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Difficulties in Arithmetic Problem-solving among Disadvantaged Children of Grade V

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Introduction

IN a Trend Report on research in mathematics education, Vol.II of Fourth Survey of Educational Research in India, NCERT (Mohammad Miyan) on the basis of 70 studies conducted till 1987 has discussed the research related to mathematics education under four categories:

A. Teaching and teacher behaviour
B. Curriculum and textbooks
C. Factors affecting achievement
D. Diagnostic and achievement test in mathematics

Some of the important observations made in this Trend Report are:

(i) Achievement in mathematics has been studied in relation to both cognitive and affective factors.

(ii) The major contributing factors for mathematics achievement are intelligence and socio-economic background of the students.

(iii) Reasoning power, space visualizations, attitude towards mathematics influence and mathematics performance.

(iv) Language mastery and variables of educational environment is an important factor in the acquisition of mathematics concepts.

(v) Variables like teacher's qualifications, class size, encouragement to teacher by the head, use of audio-visual aids and feedback were found significantly related to acquisition of mathematical concepts.

(vi) Numerical reasoning and numerical ability were found to be having a prominent place among the cognitive functions.

(vii) Blind use of rules, imparting of limited knowledge, defective textbooks, insufficient drill work, absence of methodical approach were some of the causes of low achievement.

(viii) School factors like inadequate coverage of the syllabus, inadequate attention to difficult topics were also responsible for failures in mathematics.

(ix) Factors responsible for underachievement in mathematics are some of the personality variables namely, self-reliance, sense of personal freedom, feeling of belongingness, withdrawing tendencies, nervous symptoms, social skills, general anxiety and test anxiety, parental profession, and education.

(x) There has been little efforts on the part of researches and organizations to develop tests and other measuring instruments.

The Trend Report concludes with the remark that indepth study of the mathematics curriculum, curriculum renewal, refining teaching methods are the major issues. The need to try out various methods of teaching mathematics is stressed in the report.

In Vol. I of the *Fifth Survey of Educational Research in India*, NCERT, Kapur reviewed researches in mathematics education conducted from 1988-1992. He concluded that the output in research related to mathematics education is still very small when the large number of research problems requiring immediate attention and diversity of the conditions in the country are concerned. He noticed that there are some specific factors which are responsible for underachievement such as gaps in knowledge of concepts, difficulties in understanding of mathematical language, lack of openness and flexibility in teaching, difficulty in mathematization of verbal problems and interpretations of mathematical results, the abstract nature of mathematics, fear and anxiety on the part of the students. The author has stressed the need for continued research in mathematics education keeping in mind the diversities in Indian

schools. He has given suggestions for further research in this area. Some of the suggestions relevant to the present study are:

(a) Development of special strategies for teaching the first generation learners, children from backward classes and physically and mentally handicapped children.

(b) Development of special strategies for teaching mathematics to children of tribal and hilly areas.

(c) Teaching problem-solving strategies.

Mathematics learning involves making connections between concrete mathematical experiences and abstract thinking processes. According to Edwards (1998) in order to make connections between concrete mathematical experiences and abstract thinking processes, one should have skill in handling objects, language understanding, picture and symbols. During pre-school period, by handling familiar everyday objects, children learn about their properties and components. Language acquisition does not happen by itself, but requires assistance in the form of interaction with adults in the immediate environment. According to Bruner (1990) language is required not in the role of spectator but through use. The learning of mathematical language, through an interactive activity is a vital element of children's intellectual development in school. Children should be encouraged to articulate their ideas, ask questions, listen to and follow instructions and to share challenges in discussion with peers and teachers at every stage. Pictures represent the link between objects and numbers or symbolic representation.

The last component in the process of mathematical development is the translation of mathematical thinking into a conventional written code that allows the processes of mathematical thinking to be easily communicated to, and understood by others. Research has shown that one of the problems occurring after children commence formal schooling at about five years of age, is the early instroduction of written sums using conventional methods (Edwards, 1998). Instead of doing and talking about mathematics and modelling mathematical processes with objects or in pictorial form, children are expected to continue to do increasingly more difficult 'sums' as the main thrust of mathematical work. This leads to serious difficulty among young children as their understanding of the conventional written methods is very weak as compared with their own informal methods.

According to Ginsberg (1997) children often fail to understand the necessity of rationale for written methods and during later stages when written methods become more complex. Children struggle badly. A prerequisite to performing conventional written method for arithmetic effectively is children's ability to translate arithmetic thinking processes from handling objects to conventional symbolic representation. In order to facilitate this transition many researchers have suggested the need for practical work, interactive teaching and the development of mental strategies. In addition to the above, the process of structuring of mathematical learning should not follow a strictly hierarchical sequence but embrace a network approach, where new learning is built on what children already know (Denvir and Brown, 1986).

Various psychologists like Piaget, Bruner and Gagne have put forward their theories and their implications for mathematics learning. Vygotsky (1962, 1978) provided a framework for teaching and learning which led to the development of the theories of social constructrivism in the 1980s. Vygotsky proposed that learning occurs on two levels. The first level is 'intermental' — the social level where pupils experience the language and handling of objects in the company of others. The second level is the 'intramental' — the individual or personal level where each learner tries to make sense of new knowledge and connect it clearly to what is already known.

Since 1980s the practice of primary education has been significantly influenced by the social constructivism which emphasize the need for the learner to construct his or her own meaning and understanding of knowledge through continuously reflecting his or her experiences (Wood, 1988). The social and cultural upbringing of a child has significant influence on 'learning which continues' throughout life (Rogoff and Lave, 1984). Learning is thus social as well as individual.

Cognitive and Affective Factors Related to Mathematics Learning

(i) Components of information processing — Students may have difficulty in mathematics due to problems that arise from information processing because of :

(a) Attention deficits

(b) Visual spatial deficits

(c) Auditory processing difficulties

(d) Memory problems

(e) Motor problems

(ii) Cognitive and metacognitive components — Students may have problem in :

(a) Assessing their ability to solve problems

(b) Identifying and selecting appropriate strategies

(c) Organizing information

(d) Monitoring problem-solving processes

(e) Evaluating problems for accuracy

(f) Generalizing strategies for appropriate situations

(iii) Language components — As mathematics symbols represent a way to express numerical language concepts, the following language skills are important for mathematics achievement:

(a) Ability to read

(b) Ability to write

(c) Comprehending what has been read

(d) Using rules, steps and facts

(e) Ignoring the irrelevant numerical and linguistic information

(iv) Social and emotional components — The affective domain also is recognized as an important variable in the mathematics performance of students.

(a) Academic failure

(b) Low self-esteem

(c) Mathematics anxiety

(d) Confused thinking

(e) Avoidance behaviour

(f) Mathematics phobia

Ramaa (1991), Ramaa, Ashok and Balachandra (1997), Gowramma (2000), Gowramma and Ramaa (2001) had identified the children with difficulties and disabilities in mathematics and analyzed their difficulties experienced and errors committed by them. The studies were conducted in a primary school that is up to Grade IV. Hence the investigators had taken up a project with Grade V children. The paper is based on that study.

Context Need and Importance of the Study

In addition to the findings mentioned in introduction, some of the important studies like Ramaa (1991), Ramaa, Ashok and Balachandra (1997), Ramaa and Gowramma (1999), Gowramma (2000), Ramaa (2000), Gowramma and Ramaa (2001 in press) and many other studies conducted by various investigators relating to MLL in Mathematics reveal that considerable percentage of school children have difficulties in mathematics. Similarly, the studies conducted at higher primary level and secondary level also indicate significant difficulties in mathematics. During interaction with in-service teachers by the investigators it has been revealed that considerable percentage of the teachers lack proper concept and skills in mathematics. Because of many reasons like the ones mentioned in the earlier paragraphs, elementary school children face difficulty in mathematics and commit errors while doing sums. This is one of the important reasons for higher drop-out rate by the end of elementary schools and also greater difficulty experienced by students in secondary grades.

In order to help the students having difficulty in mathematics there is an immediate need to:

(i) identify children who have difficulties in mathematics;

(ii) diagnosing their difficulties at the symptomatic level and understanding their causative and correlative factors;

(iii) develop competencies among teachers to adopt appropriate strategies to teaching mathematics ;

(iv) develop instructional materials which can be used by the teachers and parents in teaching mathematics;

(v) make provision for remedial instruction, to develop remedial instruction material and to develop skill among teachers;

(vi) modify elementary teacher training curriculum in general and with reference to teaching of mathematics in particular with reference to theory and practice.

Understanding the learner, the learner characteristics and their difficulties in learning are the pre-requisites for qualitative improvement of teacher training programme which in turn can enhance the performance level of children. As such studies are limited in India, particularly among the disadvantaged group in the elementary level specifically in mathematics problem-solving.

Objectives of the Study

The following specific objectives were aimed to achieve in the study:

(i) To select items from the Arithmetic Diagnostic Test for Primary School Children (Ramaa, 1993) which measures fundamental operations and problem-solving in:

  (a) addition

  (b) subtraction

  (c) multiplication

  (d) division

(ii) Finding out the percentage of children of Grade V from disadvantaged group who have difficulty in the different skills of the above operations.

(iii) Identifying the common errors committed by the children while doing the sums.

(iv) To compare the groups formed on the basis of district, school, section and gender in terms of the percentage of children exhibiting specific difficulties.

Methodology

In order to achieve the objectives of the study, the methodology which was adopted is discussed below.

Sample

For conducting the study, four government schools were selected from Coorg and Mysore districts. In Indian context, disadvantaged children (from low socio-economic background) can be found only in government schools and hence only government schools were taken for the present study. The medium of instruction in these schools is Kannada. Two schools from Mysore city and one each from Gonicoppa and Ponnappasanthe of Coorg were selected. The reasons for taking these two districts is to find out whether language differences in two districts has any influence on the types of difficulties experienced by these children. In the schools of Mysore city, mainly the children are from Kannada-speaking homes. Whereas in Gonicoppa and Ponnappasanthe schools, students were mostly from migrated families who speak languages other than the local

languages Coorg and Kannada but who speak Malayalam, Tulu and Urdu. Rest of the students were the local tribes Yaravas and Kurubas.

The study was conducted on Grade V students. Research has shown that written arithmetic problems (solving arithmetic problems) cause major difficulties for many children at all ages from infant to the secondary stage. These difficulties stem from the children's inability to read written problems and translate the problem into conventional arithmetic form (Edwards, 1998). Gowramma (2000) observed that even normal children of Grade IV had difficulty in arithmetic problem-solving. So the investigators were interested to see whether children of a higher grade are able to do the sums related to problem-solving, either due to maturation and/or life experience although there is no formal teaching in the school to bridge the gap. From among 317 children 138 (43.53%) were referred as average in reading and writing, out of which 42% are boys and 58% are girls.

Since the diagnostic test was a group test, and requires the knowledge of reading and writing, on the basis of teacher's opinion a list of children who were average and above average was prepared. The purpose of making this was also to eliminate children who were below average in intelligence, have sensory difficulties, serious emotional and behavioural problems, and those who do not have adequate interest and motivation for academic learning, and irregular in attending the school.

Variables: District, school, section, gender.

Description of the Tool

Arithmetic diagnostic test for primary school children (Ramaa, 1994) was used for collection of data.

Selection of Items

Since the diagnostic test is meant for children up to Grade IV, items which appear to be very simple for Grade IV children were eliminated in order to reduce the time required to administer the tool so that fatigue on the part of students can be avoided. However in division all the items were administered. Details regarding extra help at home was collected from the students. The other details were collected from school records.

The test is a diagnostic and criterion-referenced one. This test diagnoses the specific difficulties encountered by the children of primary schools of Grade I through IV, while doing arithmetic sums. The test covers three major areas of arithmetic namely, number

TABLE

The Target Sample and Number of Students Referred

School Code	Name of Schools	Number referred			Target Sample		
		M	*F*	*T*	*M*	*F*	*T*
	Govt. Model Primary School Gonicoppa						
GA	A Section	7	14	21	53	25	28
GB	B Section	10	12	22	48	24	24
GC	C Section	7	10	17	50	30	20
P	Govt. Upper Primary School Ponnapasanthe One Section	7	7	14	53	37	16
	Govt. Boys School						
M-1A	A Section	8	12	20	40	17	23
M-1B	B Section	15	8	23	38	25	13
M2	Govt. Girls School One Section	3	18	21	35	11	24
	Total	58	80	138	317	169	148
	Percentages	42.1	58	143.53			

concept, arithmetic processes — addition, subtraction, multiplication and division and arithmetic problem-solving.

The test was administered in small groups with proper instruction and supervision. Students were motivated sufficiently to take the test sincerely. The test was administered in four sessions of about two hours each. The doubts of the students were clarified during administration.

Analysis of the Data

Data was analyzed qualitatively with reference to the variables selected for the study. The purpose of such an analysis was to find out the common and unique difficulties in different criterion measures relating to addition, subtraction, multiplication and division — among different groups of children. It was also attempted to identify the most common errors among the subjects of the study.

The Analysis was done qualitatively with two purposes:

1. To identify the specific difficulties in different groups of the study.
2. To identify the most common errors committed by the subjects of the study.

An analysis of the Specific Difficulties in Different Groups

The subjects were grouped into different categories on the basis of district, school, section and gender. The items selected from the diagnostic test were grouped into different criterion measures on the basis of the nature of the task. Since it is a criterion-referenced test, one mark was arbitrarily given for every item of the criterion measure correctly attempted. On the basis of the raw scores obtained for each of the criterion measures, children were classified as masters (those who obtained 75 per cent and above of the maximum score allotted), non-masters (those who obtained zero for the criterion measure), partial achievers (those who were neither masters nor non-masters). Thus, a child who is a master in one criterion measure need not be a master in the other criterion measures.

The number of masters, partial achievers and non-masters were calculated for each school, section in that school and boys and girls studying in those schools. The total number of children in each category was converted into percentage for the purpose of comparing different groups. The results are tabulated in the form of tables in the research report (for details refer Ramaa and Gowramma, 2001).

Main Findings and Interpretations

1. As far as the two districts namely, Kodagu and Mysore are concerned, no striking difference is noticed with reference to the percentage of children belonging to the categories — masters, partial achievers and non-masters.
2. Similar observations can be made regarding different schools, sections and boys and girls in each district.
3. In the study, thus, it can be inferred that the socio-cultural differences in the two districts and the variations in the school-related variables as well as gender have got no influence on mathematics learning. This may be because all the children belong to disadvantaged category and are studying in government schools of Kannada medium.
4. In almost all the criterion measures, considerable percentage of children experienced difficulties.
5. Since the test is meant for children of Grades I to IV, it is expected that there should be more number of masters, followed by partial achievers and no or least number of non-masters. However, in the study, number of partial achievers and non-masters were more in almost all the criterion measures and in some cases majority were non-masters.
6. This suggests that for the disadvantaged children of Grade V arithmetic meant for children of Grades I to IV is found to be very difficult. Therefore, remedial instruction is very much necessary for these children to acquire the arithmetic skills. As they have not mastered the task meant for lower level, their performance in present and future grades will definitely be hampered.
7. Although the subjects were average in reading and writing as far as the teacher's opinion was concerned they had severe difficulty in mathematics. This suggests that mathematics is more influenced by socio-economic background of the students. The finding supports the view expressed by Vygotsky (1962, 1978) and the findings noticed in the Trend Reports in research on mathematics education by Mohammad Miyan (Vol. II of the *Fourth Survey of Educational Research in India).*
8. Though all the criterion measures are difficult to considerable percentage of students, the following are the most difficult ones:

(a) Addition

(i) problem-solving involving numerical relations in ascending order (by arranging the given set of numbers calculating the sum).

(ii) problem-solving involving spatial-verbal-numerical relations.

(b) Subtraction

(i) problem-solving involving numerical relations

(ii) problem-solving — arranging given set of numbers in descending order by calculating the difference.

(iii) problem-solving involving numerical relations with both addition and subtraction.

(iv) problem-solving involving spatial-verbal-numerical relations.

(v) solving the arithmetic equations.

(c) Multiplication and Division

All the criterion measures included in the test were difficult to the subjects of the study. In those criterion measures, it was noticed that normal children of middle socio-economic status also had difficulty (Ramaa, Ashok and Balachandra, 1997; Gowramma, 2000), however, the percentage of children who had difficulty was far less compared to the present sample.

Common Errors Noticed

The following are some of the common errors/deficiencies exhibited by students:

(a) Addition

(i) No mastery over basic facts; goes wrong while adding the numbers.

Example:
$$\begin{array}{r} 934 \\ 657 \\ 281 \\ \hline 1882 \end{array}$$

(ii) Does not carry the ten's place digit to appropriate place.

Example:
$$\begin{array}{r} 609 \\ 712 \\ 780 \\ \hline 2191 \end{array}$$

(iii) Forgets a digit while adding.

Example:
$$\begin{array}{r} 609 \\ 712 \\ 780 \\ \hline 1501 \end{array}$$

(iv) Does not have the concept of carry over.

Example:
$$\begin{array}{r} 934 \\ 657 \\ +\ 281 \\ \hline 171612 \end{array}$$

(v) Cannot write numbers according to place values.

Example: 3235 + 138 + 29 + 2
was written as

$$\begin{array}{r} 3235 \\ 138 \\ 29 \\ +2 \\ \hline 9515 \end{array}$$

(vi) Do not know to write numbers in ascending order according to the instruction given. Some get confused with ascending and descending orders.

(vii) While solving verbal problems, cannot discriminate between irrelevant and relevant data. They put all the numbers from the statement and add.

(b) Subtraction

(i) Does not have the concept of borrowing — Not attempted.

Example :
$$\begin{array}{r} 7693 \\ 4825 \\ \hline \\ \hline \end{array}$$

(ii) Forgets that a number was borrowed from the next place.

Example:
$$\begin{array}{r} 8605 \\ 6523 \\ \hline 2182 \end{array}$$

(iii) Subtracts lesser number from greater number irrespective of the position of the number.

Example:
$$\begin{array}{r} 7693 \\ 4825 \\ \hline 3272 \end{array}$$

(iv) Difficulty to subtract when zero is present in the sum

Example:
$$\begin{array}{r} 8605 \\ 6523 \\ \hline 2122 \end{array}$$

(v) While solving verbal problems, adds the numbers given instead of subtracting.

(c) Multiplication

(i) No mastery over multiplication facts —goes wrong while working on multiplication of numbers with more than three digits.

(ii) Does not attempt the sums — may be mainly because they do not know the meaning of symbols.

(iii) do not know multiplying zero.

Example:
$$\begin{array}{r} 60 \\ \times 6 \\ \hline 66 \end{array}$$

(iv) While solving verbal problems, puts the numbers and adds them instead of multiplying.

Example:
$$\begin{array}{r} 10 \\ \times 6 \\ \hline 16 \end{array}$$

(d) Division

(i) Does not know the meaning of division symbol

Example: $5 \div 1 = 5$

(ii) Multiplies instead of dividing.

Example: $5 \div 1 = 5$

(iii) Does not know the procedure of division

Example: $5 \div 10$

$$= 5\overline{)10}\,(10$$
$$\underline{10}$$
$$\underline{20}$$

(iv) Forgets to write the number as the quotient.

$$3\overline{)95}\,(3$$
$$\underline{9}$$
$$5$$
$$\underline{3}$$
$$\underline{2}$$

(v) While solving verbal problems adds all the numbers given in the statement.

Example: 59 instead of $7\overline{)59}\,($
$$\underline{7}$$
$$\underline{66}$$

Even normal children of middle socio-economic background (Gowramma, 2000) exhibited some of the errors/deficiencies which were observed in the present sample. The common errors/deficiencies for both the groups are:

(i) Subtracting lesser number from greater number irrespective of the position.

(ii) Subtracting when zero is present in the number.

(iii) No knowledge of multiplication facts.

(iv) Difficulty in multiplying by zero.

(v) Multiplying instead of dividing.

(vi) Procedural errors in multiplication and division.

The above errors indicate that some of the normal children of middle socio-ecoomic status also have difficulty in arithmetic problem-solving.

The studies by Ramaa (1990) and Gowramma (2000) revealed that dyscalculics (children with arithmetic disabilities) also exhibited similar type of errors.

Discussion and Conclusion

As noticed in the study majority of the children were getting extra help at home. In spite of that they had difficulty in mathematics. This suggests that mere help at home either by family members or tutors do not rectify the difficulties. There is a need for adapting

appropriate strategies to teach mathematics. In this context, it may be recalled that children with dyscalculia (learning disabilities in arithmetic) after remediation were able to perform on par with their grade level (Gowramma, 2000). This may be attributed to the systematic remedial instruction based on most appropriate principles and strategies. It can be hypothesized that disadvantaged children will improve significantly if such a systematic approach is followed either during teaching in the classroom or while giving remedial instruction. Teachers will be able to adopt these methods when they are trained properly and adequately during pre-service and in-service training programmes.

There is a need for enriching the curriculum for enabling teachers to acquire knowledge and competency in teaching mathematics scientifically. Remedial instruction materials have to be developed and experimentally validated for normal children as well as disadvantaged children.

Students of the present sort may be replicated by taking all the relevant variables like teacher qualification, methodology of teaching, ability of the pupils, etc. into consideration. Case-study approach may be adopted to understand the problems of children among the disadvantaged group. There are differences in the ways in which children learn mathematics which also contribute to their difficulty. Therefore different strategies have to be adopted for different types of learners. Research by Bath et al. (1986) revealed two different learning styles in children-grasshopper (high fliers) and inchworms or caterpillars (steady plodders). Grasshoppers are able to make leaps in learning development and are quick to recognize associated connections between one concept and another. Caterpillars, on the other hand, are more cautious on their strategies requiring affirmation of the ground they have covered before proceeding to the new work. These two categories are similar to the serialist, holist theory of Pask and Scott (1975) where the serialist uses a step-by-step approach to solving problem, whereas the holist looks at the whole problem and sees if there is any easy way of tackling it. It is also suggested by Backhouse et al. (1992) that serialist should be given specific training in holist strategy. So teachers should adapt both serialistic and holistic strategies in the classroom while teaching mathematics.

Edwards (1998) differentiated the cognitive styles of caterpillars and grasshoppers while solving the problems which was adapted from Bath et. al. (1986).

Serialists should be given opportunity to work in a holist way by:

- providing activities involving mental arithmetic;
- directing children towards quick methods;
- providing activities which encourages holistic methods;
- encouraging learners to describe their methods.

In addition to grasshoppers and caterpillars another type of learners (snail) can be noticed. The learning style of this group can be compared to a snail which climbs a wall so far and then slips back a bit. This type of learners have significant difficulty with learning mathematics and requires special learning support which can prevent their fall back. Studies involving the above strategies have to be conducted and their validities have to be established.

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