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Effect of metacognitive instructional programme on achievement of primary school students with dyscalculia in number concept

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Abstract
Mathematics is essential to all areas of daily life. It affects the successful functioning of an individual at school, at home, in the job and in the community. The current situation of global community suggests that high levels of mathematical and technical skills are needed for most jobs in the 21st century. Therefore, it is important to ensure that all students including those planning to pursue higher education should have sufficient skills to meet the challenges of the 21st century (NEGP, 1997). Dyscalculia significantly hinders academic achievement in mathematics or activities of daily living that require mathematics ability. This paper is an attempt to study the effect of metacogitive instructional programme on mathematics achievement of primary school students with dyscalculia related to number Concept. Sample of 70 dyscalculic students from 14 schools was collected through random as well as purposive sampling methods. Data was collected through Teacher's Referral Form, General Mental Ability Test for Children (GMATC, 1986), Diagnostic Test for Learning Disability (DTLD, 1993) and Achievement test for Numeracy Skills. Findings showed the positive effect of activity and various strategies based metacognitive instructional programme on achievement of dyscalculic students in number Concept.

Keywords: Mathematics achievement, dyscalculia, metacognitive instructional programme, number concept

Introduction
The education system in India is very immense, comprising various schools and higher education institutions. The National Education Policy (2020) focuses on rebuilding the curriculum, making it easier, a reduction in the syllabus and focus on core essentials and it gives more emphasis on experiential learning and critical thinking. In current scenario we can see the diversities not only on cultural or linguistic fronts, but also on the needs of children attending schools with varying disabilities (Pandey & Agarwal, 2016) [26]. 'Education for All' (EFA) is an international initiative to bring the benefits of education to every citizen in every society, launched in 1990 with combine efforts of central and state govts., civil societies, UNESCO and World Bank Group. The 'Education for All' still remains a distant dream for education of children with learning disabilities. Poor achievements in reading, comprehension and basic mathematical functions were and are the issues of concern for Indian Education.

Many teachers and parents do not have required knowledge and awareness about these difficulties. The disappointing level in children's achievement could be due to the learning problems or learning difficulties faced by them. There are instances of poor performance in spite of average and above average intelligence, sufficient teaching-learning instruction and teaching-learning materials, adequate motivation and healthy home environment, well social and cultural opportunity (Karande & Kulkarni, 2005) [14]. In India, with the diverse social and cultural differences it becomes important to identify these students and properly train them.

Learning disabilities are first observable when there is a clear and unexplained gap between an individuals' level of expected and actual level of achievement. Learning disabilities embrace problems in the area of social skills, emotional skills and behavioural skills. Sardonically, policy related to learning disabilities is yet to see the daylight. In the absence of such a policy and unsuitable environment, children with learning disabilities cannot be

rehabilitated in regular schools. Despite of increasing interest, we still have no clear idea about the incidence and prevalence of learning disabilities in India. Because of various socio cultural factors and use of various languages in India, the awareness on learning disabilities is very low.

Dyscalculia refers to a range of mathematics learning disabilities. Students with dyscalculia have difficulties in understanding what numbers mean, remembering math facts and steps to complete math problems or may have difficulty with visual-spatial concepts used in making patterns or in geometry. Dyscalculia may be related to language processing disorders which result in difficulties in learning math vocabulary needed to understand math concepts and to solve more complex problems. The children with dyscalculia may have difficulty in the areas of math reasoning, computation (addition, subtraction, multiplication and division), math memory, math writing, sequencing and math speaking, as well as visual-spatial orientation (Sahare, 2017) [30].

In India, the incidence of dyscalculia in primary school has been reported as 5.5%. However, the academic under achievement is caused by specific learning disability, the awareness about this fact has recently increased. (Mittal *et al*., 1977; Shah *et al*., 1981; Ramaa & Gowramma, 2002) [21, 33, 27]. Therefore, treatment of dyscalculia addresses the multiple facets of the disorder and focusing on educational interventions to improve study skills in general and strengthening number perception and arithmetic concepts in particular. Research in this domain indicates that students with learning disabilities can improve their overall study skills and benefit from specific techniques and assistive technology for their individual problem (Juliet & Nagavalli, 2015) [13].

Justification of the study

Mathematics is a symbolic language that allows us to deal with the abstract ideas and concepts that is not possible in our alphabetic language. Lack of achievement in mathematics is growing global as well as national concern and it is likely that there will be an internal emphasis on mathematics instruction for the new future, for learning disabled students. In fact mathematics is a way to settle in mind a habit of reasoning so the question arises, "How do we do mathematics in our heads". This question is related to the issues such as children's acquisition of arithmetic knowledge and skills and nature of arithmetic problems among children with dyscalculia.

A few researches have examined (Geary & Brown, 1991) [77] specific cognitive programme for instructing children who have mathematics disability to determine how they solve simple mathematical problems. The student understand the concept but they are unable to use it effectively in solving problems they experience difficulty in solving problems that require conceptualization and abstract mental processes. The present study intends to see the effect of metacogitive intructional programme on ahievement of primary school students with dyscalculia related to Number Concept. Hence the study is justified on that ground.

Considering the multifaceted nature of the mathematics, it is important to evaluate the metacognitive skills in order to focus on metacognitive training and its role in mathematics learning and development (Desoete, 2007) [3]. The curriculum that most students with LD are exposed to is unproductive because little emphasis is put on the everyday application of mathematics in their lives (Obudo, 2008) [25]. When elementary students with mild disabilities are taught a strategy to solve math word problems, they perform better on process and product was better than that of students who received conventional instruction (Fuchs & Owen, 2002) [5]. Teaching different strategies helped the children to learn and retain not only higher order concepts and problems, but also basic mathematics facts (Isaacs & Carol, 1999, & Steinberg, 1985, as cited in Tournaki, 2003) [10, 39, 38]. Students with LD performed better in the strategy condition as compared to the control and drill and practice conditions. Jerman & Swanson (2006) [11] also concluded that cognitive mechanisms such as memory and monitoring processes influence the learning of math.

Objectives of the study

The objectives of the present study were:

- To study the effect of the metacognitive instructional programme on achievement of primary school students with dyscaculia in Number Concept.

Hypotheses of the study

To achieve the objectives of the study, following hypotheses were formulated:

- There exists no significant difference in achievement of primry school astudents with dyscaculia of experimental group and control group after the implementation of metacognitive instructional programme related to Number Concept.

Population and sample

- **Population:** This study was conducted in Yamuna Nagar district of Haryana. The population of the present study consisted of all the students of Grade III studying in CBSE affiliated English Medium Public Schools of Yamun Nagar.
- **Sample:** In the present study, initially the random sampling technique was used to select the schools. At the first stage, the investigator selected 14 CBSE affiliated English Medium Public Schools from Yamuna Nagar district randomly. Further, the purposive sampling method was used by the investigator to identify the dyscaculic children.

Tools Used

Following tools were used to collect the data:

- Teacher's Referral Form: developed by the researcher.
- General Mental Ability Test for Children (GMATC, 1986)
- Diagnostic Test for Learning Disability (DTLD, 1993)
- Achievement Test for Numeracy Skills (ATNS) (Number Concept)

Design of the study

In the present study, the pre-test post-test control group design was used.

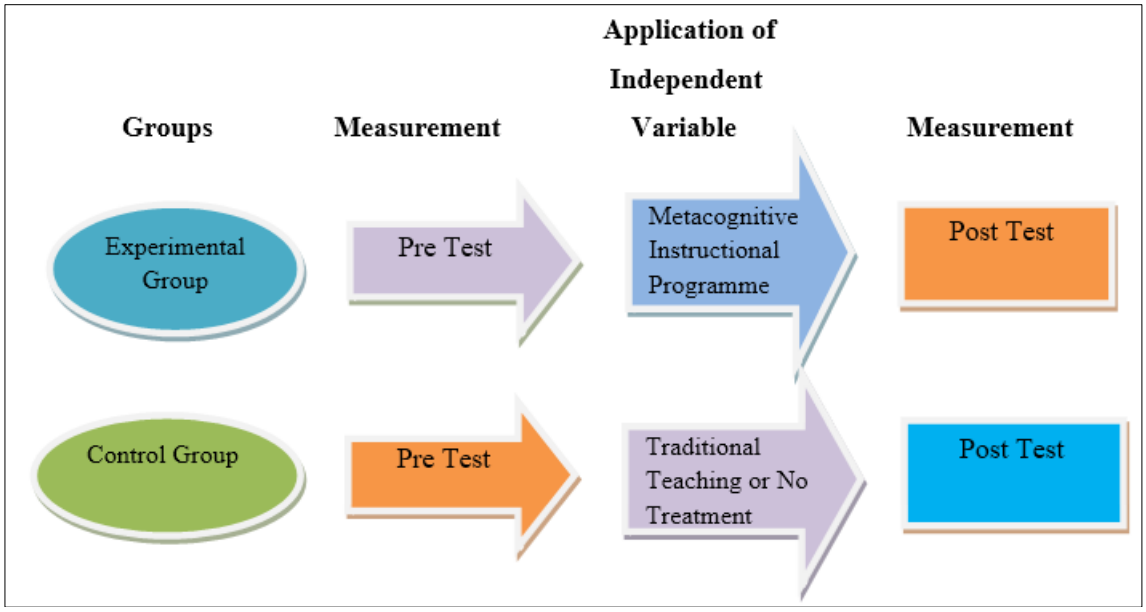

Fig 1.1: Pre-test Post-test Control Group Design

Following were the four operational stages in the study:

i. Identification
ii. Pre-Testing Stage
iii. Intervention Stage
iv. Post-Testing Stage

Stage I: Identification Stage

The purpose of Identification and Pre-Testing Stage was to identify the students with 'dyscalculia'. This stage included the following phases:

- **Phase I:** Screening the students having problems in mathematics on the basis of Teacher's Referral Form.
- **Phase II:** Assessing the level of Intelligence Quotient of referred students on the basis of General Mental Ability Test for Children (GMATC, 1986).
- **Phase III:** Identification of students with dyscalculia on the basis of Diagnostic Test for Learning Disability (DTLD, 1993)

On the basis of above criteria of identification of dyascalculic students, the description of prevalence rate of dyscalculia among the primary school students is given in the following table:

Table 1.1: Prevalence Rate of Dyscalculia

Name of the School	Total No. of Students in Grade III	Students Referred by the Class Teacher	Low achievers in mathematics with average and above average level of Intelligence	No. of Students with Dyscalculia	Percentage of Students with Dyscalculia
Total	1240	525	179	88	7.09

On the basis of results presented in table 1.1 the prevalence rate of dyscalculia is found to be 7.09% among the students of Grade III studying in CBSE affiliated English Medium Public Schools in Yamuna Nagar District. It means that these students are having average or above average level of Intelligence Quotient (IQ) but their performance in mathematics is poor. Out of 88 identified students with dyscalculia, 70 students were then divided into two equal groups experimental group and control group.

Stage II: Pre-Testing Stage

After identification of students with dyscaculia and formation of experimental and control groups, the next stage was to compare the achievement of students of both the groups. It was compared on Achievement Test for Numeracy Skills (ATNS), sub-test Number Concept to find out whether there was any significant difference between the mean performances of both the groups. The scores of Achievement Test for Numeracy Skills (ATNS), sub-test Number Concept was obtained and was taken as pre-test scores.

Table 1.2: Significance of Difference between Mean Scores of Experimental and Control Groups w.r.t. Pre-Test of Achievement Test for Numeracy Skills (ATNS), [sub-test Number Concept]

Groups	N	Mean	S.D.	t-value
Experimental	35	9.57	4.74	0.454*
Control	35	9.77	1.99	

*Not significant at 0.05 level of significance

From the table 1.2, it can be concluded that the mean scores of experimental group and control group with regard to pre-test of Achievement Test for Numeracy Skills (ATNS), sub-test Number Concept are 9.57 and 9.77 respectively and standard deviations for both the groups are 4.74 and 1.99 respectively. The calculated t-value is 0.454 which is not significant at 0.05 level of significance. Therefore, there exists no significant difference between the mean scores of

experimental and control group with regard to pre-test of Achievement Test for Numeracy Skills (ATNS), sub-test Number Concept.

Stage III: Intervention Stage

After pre-testing stage, the investigators developed and implemented the 'Metacognitive Instructional Programme' for improving achievement of students with dyscalculia in Number Concept. The duration of the whole programme was 40 days. The experimental group was taught through this Metacognitive Instructional Programme for 'Number Concept. This programme was blend of different metacognitive strategies and metacognitive activities. Different types of activities, games, study materials, projector, online videos and smart ET tools were used by the researchers to make teaching and learning effective.

Stage IV: Post-testing Stage

After the implimentation of the Metacognitive Instructional Programme, the Achievement Test for Numeracy Skills (ATNS), sub-test Number Concept was re-administered to the experimental group and control group to study the effectiveness of Metacognitive Instructional Programme on achievement of the students with dyscalculia in Number Concept.

Table 1.3: Significance of Difference between Mean Scores of Experimental Group and Control Group w.r.t. Achievement Test for Numeracy Skills (ATNS), [sub-test Number Concept]

Groups	N	Mean	S.D.	t-value
Experimental	35	11.89	2.15	7.771*
Control	35	18.17	4.27	

*Significant at 0.05 level of significance

The table 1.3 presents that the mean scores of experimental group and control group with regard to post-test of Achievement Test for Numeracy Skills (ATNS), sub-test Number Concept are 11.89 and 18.17 respectively and standard deviations are 2.15 and 4.27 respectively. The 't' value obtained is 7.771 which is greater than the table value at 0.05 level of significance. There exists a significance difference between the mean scores of experimental and control groups in post test. The result shows that the performance of experimental group is better as compared to control group with regard to post-test of Achievement Test for Numeracy Skills (ATNS), sub-test 'Number Concept' after exposure to Metacgnitive Instructional Programme (MIP).

Findings of the study

The findings of the present study are as follows:

- No significant difference is found in the pre-test scores of experimental group and control group on Achievement Test for Numeracy Skills (ATNS) sub test 'Number Concept' before the implementation of Metacognitive Instructional Programme (MIP). Therefore the achievement of both groups was considered to be on same level.
- There exists a significance difference between the mean scores of experimental and control groups in post test of sub test 'Number Concept' of Achievement Test for Numeracy Skills (ATNS). The result shows that the performance of experimental group is better as compared to control group with regard to post-test of Sub Test 'Number Concept' of Achievement Test for Numeracy Skills (ATNS) after exposure to Metacgnitive Instructional Programme (MIP).

Conclusion

Based on the findings of the present study, it can be concluded that the effect of Metacognitive Instructional Programme is significantly positive on achievement of primary school students with dyscalculia in 'Number Concept'. The students with dyscalculia improved in four basic areas of number concept i.e. addition, subtraction, multiplication and dividsion after the implementation of Metacognitive Instructional Programme (MIP). The metacognitive measures are effective way to help the children with learning disabilities. The results of the study were supported by the studies of Carluccio, 2005 [2]; Shih, 2006 [34]; Scheuermann, 2006 [32] and Kaufmann, *et al*., 2012 [15] which also reveal that by using various intervention strategies, both Instructor-oriented and technology-oriented had significant effect on learning disability students. The current study for students with dyscalculia found the significant effect of various metacognitive strategies like advance organizer, graphic organizer, think aloud, mnemonics and cooperative learning strategies on mathematics achievement related to number Concept. This result is concurrent to the researches by Naseri *et al*., 2017 [23]; Rizk *et al*., 2017 [28]; Boylea *et al*., 2016 [1]; Safari and Meskini, 2015 [29]; Sahin and Kendir, 2013 [31] as they concluded that metacognitive strategies help the children with learning difficulties in mathematics problem solving.

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