-test control-group experimental study was followed. The experimental group received progressive computerized working memory training. The control group received basic computerized working memory training. The findings revealed that both experimental and control groups subjects showed improvements in working memory as well as in mathematic achievement.

**Shehu (2015)** investigated the effect of Problem-Solving instructional strategies on students’ learning outcomes in senior secondary school Chemistry. The sample consisted of 96 senior secondary students. The
The instrument for data collection was the 30-item Chemistry Achievement Test (CAT). The data collected were analyzed using mean, standard deviation and t-test. The results revealed that student taught using problem-solving performed significantly better than those taught through lecture method.

Ely, Kennedy, Pullen, Williams and Hirsch (2014) investigated a multimedia-based intervention, which pairs video with a Content Acquisition Podcast (i.e., video plus CAP) to teach pre service teachers to implement vocabulary practices with struggling students. The sample consisted of 49 teachers. The findings revealed that those who watched the video plus CAP used significantly more teaching behaviours associated with an evidence-based vocabulary practice during instruction than the comparison group.

Hansen, Wadsworth, Roberts and Poole (2014) evaluated the effects of an intervention for teaching phonological awareness skills to kindergarten-age children with intellectual and developmental disabilities. The intervention employed a combined multiple treatment and multiple baseline design, embedded in playtime and implemented under naturally occurring conditions. Six children in a special education kindergarten class were taught syllable segmentation, first sound identification, and phoneme segmenting. Results indicated that all children made gains on each skill.

Kumar (2014) examined the effectiveness of Multimedia Instructional strategy and Modular Instructional strategy on the achievement in English of secondary school students. The study was experimental in nature and was
conducted on the sample of 500 students of class IX. Instructional Strategies were taken as independent variable whereas Achievement as a dependent one. The results showed that F ratios were significant for the main effect of Instructional Strategies. The inter correlation coefficient between the variables of Instructional Strategy and Achievement was also positive and significant at 0.01 level of confidence.

White, Summers, Zhang and Renault (2014) evaluated the effects of a self-advocacy training program for undergraduates with disabilities. The purpose of the study was to explore the efficacy of a training program with a group of college students who have physical, sensory, and/or learning disabilities regarding their acquisition of knowledge and skills related to their rights to reasonable accommodations under several disability-related federal laws. The study showed significant results concerning student acquisition of knowledge and accommodation skills.

Gambari, James and Olumorin (2013) investigated the effect of cooperative, competitive and individualistic instructional strategies on the performance of high, medium and low academic achievers using video instructional package. A total of 120 senior secondary school mathematics students were randomly assigned into cooperative, competitive, individualized, and conventional teaching methods. Students from each group were stratified into high, medium and low achievers. Video Instructional Package (VIP) on mathematics and Geometry Achievement Test (GAT) were
used as treatment and test instruments, respectively. Analysis of Variance and Scheffe test were used for data analysis. Findings indicated that there was significant difference in the performance of the groups in favour of cooperative learning strategy. Students’ achievement levels had significant influence on their performance in competitive and individualized instructional settings.

**Quince (2013)** conducted a mixed-methods study to examine the effect of self-regulated learning strategy interventions on students’ self-regulated learning conduct and academic success in community-college online courses. Two intact classes of community-college online students participated in the studies in two subsequent quarters. Results suggested that self-regulated learning strategy intervention was successful in increasing the metacognitive awareness and self-regulated learning skill levels of community-college online students. Increased metacognitive awareness and self-regulated learning skills positively contributed to students’ efficacy for academic success in online courses. Implications of the study contribute to research examining self-regulated learning strategy instruction as a means for promoting online student success.

**Crary (2010)** explored Multimedia-based animated demonstrations as an instructional strategy for teaching computer software procedures. The study compared student performance on end-of-lesson assessments after viewing a multimedia-based lesson. The experiment was a fully crossed
factorial design (2x2x2) utilizing a multimedia animation. The sample consisted of 500 high school students. An analysis of variance with repeated measures was completed for the pretest and posttest assessment using 3 between-subjects factors and 1 within-subjects factor. The study revealed that all students significantly improved from pretest to posttest with the use of animated demonstrations. Students who participated in guided practice with the animated demonstration improved significantly more from pretest to posttest than students who did not participate in guided practice.

Lifshitz, Klein and Cohen (2010) examined the effects of a yearlong Mediational Intervention for Sensitizing Caregivers on: (a) the quality of interactions between rehabilitation day center paraprofessional staff (n = 10) and their adult consumers (n = 19) with severe Intellectual Disability (ID). Regarding the staff–consumer interactions, more mediation of meaning (choice-making), expansion, and competence with explanation and less mediation of physical assistance were observed in the intervention group than in the control group following intervention. The findings of the study revealed consumers in the MISC group improved their arithmetic skills, temporal concepts, and sequential memory of two digits. Behavioural observations indicated that the MISC group revealed increased positive behaviours, autonomy, and duration of work and decreased verbal and maladaptive behaviours.
Schuit, Segers, Balkom and Verhoeven (2010) examined the effectiveness of an early language intervention which draws upon neurocognitive principles of language processing and language learning. Ten children participated in the intervention and 18 were followed for control purposes. The intervention group showed greater progress than the control group.

Heo (2007) examined the impact of multimedia anchored instruction on the motivation to learn on students with and without learning disabilities placed in inclusive middle school language arts classes. The purpose of the study was to investigate the impact of multimedia anchored instruction in language arts on the motivation to learn and academic achievement of students with and without learning disabilities (LD) enrolled in a seventh-grade general education classroom setting. Two teachers and 80 randomly selected students including 28 students with LD participated in the study. Results indicated that students in anchored instruction group made significant gains of peer learning, interest, and less work avoidance than non-anchored instruction group. Moreover, students with LD who received the anchored instruction improved their motivation to learn and academic achievement to a level similar to students without LD. The overall results of the study suggest that anchored instruction is an effective instructional approach that integrates technologies into the classroom learning as a medium for enhancing students' motivation to learn and academic achievement.
Koeze (2007) examined the effect of differentiated instruction on student achievement in an elementary school. The purpose of the study was to determine if differentiated instruction had an effect on student achievement. The study followed a mixed method design and consisted of two parts. First, a quantitative analysis of test scores from the Michigan Education Assessment Program (MEAP) and teacher and student survey results were analyzed as a means to outline broad relationships from the data. Findings suggested that the differentiation strategies of choice and interest play a vital role in achievement and student satisfaction in learning. Findings also suggested that teachers just beginning differentiation should first administer a learning styles inventory to their students.

Harris and Denet (2006) explored the effects of a multi-sensory language-based program on students who exhibit characteristics of dyslexia. The purpose of the study was to ascertain the effects of a multisensory language-based program, ‘Language’, that is offered in Louisiana school districts to students who exhibit characteristics of dyslexia. The Language program participants were compared to students with characteristics of dyslexia who participated in the traditional reading programs offered in his or her school. The instruments used in the investigation were the Developmental Reading Assessment Test (DRA) and the IOWA Test of Basic Skills (ITBS). The findings indicated that the multi-sensory language-based program had a significant effect on students who exhibit characteristics of dyslexia.
Bijl, Alant and Lloyd (2005) compared two strategies of sight word instruction in children attending a school for learners with moderate to severe mental disability. Thirty-three participants were matched according to their gender, receptive language skills and alphabet knowledge. Results showed that individuals with moderate to severe mental disability are able to learn sight words through any of the strategies implemented.

Moccia (2005) explored the influence of multi-sensory, multi-component reading intervention strategies with middle school poor readers. The purpose for the researcher was to evaluate the influence of a multisensory, multi-component reading improvement method for middle school students diagnosed with a reading disability in a suburban middle school setting. Thirty-seven students with disabilities participated in Wilson Reading System (WRS) intervention and 47 other students with disabilities participated in Individual Learning Program (ILP) intervention. The same numbers of General Education Reading (GER) students were matched to each group from the general population of approximately 500 students in grades 8 and 9. The findings revealed that the reading programs in place for students with disabilities (ILP and WRS) have an impact on student performance.

Lowery (2003) examined instructional strategies and practices used to enhance student success in the high school Algebra I inclusive classroom. The purpose of the qualitative study was to examine the instructional conditions and practices described as successful for teachers in the Algebra I inclusive
classroom. The study supported the notion that an affective classroom climate coupled with collaborative planning among team teachers, general educators and special educators who co-teach in the inclusive classroom, promotes an instructional environment conducive to learning. The effective use of time along with teacher adaptations and accommodations appeared to keep students engaged in the learning process. However, other influences, including insufficient teacher training, negative student behaviours, and inappropriate student placement, were found to affect student achievement in the inclusive classroom.

**Ricker (1996)** examined the effects of instruction in a multi-sensory imagery strategy on fifth graders' prose processing and attitude toward reading. The purpose of the study was to investigate the effects of instruction in imagery strategies on fifth-grade students' image construction, reading comprehension, and attitude toward reading. Since the dependent variables of image construction, reading comprehension, and attitude toward reading were presumed to be related, a multivariate analysis of covariance (MANCOVA) procedure was used to analyze post test data. While the findings revealed that there were no overall statistically significant post test differences among the groups, univariate F tests did reveal significant differences among the groups on two subcategories of image construction on post tests to measure the effects of instruction.
3.6 Studies related to Achievement

Choi (2015) examine the effect of Alternative teacher Compensation Programs (ACPs) on teacher retention rates and average student achievement in schools. The study used the Minnesota Quality Compensation program (Q Comp) case to examine the effect of ACPs. The study investigated teacher retention rates and student proficiency rates in Minnesota public schools over 8 years, 2003-2010. The school-level student proficiency rate for the third-grade mathematics and reading tests of the Minnesota Comprehensive Assessment (MCA) was used to measure school-level student achievement. The study found a positive effect of Q Comp on overall teacher retention rate only in schools with 5 years of implementation. Regarding the effect of Q Comp on student achievement, the study did not find any significant overall effect on schools.

Dutra (2015) conducted a study to determine the relationship of specific attributes (personological, affective, and fitness variables) of college students to their academic achievement at an independent university in central Florida. The data was collected from 168 students at Florida Institute of Technology. Multiple regression results revealed that 19% of the variance in a students' academic achievement was due to the influence of these three sets of research factors. The results of mediation analyses also indicated that three variables had significant direct effects on academic achievement, gender, and sports motivation. In addition, gender had a significant indirect effect on
academic achievement via stress, and the number of academic credits had a significant indirect effect on academic achievement via sports motivation.

**McCluskey (2015)** compared student achievement in online and face-to-face sections of MBA courses. The mixed methods study compared face-to-face and online part-time MBA sections on student's academic achievement and satisfaction at a university in the North East. The sample included part-time MBA students enrolled (N=1021) in eight courses over a three year period. Each course included a face-to-face and online section taught by the same faculty member over several semesters during the three year period. The preliminary analysis found that student characteristics (Undergraduate GPA, Graduate GPA, Undergraduate Major, Undergraduate Degree, GMAT score) did not vary by delivery mode (face-to-face, online). A regression analysis found no significant differences on achievement between face-to-face and online students. An ANOVA was conducted to see if satisfaction levels (Likert scale) varied between face-to-face and online students. Both groups reported positive satisfaction ratings, however, the results were not significantly different between the two delivery modes.

**Merilus (2015)** examined how first year international students who completed one semester described their interpersonal relations, external experiences with daily living requirements, knowledge of immigration procedures, academic achievement, socio-cultural adjustment, and willingness to stay in the United States of America (USA) after they complete their
college studies. The 256 students surveyed had a sense of successful socio-cultural adjustment to American culture when compared to international students who lived off campus, those who lived with an American roommate, and those who lived with international students. There was no significant difference for international students who lived on campus with or without an American in their interpersonal relations. In addition, there were no significant difference between male and female students and their descriptions of interpersonal relations, external experiences with daily living requirements, knowledge of immigration procedures, academic achievement, social-cultural adjustment, dealing with college life, dealing with Americans, interpersonal relations with Americans and with diverse people, personal feelings, visa help, and their willingness to stay on in the United States after they completed their education.

Salame (2015) examine the effects of adapting the instructional congruence model on the English Language Learners' (ELL) attitudes and achievement in science. The mixed-method approach was adapted. Data sources were the "Attitude Towards Science" survey, VNOS-C questionnaire, Luykx and Lee (2007) observational instrument, Gee (1997) discussion categories, video recordings, and pre and post-tests. The results of the study indicated that student achievement increased. The study also revealed that instructional congruence model in science education has been successful in reaching different learners, improving students' attitudes and achievement in
science and enhancing teacher's views and practices. The model had significant potential for meeting the challenging goals of reformed science education.

Sittler (2015) examined the effects of audio and gender in a 3D gaming environment on the achievement of different educational objectives. A sample of undergraduate Communications Media students from a mid-sized university in Western Pennsylvania was recruited to take part in the study. Participants were randomly assigned to one of three groups: Control (no music), Treatment 1 (Mozart's Sonata for Two Pianos in D Major), or Treatment 2 (self-selected music via Spotify). The study utilized a 2 X 3 factorial post-test only design with two independent variables: audio (3 levels -- none, default, and self-selected) and gender (2 levels -- male and female). The dependent variable measured achievement on three criterion-referenced tests (identification, terminology, and comprehension) as well as an aggregate score for each group. No significant difference was found between subjects that received no audio treatment and subjects that listened to Mozart. The Mozart group outperformed the control on composite scores by 7.77% (out of 100%). Both the Control and Mozart group outperformed the self-selected group significantly. In addition, overall, females outperformed males on achievement tests. Further analysis discovered that participants self-identifying as a gamer or non-gamer can have an effect on performance. Overall, the study found that both music and gender do play a role in
participants' achievement on criterion-referenced tests as they relate to instructional content.

**Torres-Pagan (2015)** conducted a study to determine if cyberlearning significantly improves student achievement in low-performing high schools. Furthermore, the study examined whether the inclusion of cyber learning support significantly reduces the achievement gap between groups of students in Puerto Rico (i.e., male vs. female, special education vs. regular education, Puerto Rican vs. non-Puerto Rican). The study followed a quasi-experimental design that involved a pre test and post test. A one-way analysis of covariance was conducted to determine if there were significant differences between the treatment students and control students on post test math achievement scores after statistically controlling for their pre test math scores. The study revealed that cyber learning was as effective as traditional learning when looking at all of the students in the study. In addition, when comparing gender, female online students had comparable results to male students in traditional and online classrooms. This means there was no significant difference in mathematics achievement between genders when students learn online. However, the study did not reveal any differences in special education students or non-Puerto Rican students.

**Wilson (2015)** examined relationship between specific health-related fitness components and standardized academic achievement tests. The study assessed the impact of optimal versus minimal physical fitness state on
student academic achievement. The study sample included 5,416 ninth grade students. These students completed a minimum of 5 of the 6 components of the ‘Fitnessgram’ tests, and who also completed the math and English Language Arts (ELA) portions of the California Standards Test. Analyses included independent samples t tests, ANOVA, and Dunnet's C test to detect differences in mean academic scores with gender and ethnicity as covariates. The findings revealed that optimally fit students had significantly higher (p < 0.05) scores in math and ELA tests relative to minimally fit students. Female academic test scores tended to be higher than male scores in both academic tests. The study concluded that School officials, when contemplating curricular programs devoid of a physical education component, might judiciously reassess the positive effects of physical fitness upon academic achievement and the associated bio psychosocial benefits for their students.

**Abdi (2014)** investigated the effect of Inquiry-Based Learning Method on students' Academic Achievement in Science course. The purpose of the study was to investigate the effects of inquiry-based learning method on students' academic achievement in science lessons. A total of 40 fifth grade students from two different classes were involved in the study. They were selected through purposive sampling method. The group which was assigned as experimental group was instructed through inquiry-based learning method whereas the other group was traditionally instructed. The experimental study lasted eight weeks. To determine the effectiveness of inquiry-based learning
method over traditional instruction, an achievement test about sciences which consisted of 30 items was administered as pre-test and post-test to students both in the experimental and control groups. For the statistical analysis, Analysis of Covariance (ANCOVA) was used. The results showed that students who were instructed through inquiry-based learning achieved higher score than the ones which were instructed through the traditional method.

Sarita (2014) investigated the effect of cooperative learning on academic achievement, academic anxiety and social competence of high school students. In the study, a pre-test-post-test control group quasi experimental design was employed with a purposive sample of 96 students from standard IX. It was found that the subjects exposed to cooperative learning method achieved higher on achievement test in comparison to those exposed to traditional method of teaching. The study concluded that when cooperative learning method was used to teach the students, there was increase in academic achievement and social competence and reduction in anxiety.

Kumar (2013) examined the effect of multimedia approach and traditional method on retention and academic achievement of Science students at secondary school level. The sample consisted of 90 students studying in standard IX. The results showed that the multimedia approach is more effective than the traditional method in teaching science to secondary school students in relation to their academic achievement and retention.
Manoj (2013) examined the effectiveness of drawing skill oriented instructional approach on achievement in basic science of students at primary level. Experimental method was used in the study. The design selected was pre-test post-test non-equivalent group design. The study was conducted on a sample of 300 students of Standard VII (150 students each in both experimental and control group). The study concluded that the Drawing Skill Oriented instructional approach is more effective than present Activity Oriented Approach on Achievement in Basic Science of students at primary level. The Drawing Skill Oriented Instructional Approach is more effective than present Activity Oriented Approach with regard to retention in achievement and retention in Drawing Skills of students at primary level.

Rajan (2013) studied the effectiveness of certain information processing models on achievement in English of students at secondary level. The design selected for the study was pre-test – post-test non – equivalent group design. For experiment, the investigator selected five groups each consisting of 80 students – four experimental groups and one control group. Out of the four experimental groups, first three were taught through the selected Information Processing Models such as Advance Organiser Model, Synectics Model and Inductive Thinking Model respectively and the fourth one was taught using all the three selected Models combined. The control group was taught through Activity Oriented Method. The investigator used different tools such as Lesson Transcripts based on Advance Organiser
Model, Synectics Model, Inductive Thinking Model and Activity Oriented Method, Achievement Test in English for standard IX, Language Creativity Test, and Language Interest Inventory. All the tools were used as pre-test and post-test. The findings of the study revealed that all the selected Information Processing Models such as Advance Organiser Model, Synectics Model and Inductive Thinking Model and all the three Information Processing Models combined are more effective than Activity Oriented Method on enhancing Achievement in English of students at Secondary level for total sample and relevant sub samples.

Rani (2013) explored the efficacy of different instructional media on academic achievement and self concept of class XII students. The major objective of the study was to find out the relative effectiveness of three modes of instructions i.e. visual, print and conventional on students’ academic achievements and self-concept. The sample comprised of 120 economic students in class XII. The data was analysed with ANOVA further interpreted by mean scores and t ratio for simple, double and triple interactional effects. In the study, visual media of instruction was found to be most effective in enhancing students’ academic achievement in economics and developing self-concept among them, as compared to print media and traditional method of teaching. Level of intelligence was found to be the major factor in elevating academic achievement and raising self-concept among students.
**Dessemontet, Bless, and Morin (2012)** examined the effects of Inclusion on the Academic Achievement and Adaptive Behaviour of children with Intellectual Disabilities (ID). A comparative study with an experimental group of 34 children with ID fully included in general education classrooms with support, and a control group of 34 comparable children in special schools has been conducted. The progress accomplished by these two groups in their academic achievement and adaptive behaviour has been compared over two school years. Results revealed that children included in general education classrooms made slightly more progress in literacy skills than children attending special schools. No differences were found between the progress of the two groups in mathematics and adaptive behaviour. The study concluded that Inclusive education is an appropriate educational option for primary pupils with ID who require extensive support in school.

**Rani (2012)** examined the effect of traditional method of teaching and multimedia approach on emotional intelligence and academic achievement of elementary school students of Haryana. The study followed pre-test, post-test, experimental design. The sample of the study consisted of 200 students studying in class VII. Traditional method and multimedia approach were used for the control group and the experimental group respectively. A two way (2x2) factorial design was employed for the statistical analysis of the collected data. In light of the gathered data, multimedia approach has been
found to be more effective on students’ emotional intelligence & academic achievement than the traditional teaching methods.

**Sheffield (2012)** examined the impact of Positive Behaviour Intervention Support (PBIS) on male and female students' academic performance. In the study, a 2x2 factorial design evaluated the effectiveness of PBIS implementation at the middle school level. The focus of the study was to examine if the PBIS framework impacted males and females achievement scores differently in the areas of Reading and Math. The results of data analysis showed that there was a significant difference in Reading scores between females and male students. Additionally, results also showed that there was a significant interaction between Gender and PBIS intervention with the PBIS females outperforming the Non-PBIS females in the area of reading. However, evidence showed that there was no main effect for gender, PBIS intervention, or interaction effect of gender versus PBIS intervention on Math scores.

**Sivaprasad (2012)** examined the effect of selected correlates of Achievement Motivation on Academic Achievement in Biology among the students at higher secondary level. The study was designed with Achievement in Biology as dependent variable and examination anxiety, study habits, self concept and home learning environment as independent variables. Gender, locale of the institution and type of management of schools were treated as background variables. The sample selected for the study was based on
stratified random sampling technique. The investigator adopted normative survey method for the study. The tools used for the study were Examination anxiety scale, Study habits inventory, Self concept scale, Home learning environment inventory and Achievement test in biology. The hypotheses and objectives were formulated and suitable statistical methods such as Pearson’s Product Moment Coefficient of Correlation, two-tailed test of significance of difference between means, the test of significance of difference between correlation coefficients, ANOVA, Scheffe’s method and partial correlation were used to analyse the collected data. The study revealed a significant correlation between each independent variable (examination anxiety, study habits, self concept and home learning environment) and dependent variable (Achievement in Biology). The findings suggested that home learning environment and study habits have the decisive impact upon the scores of biology achievement of students, followed by self concept and examination anxiety.

Bacon (2011) examined the relationship between academic self-concept and academic achievement in African American students who have experienced geographic mobility. The study used quantitative methods to assess African American students from Iowa (U.S.), to obtain information about the students’ relocation from urban to rural school environments and to understand how such moves influenced their academic performance and academic self-concept. Gender and length of time since transition were also
considered. The sample consisted of 101 African American middle school/junior high students who had been enrolled in Iowa schools for less than 24 months or more than 24 months. Results indicated a significant relationship between academic self-concept and academic achievement. Gender and the length of time since transition were not shown to be linked to students’ academic ability or performance in school.

Rajan (2011) conducted a study to determine the effectiveness of certain Embedded Strategies like Metacognitive Awareness, Approaches to Studying, Achievement in Economics, and Retention Capacity on academic performance of Economics of Higher Secondary School Students. The Quasi-Experimental Method with the Pre-test-Post-test Non-Equivalent Group Design was adopted in the study. The sample comprised of 432 standard XI students from four Locales of Kozhikode and Waynad districts. The data gathered was tabulated and statistically treated using techniques like Test of Significance (t-test), Analysis of Variance (ANOVA), Analysis of Covariance (ANCOVA), and Karl Pearson’s Product-Moment Coefficient of Correlation. The findings of the study revealed that the Embedded Strategies are more effective than the Strategies based on Constructivism in improving academic performance in Economics of Higher Secondary School students for their total sample and sub samples based on gender and locale of School.

Abdullah (2010) explored the effects of a cooperative technique Jigsaw II and instructional teacher-centered teaching method on Turkish
language teacher education department students’ attitudes to written expression course (a course in which writing skills were taught), their academic achievement, retention and their views. The sample size of experimental group was n= 42 and that of control group was n=38. In the research "pre-test/post-test with control group experimental design" was used. The data was collected through Attitudes to Written Expression Scale (ATWES) and Written Expression Achievement Test (WEAT), Students' View Form (SVF). The statistical analyses revealed that there were significant differences between the experimental and control groups in terms of their attitudes, academic achievement, and retention in favour of the experimental group. In addition, it was found that the experimental group students had positive views on the use of Jigsaw II technique.

Cheriyan (2010) examined the effectiveness of Kolb’s experiential learning model on achievement in Mathematics of students at secondary level. The study was conducted using experimental method and the design selected was pre test-post test non-equivalent group design. The sample for the experiment consisted of 326 students of standard IX. Findings of the study indicated that the achievement in mathematics of students taught using Kolb’s Experiential Learning Model was significantly higher than that of those taught using Activity Oriented Method.

Inel and Balim (2010) investigated the impact of the problem-based learning method used in science and technology teaching upon elementary
school students' construction levels for the concepts concerning the "Systems in Our Body" unit in the science and technology course and their academic achievement. During the four-week experimental application process, the course was taught using the problem-based learning method in the experimental group and the control group curriculum was only based on the science and technology textbook. The study used two groups including the experimental (n = 20) and control (n = 21) groups, and the pretest posttest control group semi-experimental design. The analysis of the obtained data revealed a significant difference in favour of the experimental group on the academic achievement test.

Kallarackal (2009) examined the relative effectiveness of Multiple Intelligence Approach (MIA) on the achievement in biology of secondary school students. The major objective of the study was to ascertain the relative effectiveness of Multiple Intelligence Approach (MIA) and Conventional Method of Direct Instruction (CMDI) on the achievement in Biology of secondary school students. The study was conducted in the pre- test - post-test non-equivalent group design. The sample of the study consisted of 188 students of which 94 students were in each experimental and control groups. The major finding of the study was Multiple Intelligence Approach is more effective than Conventional Method of Direct Instruction CMDI on the total achievement in biology of secondary school students
Shah (2009) explored the impact of teacher’s behaviour on the academic achievement of university students. The major purpose of the study was to investigate the impact of teacher’s behaviour on the academic achievement of the university students in Pakistan. 375 teachers and 1500 students from five departments were randomly selected as the sample of the study. Two questionnaires, one for university teachers and other for university students were developed for the collection of data. Collected data were tabulated, analyzed and interpreted in the light of objectives of the study by applying statistical tools of chi-square and Pearson’s Product – moment coefficient of correlation (r). The study revealed significantly positive correlation between teacher’s behaviour and students’ academic achievement scores. The major conclusions of the study were that teachers felt proud to be teachers, they adjusted themselves with the prevailing situation and circumstances, and they used different motivational techniques for teaching. Students were found to be satisfied with the positive behaviour of their teachers.

Minikutty (2005) examined the effectiveness of Concept Attainment Model of instruction over Conventional Teaching Method on achievement in Mathematics of academically disadvantaged students. In the study, non-equivalent pre test - post test control group design was used. The design provides reasonable control over most sources of invalidity. The sample consisted of 256 academically advantaged students and 249 academically
disadvantaged students who were equally distributed in experimental and control groups. The investigator conducted experiments in the intact classrooms and the groups were statistically equated using the technique ANCOVA. The findings revealed that Concept Attainment Model is more effective than Conventional Teaching Method on achievement in Mathematics of academically disadvantaged students.

Suresh (2000) investigated the effect of interactive approach model in teaching English as second language. The main purpose of the study was to compare the effectiveness of Interactive Approach Model over the Conventional Method of teaching. An experimental method with non-equivalent pre test – post test control group design was followed in the study. The sample consisted of 259 students with 130 students in the experimental group and 129 students in the control group. Tools used were Tests of English as a Second Language, and Oral Communication Rating Scale. The findings revealed that the students taught by the Interactive Approach gained higher in the achievement in English as Second language than those who were taught by the Conventional Method.

Conclusion
revealed the existence of dyslexia, dysgraphia and dyscalculia among primary school students in Kerala. Mattingly (2014) indicated that early intervention is more effective in compensating learning disability.

The studies conducted by Westreich (2013), Sideridis et al. (2013) and Shipp (2008) implied the shortcomings of the existing techniques in identification of learning disabled. Herman (2006) pointed out the high need for compensating strategies for learning disabled students. Aydeniz et al. (2012) hinted the need for changing curriculum, instruction and assessment for students with learning disabilities. Mathew (2000) detailed the importance of modern instructional strategies in minimising learning disabilities. Westendorp et al. (2011) stressed the importance of specific interventions facilitating both motor and academic abilities in children with learning disabilities. Bentum (2000) revealed that resource room instruction could not help the learning disabled. Giess (2005) and Harris et al. (2006) pointed out that multisensory intervention was successful in compensating reading disability in high school students. Magnan et al. (2004) revealed the impact of audio-visual training on performances of reading disabled children. The review helped the investigator to know the current research status in these areas and to identify the strengths and weakness in previous work. But studies on strategies to improve academic achievement of learning disabled and multisensory as an instructional strategy was rarely found. In this context the
investigator decided to develop a multi sensory strategy to improve academic achievement of learning disabled primary school students.