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Development and Standardization of Dyscalculia Screening Tool(DST)

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Abstract Dyscalculia is considered as the inability to grasp the arithmetical calculations and number concepts. The main goal of this study is to design, develop and standardize Dyscalculia Screening Tool. ThisScreening Tool is usedfor students who come under the age level of 8-10 years to screen the mathematical disability. The researcher constructed self-made Dyscalculia Screening Toolwith six dimensions namely .Numerical Difficulties, Identification Difficulties, Cognitive difficulties, Problem Solving Difficulties, Reasoning / Logical Difficulties, Understanding Difficulties to identify the students who face the difficulties in basic mathematical and numerical calculations. The pilot study was conducted for 63 students, from3 primary schools inDevakottai Educational District. The tool consists of 34 items whichwerestandardized. Thetool is standardized by Cronbach's alpha reliability value is 0.835 (N=26) and the split-half reliability value is 0.842 (N=26).The final draft contains 26 items as a standardized tool for Screening Students with Dyscalculia. The researcher analyzed the result that the students faced much more difficulties in problem solving ability, understanding the mathematical concepts, logical reasoning and lack of reminiscence capacity. The study suggests that by improving the cognitive aspects of students in their arithmetical learning process the above difficulties can be resolved.

Keywords: **Dyscalculia, Screening Tool, Standardization, Students**

I. INTRODUCTION

Dyscalculia means "specific learning disability in mathematics"[1]. Dyscalculia means rigorous or absolute incapability to count up [2]. Students with Dyscalculia generally have average intellectual ability but having difficulty in certain deliberation processes in particularly cognitive process [3].According to(Kosc 1974; Gross-Tsur, Manor & Shalev, 1996) Research on the cognitive and neural causes of arithmetical difficulties has exposed that they can be an outcome of an explicit insufficiency in number processing.Such primary deficits in number evaluation and inequity and in understanding fundamental concepts like number storing up and reversibility, in spite of otherwise classically increasing intellectual abilities, are referred to as developmental dyscalculia [4, 5].

Dyscalculia Screening is a course of action which identifies a person who is struggling to solve mathematical calculations. The researcher constructed the self-made screening tool to identify the students of lower mathematical performance, as well as showing the signs and symptoms of Dyscalculia. Adaikala Jeya A, Pio Albina A, (2019)explainedthat the importance of the screening tool is to identify a person who needs further assessment for diagnosis of a disability. Alternatively said, a person is being suspected as having disability by the act of screening. A screening procedure does not `confirm' disability, but helps in short listing for detailed assessment. Screening is assessing a whole population in order to identify those individuals for whom some intervention in development would be beneficial [6].Individually administered standardized tests, is considerably below that expected given the person's chronological age, calculated intelligence, and age-appropriate education, measures the mathematical ability (DSM IV-TR 315.1 and ICD 10 F81.2-3) which significantly interferes with scholasticattainment or activities of daily living that requirearithmeticalabilities' cited in American Psychiatric Association, 1994, Section 315.1[7].The theory of making sense of mathematics was the base to develop this instrument proposed by Chin and Tall (2012) [8].According to Butterworth (2002) the concept of numerosity was one of the important aspects in developing the screening tool for dyscalculia [9]. Nagavalli T (2015) emphasis on the different dimensions of the screening tool for primary students of dyscalculia was an inspiration to develop this tool [10]. The students were screened to check the

level of performance exists whether below or above the norms. Identification is used to scrutinize special students to establish the clear-cut personality of their difficulties (Mohd Sharani Ahmad, 2004) [11].This paper specially deals with the students' mathematical disability (Dyscalculia), and is being checked by giving the checklist to the fifth standard of primary school students, through which the tool is being standardized.

II. RELATED WORKS

The researcher reviewed 10 studies for constructing the Screening tool to identify the dyscalculic students at primary level.Robert Peard, (2010) revealed in his study that math-phobia exists among students, which is identified by feverish feelings in math class, difficulty in understanding math problem during the math class among the students [12]. FetinicaGliga, TeodoraGliga (2012), had studied on " Romanian screening instrument for Dyscalculia" a pilot test of a screening instrument focused at less dynamic children who are at-risk for dyscalculia. The findings revealed that all these children, deemed at risk for dyscalculia, scored above the threshold for mental delay on two IQ tests[13].Chin Kin Eng, et.al, (2014) developed an instrument for measuring and identifying the prevalence of Dyscalculia among primary school students in Sabah, Malaysia. The researcher developed the Dyscalculia Instrument as a computer-based assessment for students which aim to recognize the characteristics of dyscalculia by response accuracy and time to test items. The purpose of the researcher in this study tried to report the preliminary study for dyscalculia which involved 91 students in three primary schools in Sabah, Malaysia. The results showed that 5.5% primary school students in Sabah suffer from Dyscalculia [14].Esmeralda Zerafa, (2015) had studied on "Helping Children with Dyscalculia: A Teaching Programme with Three Primary School Children" that Dyscalculia is a specific learning difficulty which hinders learners from their acquiring of knowledge in mathematics. The researcher explains that it doesn't allow the person to improve the fundamental numerical concepts which are needed for the achievement in mathematics. The study aimed at exploring strategies to help dyscalculic children to conquer some of the drawbacks. The findings recommended that suitable interference can bring success in dyscalculic students to grasp the essential numerical concepts which are must for mathematics learning[15].Gurpreet Kaur, (2017) had studied on "Math-Phobia: Causes and Remedies" and this article examined the causes and remedies of poor mathematics teaching and learning in primary and post-primary schools and recommends measures to overcome them. The researcher found in the study that students have math-phobia which is conformed in the math class, with feverish feelings,struggle to understand the math problem with others, and also unpleasant environment among other students [16].Butterworth, (2003) has carried out a computer based screening test of arithmetical skills, including the identification of small and larger numerosities and comparisons of number size. These characteristics initiated to find out those who are affected by severe mathematical complications (dyscalculia) [17].

III. NEEDFORTHE CURRENT STUDY

The grasping capacity of the cognitive aspects in mathematical calculations of primary school students that are really quite difficult to identify from the teacher's perspective are, whether they come under mathematical learning disability, slow learners, lack of interest in mathematics and emotional instability etc. Some have fear of mathematics (Math Phobia); some students may not like the mathematics teacher. So they don't want to show interest to study mathematics. Thus the investigator planned to develop the dyscalculia screening tool. Hence, there is a need in India to develop an instrument to measure the mathematical disability of primary school students. This is to be administered for the 8-10 year old students as a pilot study for standardization of the tool for the screening and identification of students with dyscalculia.

IV. OBJECTIVES

The objectives of this present study are to;

- Develop the Dyscalculia Screening tool (DST)
- Find out the Reliability of the Dyscalculia Screening Tool (DST)

❖ Find out the Validity of the Dyscalculia Screening Tool (DST)

V. SAMPLE

The tool was distributed to 63 students of Devakottai Educational District who were selected randomly from 3 Primary Schools and each school consisted 21 students of 5th standard between the age group of 8-10 years.

VI. CONSTRUCTIONOFDYSCALCULIA SCREENING TOOL (DST)

6.1. Ensuring Purpose and usefulness of Items:

TheDyscalculia Screening tool (DST) has been developed by the researcher to screen the dyscalculic students between the ages of 8 and10 years studying in 5thstandard. The investigator reviewedfive screening tools for the primary school students who were finding difficulties with mathematics. The Dyscalculia Screening Toolwas prepared by referring previousresearch, in view of one's own experience, taking expert's advice with recognized authorities and modifying the accumulated materials into test items.Dyscalculia Screening Tool (DST) was developed by the researcher to gather knowledge and to identify the students' mathematical disabilities. This toolwillbe used as a preliminary study for the screening of dyscalculia students at primary school level. The investigator referred books and journals which was helpful in standardizing the tools on Dyscalculia. Dyscalculia Screening Tool prepared on the basis of Disability and Implications on Learning, (2016), **"**Understanding disability as Mandated by RPwD ACT 2016, Dyscalculia characteristics**"**, Rehabilitation Council of India, BLOCK1, and Unit 2, 29-30 and based on the characteristics of Dyscalculic students given in RPwD ACT-16, the researcher constructed the tool [18].

6.2. Structuring the tool

Dyscalculia Screening tool (**DST)** was constructed with six dimensions namely 1.Numerical Difficulties (Place Value&Numerosity) 2.Identification Difficulties (Directions, Sizes, Shapes &Sequential counting) 3. Cognitive difficulties(Memory and Thinking)4.Problem Solving Difficulties(Procedural / Motor Abilities)5.Reasoning / Logical Difficulties(Multiple Tasks) 6.Understanding Difficulties (Math Language, Formulae's & Signs etc).

6.2.1Numerical Difficulties (Place Value & Numerosity) Bynner and Parsons, (1997) as cited in Brain Butterworth, (2003) expressed that "Good numeracy skills are important for being an effective member of a modern numerate society"[17]. Difficulty in placing the numbers in accordance with the correct order like ones, tens and hundreds which are the important aspects for the basic operations of addition, subtraction etc. Numerosity is the number of objects in a set. Students with dyscalculia find difficulties withclarificationof numbersto write and read itcorrectly.

6.2.2Identification Difficulties (Directions, Sizes, Shapes & Sequential counting) Describingbigger quantities correctly can be done by using counting with language. In the developmental path towards successful counting, regardless of the culture, unless the child knows to count the sequential order of numbers then it is difficult to proceed for counting. The signifying act for counting (generally pointing) and to use that indicating act to connect one number label to one entity (i.e., one-to-one connection), to learn methods to remember already-counted entities from as yet uncounted entities and to learn the fundamental importance of the last said number word [19] are the required areas to be learnt.

6.2.3. Cognitive difficulties (Memory and Thinking) Students with Dyscalculia generally have average intellectual ability but have difficulty in certain deliberation processes, particularly in the cognitive process[3]. Memory and thinking are related to Cognitive abilities. Memory takes the procedure of trying to recall or to remember what ever had been learned earlier. Creative Thinking and concentration help the students to perform any work or computations in an extraordinary way. Memory refers to an intellectual workspace, concerned in controlling, regulating, and vigorously maintaining appropriate information to complete complicated cognitive tasks (e.g. mathematical processing). Math Memory, grasping capacity formulae's are very poor for students with Dyscalculia [1]. Working memory and math have much relation in improving the speed in daily calculations and arithmetical skills in excelling the fluency in thinking and

memory which ultimately develops the cognitive skills. Lack of memory and thinking will lead the students to be back at cognitive aspects of learning and acquiring math skills [20].

6.2.4. Problem Solving Difficulties (Procedural / Motor Abilities)ccording toKosc, (1974); Gross-Tsur, Manor & Shalev, (1996) Research on the cognitive and neural causes of arithmetical difficulties have exposed that they can be the outcome of an explicit insufficiency in number processing. Difficulties with memory, lack of critical thinking causes the inability to understand the word problems and calculations [4, 5]. Writing the numbers, drawing the shapes, filling the blanks,etc.includes the motor abilities of the students. Forgetting of symbols, operations or confusions while calculating may be the hindrance to solve the math problems. Especially children find difficulties to solve the simple math word problems and coordination of sensory organs to function the mathematical procedure and the motor abilities. Multisensory techniques might help the students to develop the procedural abilities.

6.2.5. Reasoning / Logical Difficulties (Multiple Tasks) Multiple tasks mean efficiency in organizing and performing number of duties simultaneously. Students find it difficult in connecting the previous knowledge to learn the new concepts not only in mathematics, but also in our daily living. Students find it hard to correlate the multiple tasks in a given single problem. Students who are low in mathematical scorings findit hard to simplify the steps and using the logical ideas to connect the given numbers with the related concrete objects. For exampletriangle means it has three sides and three angles (tri-three). These aspects of reasoning in mathematical concepts are lacking in many of the school children. Multisensory techniques, repeated drill and practice might help the students to develop the reasoning /logical abilities.According to Newman, R. M. (1998)Dyscalculia students are better in areas of science trying to attain higher math skills, numbers with logic not formulas in geometry;they try to achieve a lot [1].

6.2.6. Understanding Difficulties (Math Language, Formulae& Signs etc) Poor sense of number and understanding the mathematical concepts is the major problem for Students with dyscalculia. Not only that but also they find it hard to understand the arithmetical language of signs, formulae, sizes, quantity of number and therelationship of numbers to one another. Approximately 3 to 6 percent of students suffer from dyscalculia [21]. Students struggle due to the language difficulties which have an effect on their ability to comprehend and formulate the ideas or instructions into actions of carrying out the arithmetical calculations and especially solving theword problems in mathematics. There are many reasons why children may find it difficult to monitor their own mathematical thinking, and most young children have limitations in expressing their ideas due to language difficulties where rote memory may also be the reason for arithmetical information like arithmetical facts, multiplication tables and sequential counting etc. These hindrances can also cause understanding difficulties in developing the mathematical knowledge of the students.

6.3. Pilot test

The pilot test was administered to find the weakness and practicability of the items. It was tried outon an investigative basis in 63respondents. The aim at this point was to get out of the irrelevant items from the procedure. Items which were not suitable, lengthy, ambiguous and not appealing were reconstructed to be shortlisted, precise and easily answerable.

VII. ITEM ANALYSIS

According to Sommer & Sommer, (2005) the degree to which the various Items "Hanging Together" show an Item Analysis [22]. To find the statistical validity the modified Draft tool with 34 items were negative statements and among them 6 from Numerical difficulties, 7 from Identification difficulties,5 from Cognitive difficulties, 6 from Problem Solving Difficulties, 5 from Reasoning / Logical Difficulties, 5 from Understanding Difficulties administered to a sample of 63 students studying in 5^{th} standard (8-10) agegroups belonging to Government, Aidedand Matriculation in rural and Urban Areas. The studentswere instructed to read carefully and put the tick on either Yes or No. The collected Responses were scored with help of a scoring key set by the Investigator. DyscalculiaScreening Tool is a Two-point rating scale. The scoring was "0 for Yes and 1 for No". Item total and the sum of each individual score were calculated. When respondent's reactions of the scoring got over, the validity of everything has been set up by subjecting the statistics to 'Goodness of Fit Test'

which is generally called one sample test of chi-square. It is one of the several applications of chi-square test[23]. Now it is used to test the hypothesis shaped for every statement in the draft tool that the answers established under the two-point scale ranging from 'Yes or No'.

VIII. DRAFT TOOL

Table No.1equips the number of statements arranged for the Dyscalculia Screening Tool (DST).The different dimensions of the final form of the tool are furnished in table no.1.

Table 1: Dimension wise item categorization

S.NO.	Dimensions	Statements
1.	Numerical Difficulties	6
2.	Identification Difficulties	7
3.	Cognitive Difficulties	5
4.	Problem Solving Difficulties	6
5.	Logical/Reasoning Difficulties	5
6.	Understanding Difficulties	5
	Total	34

IX. VALIDATION OFTHE TOOL

The validity of a tool is the degree to which it measures and also supposed to measure. The validity of the current tool is tested in terms of content validity, item validity, and constructsvalidity.

9.1.Content Validity

The test items represented the wholerange of probable items. The test questions may be taken from a hugegroup of items which wrap a largeseries of topics. In order to establish the content validity of the constructed tool, the investigator submitted the draft tool to the research supervisor for suggestions and modifications. After incorporating the suggestions given by the supervisor, the investigator consulted three experts in the field of mathematics education and psychology. The experts after going through the draft they had suggested changes in the statements of the tool. The researcher carried out the necessary modifications and established the final tool.

Table: 2

Item -Dimension total Goodness of Fit Test

Item No.	**Goodness of Fit**	**Table Value at0.01 Level**	**Remark**	ItemNo.	**Goodness of Fit**	**Table Value at0.01 Level**	**Remark**
1.	**13.349**	**6.64**	**Accepted**	18.	**38.111**	**6.64**	**Accepted**
2.	**29.349**	**6.64**	**Accepted**	19.	**44.587**	**6.64**	**Accepted**
3.	**48.016**	**6.64**	**Accepted**	20.	**17.286**	**6.64**	**Accepted**
4.	**38.111**	**6.64**	**Accepted**	21.	**41.286**	**6.64**	**Accepted**
5.	**55.254**	**6.64**	**Accepted**	22.	**41.286**	**6.64**	**Accepted**
6.	**19.444**	**6.64**	**Accepted**	23.	**15.254**	**6.64**	**Accepted**
7.	**59.063**	**6.64**	**Accepted**	24.	**9.921**	**6.64**	**Accepted**

8.	**48.016**	**6.64**	**Accepted**	25.	**51.571**	**6.64**	**Accepted**
9.	**59.063**	**6.64**	**Accepted**	26.	**24.143**	**6.64**	**Accepted**
10.	**51.571**	**6.64**	**Accepted**	27.	**59.063**	**6.64**	**Accepted**
11.	**51.571**	**6.64**	**Accepted**	28.	**51.571**	**6.64**	**Accepted**
12.	**11.571**	**6.64**	**Accepted**	29.	**24.143**	**6.64**	**Accepted**
13.	**44.587**	**6.64**	**Accepted**	30.	**59.063**	**6.64**	**Accepted**
14.	**59.063**	**6.64**	**Accepted**	31.	**48.016**	**6.64**	**Accepted**
15.	**48.016**	**6.64**	**Accepted**	32.	**24.143**	**6.64**	**Accepted**
16.	**59.063**	**6.64**	**Accepted**	33.	**35.063**	**6.64**	**Accepted**
17.	**26.683**	**6.64**	**Accepted**	34.	**3.571**	**6.64**	***Rejected***

Table No.2 furnishes the "Goodness of Fit value" for each one of the 34 Items. Table No.2 explains that by removing item number 34, the enduring 33 Statements are to be retained as the stated null hypothesis for this statement are Accepted at 0.01 levels.

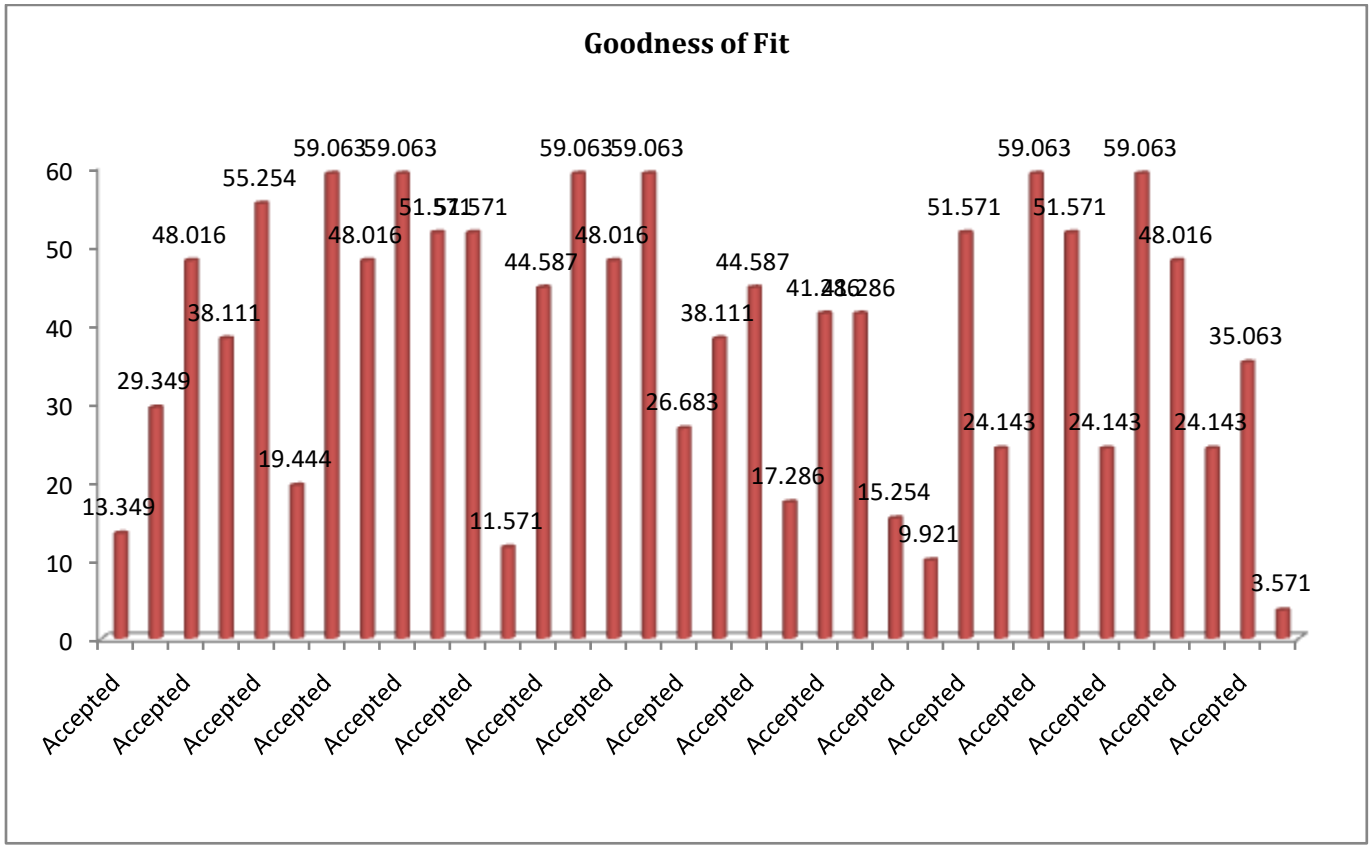

Figure: 3

Graph for Goodness of Fit Test

9.2. Construct Validity

The Item-Dimension total correlation coefficient was computed for each statement to set up the construct validity of the created questionnaire. Dimensions such as 1.Numerical Difficulties, 2. Identification Difficulties 3. Cognitive difficulties, 4. Problem Solving Difficulties 5. Reasoning / Logical Difficulties 6.Understanding Difficulties are incorporated in the statements. Table: 4 reveal the Item-Dimension total correlation coefficient forthe 33 items.

Table: 4

Item-Dimension total correlation coefficient

Item No.	**Correlation Coefficient**	***Remark***	Item No.	**Correlation Coefficient**	***Remark***
1.	**0.023**	***Rejected***	18.	**0.439**	**Selected**
2.	**0.242**	**Selected**	19.	**0.397**	**Selected**
3.	**0.598**	**Selected**	20.	**0.500**	**Selected**
4.	**0.453**	**Selected**	21.	**0.366**	**Selected**
5.	**0.347**	**Selected**	22.	**0.484**	**Selected**
6.	**0.412**	**Selected**	23.	**0.707**	**Selected**
7.	**0.356**	**Selected**	24.	**0.393**	**Selected**
8.	**0.510**	**Selected**	25.	**0.265**	**Selected**
9.	**0.004**	***Rejected***	26.	**0.373**	**Selected**
10.	**0.207**	**Selected**	27.	**0.422**	**Selected**
11.	**0.265**	**Selected**	28.	**0.324**	**Selected**
12.	**0.535**	**Selected**	29.	**0.230**	**Selected**
13.	**0.117**	***Rejected***	30.	**0.422**	**Selected**
14.	**0.356**	**Selected**	31.	**0.474**	**Selected**
15.	**0.180**	**Selected**	32.	**0.166**	***Rejected***
16.	**0.126**	***Rejected***	33.	**0.024**	***Rejected***
17.	**0.049**	***Rejected***			

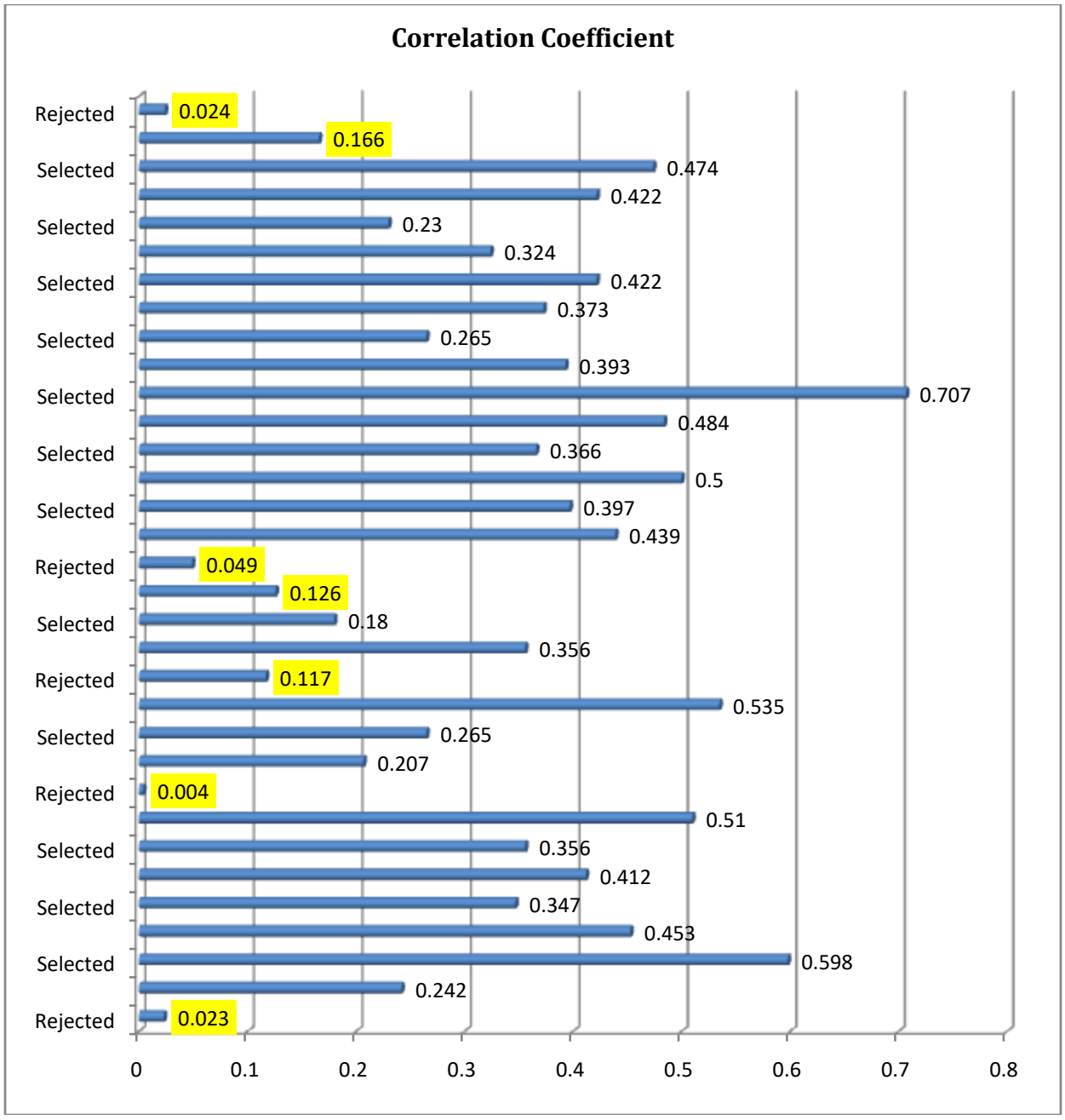

Figure : 5

Graph for Correlation Coefficient

Finally, 7 items are detained on the scale. And, 26 items are selected out of 34 items. From table No.4 it may be seen that 26 Items are significantly correlated with their own dimensions, from now retained in the scale where-as six statements (1, 9, 13, 16, 17, 32, 33,) were not securing significant correlation with their own dimension were deleted.

Table: 6

Dimension wise item categorization

S.NO	Dimensions	Statements
1.	Numerical Difficulties	1,2,3,4,5,
2.	Identification Difficulties	6,7,11,17,25
3.	Cognitive Difficulties	8,9,10,19
4.	Problem Solving Difficulties	13,14,15,16,20
5.	Logical/Reasoning Difficulties	12,18,21,22,23
6.	Understanding Difficulties	24,26
	Total	26

X. RELIABILITY

The reliability of Dyscalculia Screening Tool was established by calculating Cronbach's Alpha and Split Half method. The Cronbach's Alpha Reliability value is 0.835 (N=26) and the Split-Half Reliability value is 0.842 (N=26).The Cronbach's Alpha value for each dimension and total are as shown in Table 7.

Table: 7.
Cronbach's Alpha Value for each item

S.No.	Corrected items-Total correlation	Cronbach's Alpha if Item Deleted.	S.No.	Corrected items-Total correlation	Cronbach's Alpha if Item Deleted.	S.No.	Corrected items-Total correlation	Cronbach's Alpha if Item Deleted.
1.	**0.242**	**0.808**	10.	**0.535**	**0.794**	19.	**0.393**	**0.802**
2.	**0.598**	**0.797**	11.	**0.356**	**0.807**	20.	**0.265**	**0.807**
3.	**0.453**	**0.800**	12.	**0.180**	**0.809**	21.	**0.373**	**0.802**
4.	**0.347**	**0.805**	13.	**0.439**	**0.800**	22.	**0.422**	**0.806**
5.	**0.412**	**0.801**	14.	**0.397**	**0.802**	23.	**0.324**	**0.805**
6.	**0.356**	**0.807**	15.	**0.500**	**0. 796**	24.	**0.230**	**0.809**
7.	**0.510**	**0.800**	16.	**0.366**	**0.803**	25.	**0.422**	**0.806**
8.	**0.207**	**0.808**	17.	**0.484**	**0.799**	26.	**0.474**	**0.801**
9.	**0.265**	**0.807**	18.	**0.707**	**0.785**			

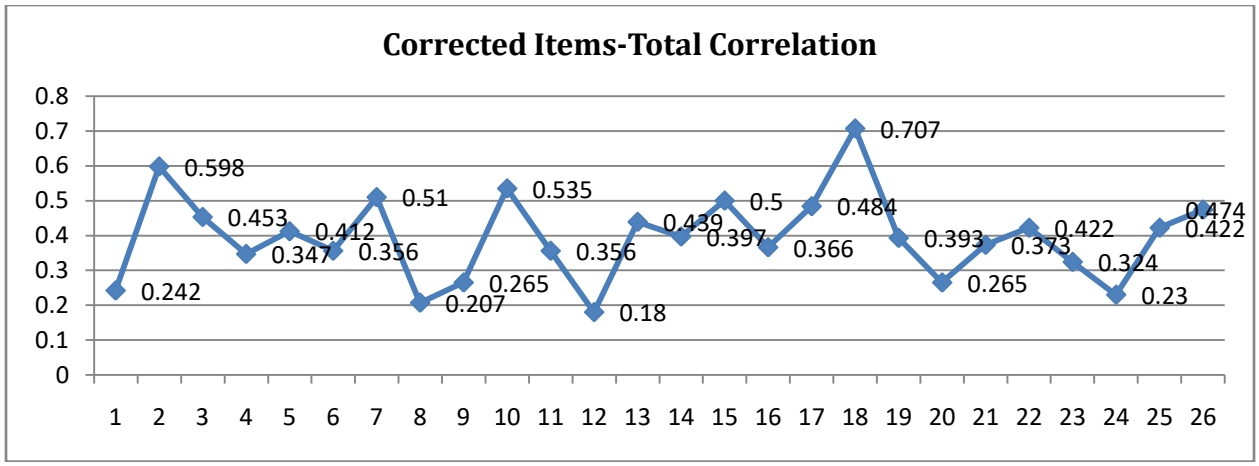

Figure: 8
Graph for Corrected items-Total Correlation

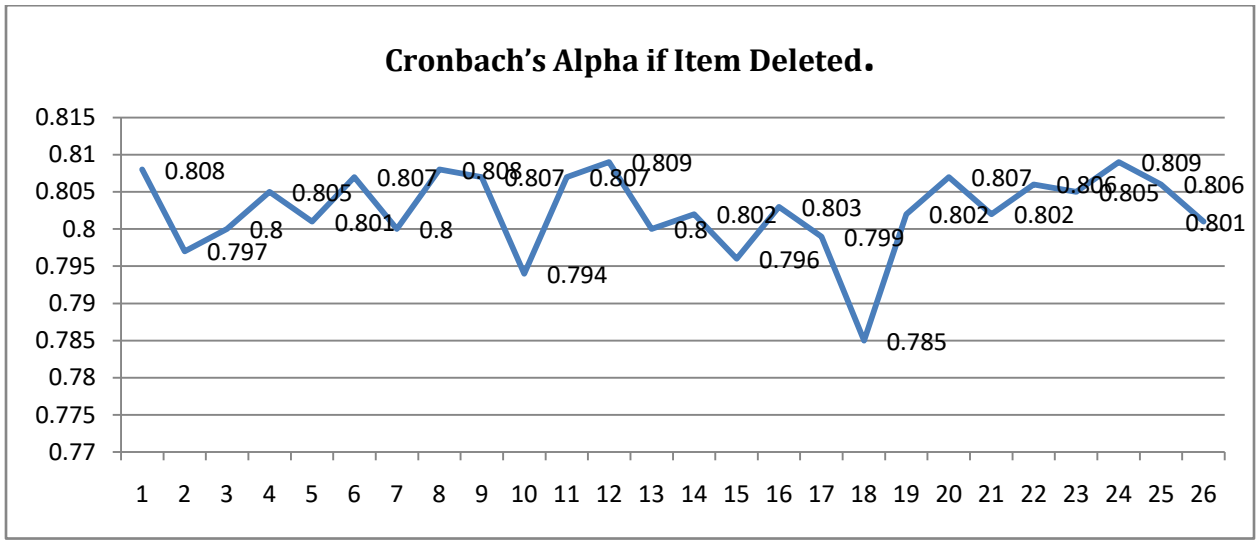

Figure: 9.
Graph for Cronbach's Alpha Value
The calculated values of 'Cronbach's Alpha' support the internal reliability of the tool.

XI. CONCLUSION

The final draft of the Dyscalculia Screening Tool (DST) is designed with the 26 valid items undersix dimensions. This screening tool is a Two-point rating scale. The scoring was "0 for Yes and 1 for No" separately for eachnegatively expressed items. The top score indicates the survival of highlyvalid Items. The statistical analysis fulfilled the criteria as well as satisfied the validity and reliability of the tool and also the feasibility of the responses from the conducted test. The screening tool focused at the knowledge and functioning of the mathematical ability. This tool would be ofa great assistance not only for the researcher but also for the primary school teachers to find the students with dyscalculia in their classrooms. The right treatment and support, if a child of dyscalculia is getting, thenthe opportunity for the development of mathematical ability will increase.

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