Methods of Teaching Mathematics in Primary Classes: Experience of General Education Teachers

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Abstract:

Math is a subject that has much applicability in our daily life as it can directly affect the earning capacity and livelihood of a person. This accounts for the increased relevance of Learning disability in Mathematics (MD)/ Developmental dyscalculia (DD) as a topic of scientific research. Studies indicate that early identification and remediation can overcome DD to a large extent. Development of any remediation program for children with DD requires an appraisal and knowledge of the current methods followed in classroom teaching. With this in mind the present study was taken up to understand the teaching practices followed in Mathematics by general education teachers of primary schools. Focus group discussion participated by primary level teachers was employed for the purpose. The results indicated that there existed certain general methods employed by almost all the teachers for teaching the subject of Math, and also certain specific teaching styles employed by some individual teachers. The teachers also reported that there are certain differences between actual teaching practices and curricular guidelines given for teaching.

Keywords: *SLD Math, Teaching practices, Focus Group Discussion, Delphi technique, Dyscalculia, Primary education.*

I. INTRODUCTION

Mathematics is one of the subjects taught in class which has direct applicability to our life on a daily basis. All transactions in our life are somehow or the other related to the concepts of Math; from the geometric shapes we see around us, to the addition and subtraction of people in the vehicle we commute, to purchase of products. Proficiency in Mathematics accounts for variance in employment, income and work productivity even after accounting for the effects of intelligence and reading (Rivera-Batiz, 1992).

The main goal of mathematics education in schools is the "mathematisation" of the child's thinking. Clarity of thought and pursuing assumptions to logical conclusions is central to the mathematical enterprise. There are many ways of thinking, and the kind of thinking one learns in mathematics is an ability to handle abstractions, and an approach to problem solving (NCERT, 2006). The curriculum in each class is assigned in such a way that it is challenging enough to the majority of the students. Here the children on either end of the continuum - the gifted and the slow learners - are being left out. The primary teachers are left with the task of teaching students with diverse academic ability and achievement levels by adapting the lessons to suit all the students (Corno, 2008); without compromising on the time frame. Successful differentiation of students based on their achievement level requires advanced subject matter knowledge, pedagogical skills and classroom management skills (VanTassel-Baska & Stambaugh, 2005).

There is converging evidence that mathematical disability develops from an intuitive understanding of numbers, viz., 'number sense' or 'number module' (Dehaene,1997; Butterworth, 2005). This finding is supported by the fact that children show mastery over core numerical concepts even before formal math teaching begins at school (Fuson, 1988; Gallistel & Gelman, 1992). However, Mathematics at school level is a hierarchical subject, which is organized systematically, and which requires a systematic and structured approach to teaching as well as learning. In India, Math is a major source of concern, with declining math levels almost in every state. The gravity of the problem is evident from the fact that only about 26% of 3rd graders can do two digit subtractions and close to only 44% of 8th graders can do the basic operation of division of 3 digits by single digit (ACER, 2015).

Most students studying in general education stream encounter difficulties in learning certain concepts in school level math at certain stages of math learning. These may be compensated through additional effort in terms of time spent on clarifying the underlying concept and drill/practice. But there remains a group of students who have persistent under-achievement in math, primarily due to core deficit of number sense, despite adequate intelligence and school exposure but devoid of any sensory problems. This condition is identified as Developmental dyscalculia.

Developmental Dyscalculia could be defined as a dysfunction of developing neural networks, specifically for the numerical domain, due to a variety of possible reasons, including genetic vulnerability, deficits in domain-general abilities such as visual-spatial and verbal processing or

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attention and working memory, as well as adverse or maladaptive environmental and psychological conditions like deprivation and anxiety (von Aster & Shalev, 2007).

Developmental dyscalculia has an estimated prevalence ranging from 5- 6.5% of school going population (Gross-Tsur, Manor & Shalev, 1996; von Aster & Shalev, 2007). In India, Ramaa and Gowramma (2002) conducted two independent studies for identifying and classifying children with dyscalculia in primary schools and found that when other possible causes of arithmetic failure had been excluded, figures for dyscalculia came out as 5.98% (15 cases out of 251) in one study and 5.54% (78 out of 1408) in the second.

Children with developmental dyscalculia are characterized by persistent difficulties in learning and remembering arithmetic facts (Ginsburg, 1997; Jordan & Montani, 1997; Jordan, Kaplan and Hanich, 2002), executing calculation procedures (Russell & Ginsberg, 1984), immature problem solving procedures (Geary, 1990; Geary, Bow-Thomas & Yao, 1992) memory retrieval deficits (Barrouillet, Fayol & Lathulie´re, 1997; Geary, 1990; Geary, Hamson & Hoard, 2000) and poor performance in tasks requiring an understanding of basic numerical processing (Landerl, Bevan & Butterworth, 2004; Butterworth, 1999).

Though their mathematical problems are persistent and fail to respond to otherwise effective interventions such as extra drill and coaching provided by teachers/parents, specialized interventions in Tier 2 and Tier 3 are found to be effective even in severe cases of Developmental dyscalculia (Gersten, Beckmann, Clarke, Foegen, Marsh, Star & Witzel, 2009). Early interventions are seen to produce substantial improvement in math performance (Dowker & Sigley, 2010; Fuchs, Powell, Seethaler, Cirino, Fletcher, Fuchs, & Zumeta, 2009; Geary, Bow-Thomas & Yao, 1992); though there are only few high quality intervention studies (Gersten, Jordan & Flojo, 2005).

Learning Disability in Math /Developmental Dyscalculia can be established as early as in class 3 (Fuchs, Fuchs, Compton, Bryant, Hamlett & Seethaler, 2011); but the identifiable features of Developmental dyscalculia manifests even earlier (Fuchs & Fuchs, 2001; Fuchs et al., 2005). Features of SLD in Math can be detected as early as 5-7 yrs. Considering the aforesaid facts, the current investigation was focussed on early identification and development of an early intervention program for children with Developmental dyscalculia (6-7 yrs & 8--9 yrs) identified from General Education Class rooms through a Research Project, funded by the Department of Science & Technology, Govt: of India.

Any remedial program for children with DD is an alternate route to address their specific difficulties in the academic skill of math. Hence it was thought to be essential to understand the current teaching practices, methods and techniques adopted by teachers in general classrooms for Math teaching. To achieve this purpose, the investigator conducted a series of focus group discussions with primary school teachers in different schools to assess their tutoring techniques and the sequence of topics introduced in Classes 1 & 2.

Objective:

The objective of the present study was to formulate an idea of the traditional teaching practices followed in primary school classes, by achieving a consensus through discussions, among the general education teachers. An attempt has been made also to probe into the specific sequence of introducing new topics for study, the motivational strategies used by teachers, and the limitations they face, if any, in teaching children with diverse ability and achievement levels within a given time period.

II. METHOD

Participants:

The participants for the study consisted of primary level teachers having a minimum of 5years of teaching experience. A total of 5 teachers teaching in primary section (classes 1 to 4) in the CBSE curriculum were selected for inclusion in the focus group. The participants in the present study had an average of 12 years of experience in teaching math in primary classes. . All the participants were females.

Procedure:

Focus Group Discussion (Laimputtong, 2011) and Delphi method (Hasson, Keeney & McKenna, 2000) were used to investigate the teaching practices employed by primary school teachers. Focus group discussions are structured discussions with a group of persons involved in the topic in which certain roles (e.g., a discussion leader, a time keeper and a secretary) and rules (e.g., only on-topic contributions) are specified and adhered to. The Delphi technique entails the repeated administration of a questionnaire in order to achieve consensus among experts. After the first round of administration, the initial responses are presented anonymously to the participants, who are then asked to fill out the questionnaire again. This procedure is repeated until consensus (specified with a consensus criterion) is reached (Prast, Van de Wiejer-Bergsma, Kroesbergen & Van Luit, 2015).

The Central Board of Secondary Education provides a specific curriculum for class one to twelve; with sequence of topics and assignment of time frame for its completion. The investigators attempted to find out whether the schools followed these instructions, or whether they have any additional teaching methods which may be unique to each teacher.

An initial preparation of the discussion questions was done based on the curriculum suggested by the CBSE board for primary school mathematics education. It included open ended questions to guide the discussion. After an initial set of ice breaker questions the discussion moved to the core questions. The initial ice breaking questions were:

1. What do you like most about your profession?
2. What is your favourite subject to teach?
3. Why do you like it over the others?
4. How important do you think this subject is useful in contributing to a child's academics and daily life and why?

The response to the ice breaker questions indicated that intrinsic satisfaction in teaching and the opportunity to interact with children were considered by the teachers as worthy aspects about the teaching profession.

All the participants of the group voted Mathematics as their favourite subject to teach. The importance of Mathematics in a person's daily life was stressed by the teachers. On the whole the ice breaker questions gave a perception of the like mindedness of the participants of the group.

Consensus procedure:

The session was monitored by the Principal Investigator as the discussion leader, Junior Research Fellow as time keeper and the Research Associate as the Secretary. The discussion was carried out in two sessions of 2hrs each on adjacent days. The discussion leader was seated in the centre of the group (Fig 1), with the time keeper, who was also taking the audio recordings of the proceedings, was strategically positioned near the group to make sure that all the information stated were correctly recorded. The whole session was audio-taped, so that no details of the discussion were missed at the time of consolidation of consensus report. The secretary sat behind the discussion leader, being unobtrusive and taking notes of the whole proceedings.

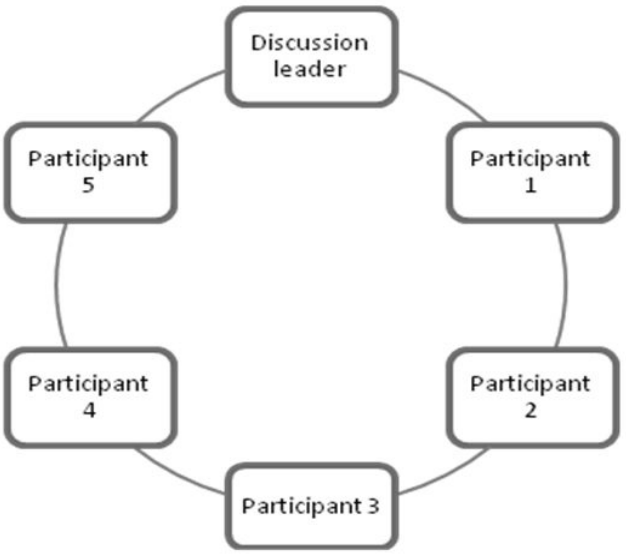

Fig 1: The focus group was seated as shown in this figure.

Consent forms stating the purpose of the discussion as well as the condition of confidentiality were distributed to the teachers. They were given time to go through the form, clarify doubts if any, and make an informed choice on whether they want to participate or not. After collecting the consent forms and making sure that all the forms were read and signed, a brief introduction on the Project and the aim of the focus group discussion was given by the discussion leader. This included the mention of target group, the purpose of early identification and need for knowing the existing practices. The teachers were encouraged to disclose the teaching practices they use in class, however negligible they think a particular detail is.

Based on the curriculum provided by CBSE, the core questions of focus group discussion were formulated as follows:

1. Do you have a criteria or sequence for topic introduction?
2. How do you introduce Math concepts in a class room situation?
3. What are the methods commonly used to teach each topic (Geometry, Number, Money, Measurement, Data Handling, Patterns)?
4. If you are making any changes in the existing methods, what are the suggestions?
5. How do you motivate children to learn Math/ any new strategies in Math?

The questions were asked one at a time and moved on to the next question only after all areas relating to the question was exhaustively discussed. Core questions started with the general teaching methods and then graduated to specific areas and the methods employed for teaching them. Further discussion on the assessment techniques were used to probe into how the teachers get a feedback on the understanding of a child on a particular topic in class strength of 30 to 40 children. Then the discussion proceeded to the motivational strategies used and the time constraints faced by teachers. The results of the consensus reached by the teachers could be utilized for formulating a remediation for children with difficulty in maths in Class 2. At the culmination of the discussion, 70 statements evolved relating to different teaching methods, topics covered, assessment techniques, identification of children with difficulty, additional support provided to children with difficulty, time constraints, motivational strategies and suggestions.

Table 1: Core questions, new statements and the consensus reached

Core questions	New statements	Original statements		New statements	
		No.	Consensus	No.	Consensus
Sequence of topic	Time/Patterns	6	6	2	2
Introduction of topic	Oral repetition	3	3	1	1
General methods used	Project activities	5	5	1	1
Assessment	Nature of mistakes	7	7	1	1
Specific areas: 1. Geometry		5	5		
Specific areas: 2. Number		22	22		
Specific areas: 3. Money		7	7		
Specific areas: 4. Measurement		2	2		
Specific areas: 5. Data handling		1	1		
Specific areas: 6. Patterns		2	2		
	Difficult topics			4	4
Time constraints		6	6		
Suggestions for improvement		3	3		
Motivational strategies		1	1		

In the first round of Delphi questionnaire, the 70 statements were presented to the teachers in the order similar to the proceedings in the discussion. The teachers were requested to rate the statements on a five point scale (strongly disagree [1], disagree [2], neutral [3], agree [4] & strongly agree [5]). The responses were grouped as agreed items, disagreed items and neutral items; with the intention of taking the neutral items and those with below 60% consensus to the next round of discussion.

In the second round of discussion, the teachers were informed of the consensus that they have reached through the previous questionnaire. The statements at this point were grouped into Methods and Topics of teaching, Motivational techniques, Methods of assessment and Constraints that limits further improvement in their teaching strategies.

III. RESULTS

The number of statements assigned to each area and the consensus reached is depicted in Table.1. The first six statements were related to the sequence of topic introduction. Here, there was a 60% consensus against the order suggested by the investigator, as the first topic introduced was "numbers", while according to the CBSE curriculum Geometry comes first. The topic of numbers is also taught in two separate sections (Up to addition and subtraction in the first and multiplication and division in the second) as it requires a lot of attention on the part of the children. Between the two sections of numbers an easier topic like "patterns" or "time" is introduced.

Both the initial and new statements regarding the method of teaching added to the questionnaire were approved by the teachers with 100% consensus. Regarding the areas that majority of the children find difficulty in, there was consensus regarding the following observations:

- In class one it is with ordering of numbers and operations of addition and subtraction.
- In class two, the concept of division, which is given whole of 2 months to teach/understand, is felt to be difficult by all the students
- In class 3 multiplication tables and division mastery.
- In class 4 LCM, HCF, multiplication, and division of large numbers.

The sequence of topic introduction and the methods used are represented in Figure 2. Teaching methods in order of introduction is represented in the centre and the topics are arranged in the sequence taught around the methods of teaching. Similar pattern is utilized throughout primary classes, only the number becomes bigger or an additional operation is added to the previous year's portions.

IV. DISCUSSION

The objective of the present study was to formulate an idea of the traditional teaching practices followed in primary school classes, by achieving a consensus through focus group discussions, among the general education teachers. All the statements received 100% consensus from the teachers except for the sequence of introduction of topics. Here the lack of consensus was due to the fact that each teacher had the liberty to assign a chapter they deem easier between the first and second sections of the topic "numbers". However the agreement can be attributed to the nature of this particular study and the exhaustive discussion carried out over two sessions that left little room for disagreement in their views. This may be due to the fact the CBSE curriculum itself gives clear cut directions on what portions need to be introduced along with guidelines on how they should be covered. An additional inference could be that the teachers make little deviation from the guidelines prescribed by the CBSE curriculum. Another reason for their agreement might be due to the fact that the teachers make their lesson plan for the year together and have a relatively similar technique of teaching.

Introduction of all topics starts with various types of concrete aids like, number cards, charts, models and picture cards. This is followed by the oral repetition of the concept and written practice. The students are also given Project activities to make the topics more interesting; which are done at home and brought to class and also some activities like collecting beads from outside the class and utilized to teach counting, addition etc in class. Another visual assistance is given through "Smart class"; and though used only at a frequency of once in a week, it is extremely useful.

To get a perspective of the understanding of the students, once the concept becomes clear, problems are given to be worked out in class with the supervision of the teacher. Children are also by turns, made to do problems on the board. Teacher moves around the class to make sure all the children are able to do the problem on their own & points out errors made and clarify doubts as per availability of time. Problems using the concept are given as homework to check whether the children are able to do the on their own without help. Peer tutoring is encouraged in topics like math tables. Further assessment is done through surprise tests on a weekly basis or once a concept or topic is completed. There are also monthly tests on the topics to be covered in that period of time.

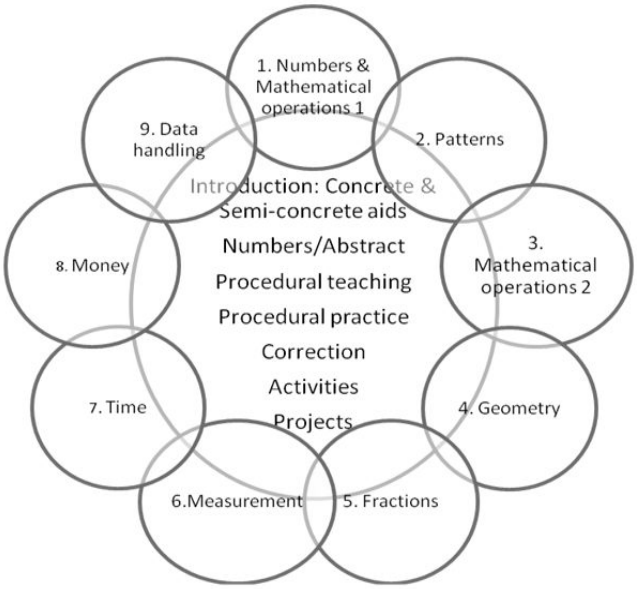

Fig.2. Sequence of topic introduction & methods of teaching

The first and the most important topic in each year are numbers and its operations. The maximum number of periods are utilised in the training and mastering of mathematical operations dealing with numbers. Number introduction starts with counting in order, sequential counting, number reading (oral), number names (in words) and place values (arranging in ascending and descending order and before and after concept).

In class 1, numbers from 101-500 (number reading only-oral), even & odd numbers and numbers up to 100 in words was taught. In class2, number reading from 500-1000 is completed and writing from 100 onwards to 999 in words was taught. Arranging numbers in ascending /descending series is taught through sequential counting for single digits and observing tens values and then the ones values in case of two digit numbers. Even & Odd numbers are taught by grouping

them in pairs objects or pictures and odd number being the one that does not having a pair. Abacus is used to teach place value of groups of 10. Objects or manipulatives like pencils or columns in graph paper are also utilized.

Operations are considered the most important area in the topic of numbers and are introduced in the sequence of addition, subtraction, multiplication and division. The first lesson on operation includes addition and subtraction. Addition is first taught using concrete objects, then with semi concrete objects like pictures and then with the abstract numbers, in the following order first with 2 single digit numbers, then with a single digit & 2 digit number and with 2 two digit numbers. For further clarity, whole class activities like making certain number of children stand in line and two more children are added to the group to represent the addition of two. Number line is also used to teach addition. Once the children have mastered addition they move on to subtraction.

Subtraction is first taught using concrete objects, then with semi concrete objects like pictures and then with the abstract numbers. Subtraction taught by taking away one, two etc from a given number. Children are taught to check their answers using addition method. For further clarity, whole class activities like making certain number of children stand in line and two children are taken from the group represents the subtraction of two. After mastering subtraction a relatively easy topic is given.

The second topic taught is patterns. It includes picture and number patterns. The patterns make use of the principles of addition and subtraction taught earlier. After patterns, rest of the mathematical operations (multiplication and division) are taught.

Multiplication concept is introduced as repeated addition. In class 1 tables of 1, 2, 5 & 10 are taught. In class 2 tables of 3, 4, & 9 are taught. Times tables are learned by rote, through oral repetition strategy in class. Other methods like cueing for a pattern in each table (e.g.: table of 2 constituted by even numbers), use of table charts displayed in class, peer tutoring as a support group and cueing on similarities between first half and the second half of the table are used for learning. After multiplication is mastered thoroughly; division is started. Division introduced as equal sharing in case of numbers without reminder and repeated subtraction in case of numbers with reminder. Concrete demonstration using objects, sets of objects, children made to stand in groups are used etc.

The fourth topic taught is geometry. An average of three periods is used for concept introduction. In class 1, shapes are introduced by using objects, showing pictures and naming them. For solid shapes, children are asked to make models and bring objects of similar shapes from home. In class 2, geometry starts with definition of point, proceeding to line, line segment and ray.

The fifth topic is fractions. Fraction is taught as part of one whole. Then the mathematical operations with fractions are taught. Fraction is taught as a separate topic and in a different timeline from division.

The sixth topic is measurement. In class 1, units to measure different things are taught in relation to real life; e.g. water bottles to show capacity, children compared for height, cloth length in metre and distance in km; difference between school and different points. This is followed by measurement with gradation, Millimetre, Centimetre, Decimetre, Metre, Decametre, Hectometre and Kilometre. Explicit rules are taught for conversion like divide as you convert to upper gradation and multiply as you convert to lower gradation.

Time is taught as a separate topic from measurement. In class 1 time is introduced with the distinction of events as earlier or later. In class 2, children learn to read the calendar & clock time correct to hour.

The eighth topic is money. For concept building maximum of 2 periods is utilized in each class. In class1, money identification is taught using pictures. Methods used include, tracing coins at concrete level. In class 2, coin and note or currency identification is taught, with conversions

The last topic taught is data handling. This includes arranging sets of different objects in a given box on the table. Connecting to routine activities like asking for preferred channels, representing as data and finding out which is the most preferred and least preferred ones based on this data.

The discussion also touched areas like motivational strategies and difficulties faced by teachers in managing children of diverse potentials. Teachers used rewards like stars and stickers and the weekly performance of the children were displayed in class on a chart as a token of appreciation. These methods were found effective in encouraging the children to perform better.

The main constraints faced by teachers were limitation of time. They were to teach a given curriculum of topics in a time frame. This pace might not be suited for the slow learners. Teachers observe that individual attention to these children do yield results, but they do not have time to cater for such needs.

Summary:

The study was intended to formulate an idea of the traditional teaching methods followed in the general education classroom to aid in the development of an alternate remedial program for Mathematics. The target group for the discussion are teachers of children in classes 1 and 2. The discussion was very informative from the experimenter's point of view. In addition to the general methods, teaching practices followed in each specific area was discussed in detail. This gives an insight on the additional requirements in terms of teaching/remediation strategies, which should be emphasized in the case of both children with normal academic achievement and children with special needs. The pedagogy followed in school, the teacher's expectation of average performance and their experiences with slow learners gave sufficient pointers to aid an efficient remediation.

V. CONCLUSIONS

General education teachers in primary classes of Class 1 & 2 have a specific sequence of topic introduction in Math, starting from Numbers & related concepts and proceeding to Numerical operations, are followed later only by other topics in the curriculum, as they consider the former topics foundational in nature. The techniques used for topic

introduction includes concrete objects but limited to an average of 3 periods per topic, followed largely by procedure teaching and class room practice and concluded with student activities, project works and tests. Making available smart classes immediately after each topic is introduced is opined to be a sure way to improve quality of classroom learning of Math. Motivational strategies like reward and performance charts displayed in class are currently in use and are found to be effective in improving performance of students. Constraints faced by teachers are limitations in time, both for pacing topics as per needs of slow learners or in making sure all students have adequate conceptual clarity and inability to provide individual attention to those low achievers who are identified by them, due to time constraints imposed by the curriculum.

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