AN ANLYSIS OF DIFFICULTIES EXPERIENCED BY THE CHILDREN WITH HEARING IMPAIRMENT WHILE DOING MATHEMATICS

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Principal Investigator

(Dr. I. P. Gowramma)

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INTRODUCTION AND REVIEW OF LITERATURE

1.0 Introduction

Mathematics is vital for educational development. Many students find it difficult to cope up with mathematics in the classroom. But the future demands of a vocational set up and comfortable living expects competence in the skills of problem solving and logical reasoning. Moreover, today's society is technologically oriented and information rich. Children need to develop mathematical skills to build up the confidence and competence which are vital for effective participation in society. Therefore, there is a need to provide all the students with equal opportunities to learn mathematics irrespective of their difficulties and disabilities. This places responsibility on teachers to provide similar learning environments for student populations that differ in learning ability, culture, race, gender and socio-economic background.

For all children, understanding of mathematical concepts requires considerable experience. Haynes (1999) states "Concepts should be taught in such a way that children develop the ability to think mathematically and new experiences should allow them to refine their existing knowledge and ideas in constructing new knowledge". It is also observed that mathematical processes such as problem solving, developing logic and reasoning and communicating mathematical ideas depend upon children having good communication skills. Review of literature between 1980 and 2000 indicates that Children With Hearing Impairment (CWHI) lag behind their hearing peers in mathematics achievement tests. (Swanwick, Oddy and Roper, 2005). Quantitative skills, which are considered basic concepts, are an important aspect of language development. In addition to basic language, number and patterns, sequencing and specialized vocabulary are specific to math, which are essential to learn math concepts in school. Children with hearing impairment deficient in all the above areas find learning of mathematics a difficult task. It is a well-known fact that the so-called normal children also face difficulty to learn the concept as well as the skill of performing mathematical operations. Flexer (1999) suggests that hearing impairment, whether slight or profound in nature, if unmanaged, can have a negative impact on the development of not only spoken language but also academic competencies.

Inclusive education being a compulsory policy, children with hearing impairment are exposed to the same instructional strategies used for normal children and the time given to them to learn a concept is the same as that of their counterparts with normal hearing. Can this be justified? Without authentic experience and vocabulary development, children with hearing impairment find it hard to master the concepts of mathematics as well as the skills to perform the operations. For students to learn and act on knowledge of mathematics, they must understand terms regarding amount or direction (i.e., language-based knowledge), understand that numbers stand for a quantity, hold multiple pieces of mathematical information in memory and perform mathematical operations (e.g., add, multiply) on them, and know that numbers can be manipulated in meaningful ways.

1.1 Factors related to mathematics learning

It is observed that 25% of children in regular educational stream perform below the expected level in mathematics, Gowramma (2005). There are various reasons for students in primary school level to lag behind the norm. Some of the important factors for poor performance in maths are mentioned below.

- Intelligence - Sub-average intellectual functioning.
- Sensory and motor factors - Defects in primary sense organs and motor co-ordination.
- Neurological factors - Genetic or congenital factors leading to defects in brain.
- Emotional factors - Serious emotional problems.
- Behavioural factors - Serious behavioural disorders.
- Environmental factors - Lack of adequate logic-mathematical experience or faulty methods of teaching.
- Dyscalculia - Specific learning disability in the area of mathematics.

Sensory impairment restricts the child to have adequate exposure in the environment. Hence, it is natural to consider it as a contributing factor for poor academic performance in general and mathematics in particular.

1.2 Review of related studies

In the present section a brief review of some of the significant studies in the field of mathematics learning of CWHI are given. A summary of the findings of the studies are discussed under the following sections:

1.2.1 Factors contributing to mathematics learning of CWHI.

1.2.2 Comparison of the performance of CWHI and normal children.

1.2.3 Sign language and mathematics learning.

1.2.4 Language and mathematics learning.

1.2.5 Cognitive characteristics of CWHI.

1.2.6 Problem solving skills of CWHI.

1.2.1 Factors contributing to mathematics learning of CWHI

Several possible explanations for the performance of CWHI in mathematics have been proposed, all of which in one way or the other contributes to underachievement.

Normal children hear mathematical talk from birth and most of them are involved in mathematical talk from early years, observed Gregory (1998). He explores the reasons like early incidental learning and reinforcement, which are limited for CWHI, because of which they underachieve in mathematics. Pau (1995) also observed that delay in early access to mathematical conversation as a contributing factor for the poor performance of CWHI in mathematics.

A study by Nunes and Moreno (1997a) suggests that, knowledge of the counting string is a significant predictor of performance on some numerical problems and they suggest that a 'greater stress in teaching young CWHI to count in school is likely to have a positive impact on their numerical knowledge'. They focused on core mathematical concepts, which most hearing children learn informally outside school, and ways in which they are represented in the school curriculum. The intervention materials explored ways of presenting mathematical problems visually, using drawings and diagrams. Both of these intervention strategies were successful, thus providing clear pointers for support strategies, which can ensure CWHI access to the mathematics curriculum.

Hitch (1983) suggested a more specific focus on the experience of CWHI on spoken language and the consequences for the development of inner speech which is seen as a means of mediating the processing of numerical information. The lack of auditory experience of CWHI might also affect short-term memory skills and account for slower response time in addition and subtraction tasks and their poor memory for digits (Epstein et.al., 1994). Since there is no evidence to know whether CWHI develop alternative strategies, perhaps based on their visual learning strengths to process verbal information and mediate short-term memory tasks, it needs to be explored further.

Mousley and Kelly (1998) suggest that several factors contribute to the difficulties experienced by CWHI with regard to problem-solving and general reasoning skills. These factors include difficulties in building meta-cognitive skills and the tendency of many CWHI to proceed too quickly when attempting to solve a problem rather than pausing to think it through or develop a coherent plan. They further noticed that "the internalization and application of new knowledge and skills are enhanced by repetitive practice, active participation, interactive discussion and evaluative feedback" and confirmed that CWHI need to receive constant repetition of mathematical concepts in order to retain them

Nunes & Moreno (1998) identified one mathematical concept - *additive composition* - that is crucial to progress in mathematics, often mastered by children before they enter school or quite early on in their school lives, and that seems to create a significant obstacle for CWHI in their pursuit of learning mathematics.

The findings above stress on counting, auditory experience, meta cognitive skills, special vocabulary etc as contributing factors for mathematics performance in schools.

1.2.2 Comparison of the performance of CWHI and normal children

Studies of mathematical achievement and understanding have generally concluded that there is no significant cognitive basis for major differences in mathematical performance between deaf and hearing students and that achievement differences that are observed are the result of a combination of linguistic and experiential delays for the CWHI (Titus, 1995; Serrano Pau, 1995).

Most studies (Wood et al, 1983; Nunes, and Moreno 1998) have found either no correlation or only a very small correlation between the level of hearing loss and mathematics attainment. This result suggests that hearing loss is not a direct cause of difficulties in mathematics.

CWHI were better than the hearing children at reproducing from memory, arrays of objects presented visually. Because the size of the arrays did not require counting. They were no worse than hearing children at reproducing the arrays when the objects were presented in a temporal seqence (Zarfaty et al., 2004).

Stanford Achievement Test is the most widely administered test given to deaf and hard of hearing students ages 7 through 18 in the US. The mathematics performance of CWHI and that of hearing students show disparity in this norm-referenced test. It is noticed that CWHI achieve at a higher-grade level in mathematics than in reading and other language skills. (Stewart and Kluwin 2001) though their mathematics performance was below grade level.

Paranjape (1998) compared the language and mathematics achievement of normal and hearing handicapped pupils at the end of the primary cycle.

The following observations are made:

1. At the end of primary cycle, there is a significant difference between normal and hearing handicapped students in language achievement. The former group performed better than the latter. However, this is not so with regard to mathematics achievement.

2. There were no significant differences in the performances of boys and girls in language within the sample of normal and hearing Handicapped groups. However, in mathematics, boys who were non-handicapped performed significantly better than their female counterparts. No such sex bias was seen in the hearing handicapped group of students.

3. Handicapped students with a special school background performed significantly better in mathematics than those who were directly admitted to the general schools. This was not so with regard to language achievement.

Meadow & Orlans (1980) indicates that there is evidence to suggest that CWHI learn concepts in the same sequence and in the same manner as hearing children do. Their finding suggests that the mathematics reasoning is on par with normal hearing children. However they noticed that the learning process is slower among CWHI.

Nunes & Moreno (1998), have argued that hearing loss cannot be treated as a cause of difficulties in mathematics but as a risk factor. Several findings in the literature suggest that hearing loss is not a direct cause of difficulties in mathematics.

First, not all CWHI are weaker in math than their hearing counterparts:

Approximately 15% of the profoundly hearing handicapped children perform at average or above average levels in standardised tests (Wood, Wood, and Howarth, 1983). If hearing loss were a direct cause of difficulties in mathematics, there should be no CWHI displaying achievements adequate for their age level.

Studies in this section observed that there is no significant difference between hearing and children with hearing impaired in their mathematics performance. The reasons for the differences observed in some studies are attributed to other factors like language and experience and the sensory deprivation is considered as a risk factor.

1.2.3 Sign language and mathematics learning

Some children educated in sign language develop their own algorithm in sign to solve number fact questions, instead of attempting to rely on memory of verbally coded number facts (Nunes & Moreno, 1998). The development of a sign bilingual approach to the education of CWHI has focused attention on the use of sign language. Being a visually-spatially-organized language, it could have much to offer to the teaching of mathematics. Because the language conveys more information about size, location and spatial relationships than spoken language, it could be a rich language for exploring and explaining mathematical concepts.

An indication of the richness of sign language in conveying mathematical concepts is hinted at by the Reference Notes to the National Curriculum Assessment (London, 1993) where it states 'Although sign can be used to present and respond to the mathematics standard assessment tasks, care should be taken that the signs used in presentation do not give clues to the answer, nor cause confusion' (p. 4).

There is some research that seems to indicate that CWHI who use sign language may have strengths, which are relevant to mathematics. A study by Braden (1994) collected together all studies of intelligence and CWHI. He compared non-verbal intelligence and verbal intelligence. Verbal intelligence relates to problem solving where there is verbal/linguistic component, it has a linguistic basis while non-verbal intelligence involves solving problems which do not have an apparent language component. Braden reviewed 208 studies, which included 171,517 deaf subjects from 234 independent samples, involving 324 reports of IQ. He found that the mean IQ from all studies (324 reports) was 97, the mean verbal IQ (32 studies) was 86, and the mean non-verbal IQ (195 reports) was 100, establishing the CWHI had the same non-verbal intelligence as hearing people. However, he then went on to consider those CWHI who had parents who were with Hearing Impairment and found that the average non-verbal IQ of those parents with Hearing Impairment parents was 108, a score which differs significantly from that of hearing people.

This is an important finding when we think about teaching mathematics. It may be that if CWHI use sign language they develop a particular area of intelligence to a higher level-the organization of space and memory for spatial concepts. Studies have shown that the ability to think spatially is related to mathematical ability (Bishop 1980)

Another issue is the mode of access to mathematical concepts. The development of sign bilingual education for CWHI raises a number of questions about mode of access to the curriculum. It is argued that because sing language is a visually-spatially organized language it should lend itself well to the relationships (Gregory, 1998). This is not to say that all CWHI should be taught mathematics through sign language but rather that we should evaluate the extent to which the language but rather that we should evaluate the extent to have a better ability to think spatially than hearing people (Braden, 1994, Bellugi et al.,). Nunes and Moreno (2002) explore the ability to think spatially to some extent in their intervention programme, which uses drawing and diagrams to visually present mathematical concepts. This study provides evidence that the pupils benefited from visual emphasis.

Visual spatial ability is directly linked to mathematical ability. The above studies drive home the point that CWHI have better visual spatial concepts which in turn help them to form mathematical concepts.

1.2.4 Language and mathematics learning

Most of the published research studies on mathematics look at mathematical achievement as part of wider studies of general educational performance where, most often, literacy is the main focus, because of the language skills required to access mathematical information.

Much of the information that hearing children learn about language is picked up from their environment. In comparison with their hearing peers, CWHI miss out on various concepts and vocabulary that hearing children pick up incidentally. Counting is as relevant to the preschool age, as the conversations relating to. mathematical ideas continue throughout the school-years. The extent of the difficulty can be appreciated, if one consider the incidental information that hearing children pick up throughout their school lives, which will be more difficult for many CWHI to access, whether thy use sign or speech.

Kidd (1991) provides an analysis of a number of mathematical problems, based on a textbook in use with CWHI at the time of the study. She suggests that while syntactically the problems are similar to normal written language there are some significant differences. Firstly, there are many more prepositions, which are known to be difficult for CWHI. Secondly, there are many phrases dealing with time. Nominalization, the use of verbs as nouns, is said to be difficult for CWHI (Quigley et al, 1978, cited by Kidd). Yet a high proportion of the mathematical problems investigated contained these. Finally, she pointed out the high number of propositions to be considered within problems as a complicating factor. This would seem to imply that it is not simply the process of reading that is the issue but understanding the meaning through understanding the context.

Another argument is that mathematics has a specialist language and vocabulary which presents them with a number of linguistic problems (Gregory 1998, cited in Kinght and Swanwick).

Durkin et al., (1986) in their review of the literature suggest that hearing children can produce a numbers word sequence at two years of age and by three years of age have some ability to discriminate acceptable and unacceptable counting by others. They studied ten children and their mothers from when the children were 9 months of age until they were 30 months. They filmed the mothers and children in interaction, in a situation not specifically focused on number words. They found that mothers used many number words the most frequent being the first four numbers.

Counting has been shown to develop more slowly in deaf than in hearing children regardless of whether they speak or sign (Secada 1984). Oral counting seems difficult and Munes and Moreno (1997a) report confusions, particularly between words that have phonological similarity and numbers that have similar lip patterns.

Wood et al. (1986) suggest that it is clear from their research that hearing-impaired students as a group have a greater variability in their performance on mathematical tasks than the general student population. They suggest that it is critical to recognize the different demands of linguistic tasks.

Anghileri (1995) discusses how the "language of mathematics consists of words and symbols that have meanings related to particular contexts and to procedures for solving problems". Meanwhile Pimm (1987, cited in Bicknell, 1999) discusses that rather than seeing mathematics as a language in itself it should be seen as "a set of meanings that is appropriate to a particular function of language, together with the words and structures which express these meanings".

Barton (1995) notes several distinct features of mathematical language which make it complex and foreign for many learners, including having familiar words with precise meanings that differ from their normal meanings. This would suggest that the interpretation of the language of mathematics with its ambiguous vocabulary is particularly challenging for CWHI. Mathematical or cognitive concepts which involve specific language related to volume, shape, size, comparisons, measurement and reasoning are particularly difficult for CWHI to grasp.

The challenges that CWHI encounter with regard to language/mathematical language were also evident during Ray's (2001) observations. It was apparent that the children had not understood concepts such as in front of, behind, under, same, different.

CWHI find it difficult to understand verbal and written mathematical problems. Pau (1995) states that in order to solve written problems correctly CWHI need to correctly interpret every one of the words contained in the problem's text.

Pau (1995) suggests that "It is vital that any teaching programme designed to improve the child's problem-solving level should include general text-comprehension and, in particular, mathematics text-comprehension activities". Haynes (1999) states that "In order to maximize the learning the adult must ensure that purposeful play experiences, within an enriched environment, offer challenges and opportunities for exploration and problem-solving".

Underachievement in math of CWHI is attributed to lack of understanding of the language of maths and difficulty in accessing mathematical concepts, due to that. It is definitely not because they do not have ability.

There is consensus among the researchers about the role of language, reading and understanding for the development of mathematics concept in the primary stage of learning.

1.2.5 Cognitive characteristics of CWHI

Moores (1987) described three stages in the development of understanding of the cognitive abilities of persons with hearing impairment. In the first stage, which lasted from the beginning of the twentieth century until the 1950s, the prevailing notion was that persons who were hearing impaired had deficient intellectual abilities. The development of intelligence testing in the early part of the twentieth century confirmed the assumptions about the intellectual abilities of deaf persons. Although there were inconsistencies in the findings, most researchers concluded that persons who were deaf functioned below the norm on most tests of cognitive skills (Pinter, Eisenson, & Stanton, 1941).

Studies of mathematical achievement and understanding have generally concluded that there is no significant cognitive basis for major differences in mathematical performance between hearing and hearing impaired students and that achievement differences that are observed are the result of a combination of linguistic and experiential delays for the CWHI (Titus, 1995; Pau, 1995).

Research shows that children who are hearing impaired have normal intellectual potential (Meadow, 1980). However, for normal cognitive development, particularly in a mathematical sense, a child must be introduced to a diversity of mathematical experiences along with a rich language base (Ray, 2001).

Wood et al. (1986) based on their study conclude that the role of language is critical to understanding the delays in performance of CWHI as opposed to earlier belief that deafness by itself causes a cognitive deficit that accounts for an inability to solve problems.

Stone (1980) noted that deaf and hearing-impaired students had difficulties when undertaking sequencing tasks. Rittenhouse and Kenyon (1991) support and extend Stone's conclusion about the cognitive difficulty of CWHI by illustrating that differences in performance on sequencing and conservation tasks is not due to inferior cognitive abilities but rather a lack of experience and language.

The above studies clearly indicate that cognitive delays and deficits of CWHI is the result of experience and language deficits. They do not have any cognitive delay or deficit otherwise.

1.2.6 Problem solving skills among CWHI

CWHI are poor compared to hearing children at early, non-linguistic number representations. They are behind in learning the culturally transmitted number string, also. This may result in CWHI failing to develop informal problem-solving strategies, which prepare most children for the more formal learning of number and arithmetic that they will have to do at school (Nunes.T, and Zarfaty.Y, 2004).

Marschark et al. (2002) argue that word problem solving activities involve general thinking skills as well as reading comprehension. The general thinking skills outlined included selective attention, analysis, the ability to consider all information and use of analogies to known information to better understand the new problem. A relevant example of this is the use of story problems in mathematics as a way of providing a framework for developing children's problem-solving skills in their learning of new mathematical concepts. Pagliaro and Ansell (2002) say that story problems allow learners to use their existing knowledge and experience (schema) to make connections with and respond to the new information (the mathematics problem). This study looked at the frequency and mode of story problem presentation and concluded that teachers tend to use story problems only when they consider that the children have the linguistic and mathematics skills to solve the problems. This means that challenges of problem-solving are not introduced as a part of the learning process but rather as opportunities to show what they have learnt.

The relationship between pupils' problem-solving skills and teaching style was investigated in a study by Kelly et al. (2003). They found that CWHI exhibited unrefiective behaviour, lack of persistence in working through difficult problems and difficulties in transferring learning from one context to another. The students performed well on tasks involving on dimension but performance dipped when two or more dimension were involved. They investigated this through a teacher survey, which identified that teachers tended to focus on practice exercises and drill rather than true problem-solving, thus avoiding cognitively challenging aspects of word problem solving. As a result, CWHI were not being engaged in sufficiently challenging world problem situations.

In mathematical processes such as developing logic and reasoning, problem-solving is especially difficult for children who are deaf as a sound language base is needed for putting observations into words or making predictions. Without communication skills, the child can be isolated in the learning environment and may be unable to participate in group activities and discovery (Ray, 2001).

Zavenberg, Hyde and Power, (2002) examines the performance of hearing-impaired students in solving arithmetic word problems. It was found that the subjects' solutions of word problems confirmed trends for hearing students, but that their performance was delayed in comparison. The results confirm other studies where deaf and hearing-impaired students are delayed in their language acquisition and this impacts their capacity to successfully undertake the resolution of word problems.

There is much research to show that children solve problems that involve addition and subtraction (Carpenter & Moser, 1982) as well as multiplication and division (Nunes & Bryant, 1996) using logic and counting before they were ever taught about arithmetic operations in school. The algorithm is efficient in producing the right answer for number facts questions. However, after one teacher taught the children to use this algorithm to solve, it is noticed that the children were less successful in solving word problems with the algorithm, which required them to make a choice of operation, than with informal procedures that relied on counting and did not require a choice of operation (Nunes & Moreno, 1997).

Though delayed language acquisition and poor reading comprehension of CWHI are considered as the primary hurdle for them to solve word problem, teaching strategies to develop problem solving skills are also considered as essential components of training.

1.3 Context need and Importance of the study

Studies conducted by various investigators (Mohammad Miyan, 1992) relating to MLL in mathematics reveal that considerable percentage of school children have difficulties in mathematics. During interaction with in-service teachers by the investigator it has been observed that many teachers themselves lack proper concept in mathematics and they express their inadequacy to give the conceptual knowledge to basic mathematics learnt during the primary school stage. When the normal children have so much of problem in mathematics and teachers face difficulty to teach them, children with hearing impairment, who are deprived of one important mode of acquiring knowledge are sure to face problems similar to normal children and also different kinds of problems to learn mathematics.

Findings mentioned in section 1.2, suggests that CWHI lag behind hearing children in originality, imagination and abstract thinking. These skills being very important aspects of mathematics learning, it is observed that children with hearing impairment lag behind in academics. Mathematics being a linear and link subject children cannot overcome their problem automatically. There is a need to help them right at the primary school itself so that the gap can be bridged. Basic mathematics concepts are crucial to build upon knowledge in the subjects at the later stage. How CWHI perform in mathematics in college is in large part a result of how well they have been prepared in mathematics during their first 12 years of schooling (Stewart & Kluwin 2001). Hence to help CWHI with their difficulties in mathematics, at the earliest, there is a need to:

1. Compare the mathematics performance of CWHI with normal children.
2. Diagnose their difficulties at the symptomatic level and understanding their causative and correlative factors.
3. Develop competencies among teachers to adopt appropriate strategies to teach maths to CWHI.
4. Develop instructional materials, which can be used by the teachers/parents in teaching mathematics to children with hearing impairment.
5. Modify the teacher training program curriculum for CWHI with reference to teaching of mathematics.

1.4 Objectives of the study

Review of related literature indicate an encouraging point of view which maintains that CWHI can achieve their potential if the environment, instruction and materials are appropriate. We need to be able to identify more precisely why CWHI lag behind their hearing peers. The details of the deficits should be explored in order to plan effective ways to help them acquire these important skills. This study is proposed with this aim. The specific objectives of the study are as follows:

a. To compare the mean performance of CWHI with the performance of normal hearing children on Arithmetic Diagnostic Test (ADT) from grades 4 and 5.

b. To compare the mean performance of different groups of CWHI with that of normal hearing children.

c. To identify the common errors committed by CWHI in number concept fundamental operations and mathematics reasoning

d. To compare the percentage of children committing each type of error, from special and normal schools.

e. To compare the frequency of errors committed by CWHI with children with normal hearing from grades 4 and 5 from special schools and normal school.

METHODOLOGY

2.0 Introduction

The methodology adopted to achieve the objectives is discussed in this chapter. This chapter includes details about sample, procedure employed for collection of data and analysis of the data along with the description of the tool used in the study.

2.1 Sample

There are four schools for children with hearing impairment in Mysore city. It was decided to keep all the four schools for data collection. One normal school was selected to compare the performance of children with hearing impairment with the performance of normal children. The details of the schools along with the number of children in grades 4 and 5 are given below in the table.

Table 2.1: Details of the schools and number of children in the grades selected.

SI. No.	School Name	School code	Std.	Gender		Total Students	
				Boys	Girls		
1	Mercy convent (Special school)	SSA	4th	3	12	15	29
			5th	3	11	14	
2	Sai Ranga school (Special school)	SSB	4th	11	-	11	20
			5th	9	-	9	
3	Govt.Deaf School (Special school)	SSD	4th	15	-	15	28
			5th	13	-	13	
4	Puttaveeramma School (Special school)	SSC	4th	—	11	11	24
			5th	-	13	13	
5	Kukkara halli Govt. school (Normal school)	NSE	4th	2	6	8	18
			5th	6	4	10	
Total Students				62	57	119	119

The study was restricted to grades 4 and 5 only, as the test items required the students to read, understand and then solve the problems from the tool used. Two to three years of school exposure was necessary before they independently answer the test. Most of the children in the special schools and in government schools do not have preschool training. They are directly taken to grade 1. So three years of school exposure was kept as a cut-off point to rule out poor academic exposure.

In grades 4 and 5, 35% score was kept as cut off to consider the data for analysis. This was done to eliminate the other possible factors for poor performance like slow learning, learning disability, serious emotional and behaviour problems which might co-exist with hearing impairment. The number of students eliminated at this stage is given in the table below.

Table 2.2: Number of students who scored above 35%

SL. NO.	Name of the school	Total students	Students scored 35% and above	No. of students eliminated
1.	SSA	29	24	5
2.	SSB	20	12	8
3.	SSC	24	21	3
4.	SSD	28	26	2
5.	NSE	18	16	2

2.2 Description of the tool

Arithmetic Diagnostic Test (Ramaa, 1994)

This test diagnoses the specific difficulties encountered by children of primary schools of grade I through IV, while solving arithmetic problems. The test covers three major areas of arithmetic, namely number concept, arithmetic processes (operations)- Addition, Subtraction, Multiplication and Division, and Arithmetic Reasoning.

Since it is a diagnostic test, it includes problems that represent each type and sub type of tasks, that fall under each of the major areas. Thus the test is quite comprehensive in identifying the strengths and weaknesses of the individual child. Due weightage is given to different types of tasks. Two items in case of arithmetic processes and reasoning represent each subtype of the task. This helps in thorough diagnosis of the difficulties faced by the children in dealing with particular subtype of arithmetic task. The sub items and the items are arranged in the order of increasing level of difficulty within the different sections of item, as well as between the sections.

2.3 Procedure for collection of data

The test was administered in groups with proper instruction and supervision. Some of the items, which are having multiple operations were deleted, as students might not have come across such problems. To maintain uniformity flash cards were prepared to show examples for few items before hand. The same was used in all the five schools. Students were motivated sufficiently to take the test sincerely. The test was administered in 4-5 sessions of 1 to 2 hours duration each. Doubts were clarified before and during administration.

2.4 Analysis of the data

Quantitative analysis was done which aimed at comparing the mean performance of CWHI and normal hearing children. The performance of different groups of children with hearing impairment was also compared with the mean performance of normal children.

It is intended to analyse the data qualitatively, for the percentage of children committing each error identified in the study. This was done for all the five areas of arithmetic addressed in the study. For qualitative analysis, only two special schools SSA, SSB and the normal school NSE were selected due to time constraint. Data was analysed qualitatively with reference to the types of errors and their frequencies. The purpose of such an analysis was to compare the common and unique difficulties of children with hearing impairment in different criterion measures related to number concept, addition, subtraction, multiplication and division in comparison with the errors of normal children. Further, qualitative analysis aimed at calculating the frequency of each error committed by a student and the total frequency of the same error in a particular school. The detailed analysis, results and discussion are given in the following chapter.

ANALYSIS OF THE DATA AND INTERPRETATION OF THE RESULTS

3.0 Introduction

As mentioned in section 2.4 of chapter II, both qualitative and quantitative analysis were done. The details are discussed below

3.1 Quantitative analysis

Data related to the performance of all the four groups among CWHI and the normal children on Arithmetic Diagnostic Test on all the areas of arithmetic assessed were analysed quantitatively.

3.1.1 Comparison between the mean performance of special schools and normal school:

For comparing the performance of CWHI and normal children, the mean score obtained by the students from different special schools and the mean score obtained by the normal children were compared. The results are given in the table below.

Table 3.1: Comparison of the mean performance of CWHI and normal children.

Type of the school	N	Mean	SD	t - value	d.f	Significance P
Normal	16	116.69	24.45	1.624	97	0.10 (> 0.05)
Special	83	106.77	21.96			

Findings:

It is clear from the above table that there is *no significant difference* between the performance of CWHI and normal children in mathematics assessed using ADT.

3.1.2: Comparison of performance of different groups of CWHI and normal children

The means of all the five groups, on different areas of mathematics assessed namely, Number Concept, Addition, Subtraction, Multiplication and Division were compared. As there were more than two groups to compare, in more than one area of mathematics, MANOVA was used to analyse the difference between the groups in all the areas of arithmetic assessed.

Table 3.2: Table showing the results of MANOVA.

Areas of mathematics assessed	Degrees of freedom	F	Significance P
Number Concept	(4,89)	77.323	.000
Addition	(4,89)	5.642	.000
Subtraction	(4,89)	4.174	.004
Multiplication	(4,89)	18.056	.000
Division	(4,89)	15.888	.000
Total	(4,89)	9.533	.000

It is evident from the above table that there is significant difference between the schools in all the areas of mathematics assessed ($p<0.01$).

Duncan's post-hoc test was conducted to see the pair wise differences and subsets in terms of their performances in the schools in each area assessed. The results are as follows.

Table 3.3: Showing the performance of different schools in mathematics in all the areas assessed and the formation of subsets

Schools	N	Subset		
		1	2	3
SSC	21	91.48		
SSB	12	100.7	100.7	
SSD	26		110.4	110.4
NSE	16			116.6
SSA	24			119.1
Significance		.131	.114	.182

Findings:

1. The above table indicates that though there is significant difference between the schools SSC and SSA in over all performance, the other three schools SSB, SSD and NSE show intermediate performance with one another.
2. The special school SSA records the best performance among the five schools selected followed by the normal school NSE.
3. The special school SSC shows the lowest average score among the five schools.

Table 3.4: Showing the performance of different special schools and normal school in Number Concept

Schools	N	Subset			
		1	2	3	4
SSD	26	14.69			
SSC	21		19.62		
SSB	12		21.58		
SSA	24			30.21	
NSE	16				34.50
Significance		1.000	.156	1.000	1.000

Findings:

1. Normal school children performed better than the other four special schools in number concept
2. There is no uniformity in the performance of children in the special schools.
3. Except for SSC and SSB all the schools have shown divergent performance

Table 3.5: Table showing the performance of different special schools and normal school in Addition

Schools	N	Subsets		
		1	2	3
NSE	16	30.94		
SSC	21	34.00	34.00	
SSB	12		36.25	36.25
SSD	26			37.65
SSA	24			37.71
Significance		1.000	.159	.396

Findings:

1. There is no significant difference between the performance of three special schools SSA, SSD and SSB.
2. The performance of children in the other special school SSC is not very different compared to the above three schools.
3. The normal school NSE records poor performance in addition compared to special schools.

Table 3.6: Table showing the performance of different special schools and normal school in subtraction

Schools	N	Subset	
		1	2
SSC	21	24.33	
NSE	16	29.13	29.13
SSD	26	29.19	29.19
SSB	12	30.00	30.00
SSA	24		33.50
Significance		.066	.158

Findings:

1. Special school SSA has performed better compared to the other special schools and the normal school.
2. The performance of children in the normal school is similar to the three special schools selected in the study.
3. In subtraction, special schools SSA and SSC are at the extremes and the performance of other three schools are similar.

Table 3.7: Table showing the performance of different special schools and normal school in Multiplication

Schools	N	Subsets		
		1	2	3
SSB	12	7.67		
SSC	21	9.90		
SSA	24		13.71	
NSE	16		16.00	16.00
SSD	26			19.15
Significance		.175	.165	.057

Findings:

1. The special school SSD shows better performance in multiplication
2. The special school SSD shows no significant difference from the performance of NSE.
3. The special schools SSB and SSC show poor performance with no significant difference.

Table 3.8: Table showing the performance of different special schools and normal school in Division

Schools	N	Subsets		
		1	2	3
SSC	21	3.62		
SSA	24	4.04		
SSB	12	5.17	5.17	
NSE	16		6.13	
SSD	26			9.77
Significance		.131	.321	1.000

Findings:

1 The special school SSD shows better performance in division.

2 There is no significant difference between the performance of Schools SSB and NSE

3 There is no significant difference between the performance of three special schools SSC, SSA and SSB as shown in the table

3.2 Discussion:

There is no clear-cut indication to show uniformity in the performance of children from five schools. In different areas of arithmetic assessed, the subsets neither formed in any regular combinations nor confirm to any norm. Hence it is inferred that there is no significant difference in the performance of children with hearing impairment and normal hearing children in all the areas of mathematics assessed in the study. The performance of children in special schools are better in all the areas assessed, except in number » concept. This is very encouraging that if proper learning environment is given and appropriate teaching methods are used, children with hearing impairment can achieve like their hearing counterparts in mathematics. The quantitative analysis results indicate difference in the performance of different groups of CWHI and normal children. But it is not suggestive that one particular school is showing better performance. The similarity in performance is varied for different groups for different areas of mathematics assessed in the study. Hence further analysis was carried out to see if there is any qualitative difference in the performance of children from different groups.

3.3 Qualitative analysis

Qualitative analysis was done at two stages. Only two special schools SSA and SSB were considered for qualitative comparison with the normal school NSE. The details are as follows.

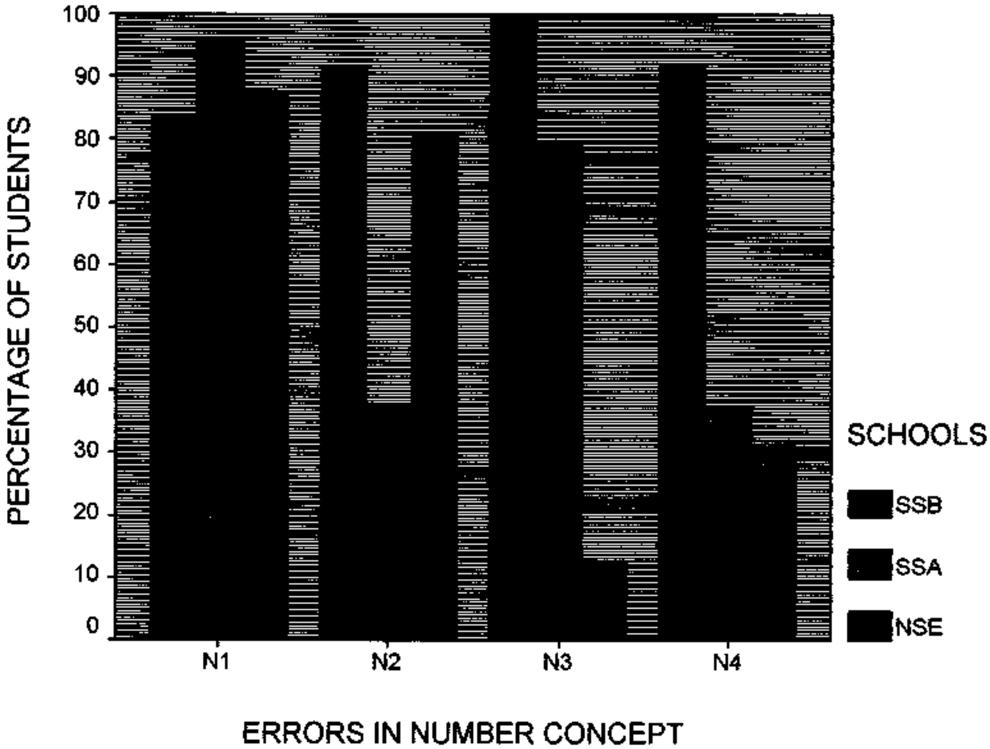
3.2.1 Comparison of the percentage of children committing different errors

At the first stage, qualitative analysis aimed at comparing the percentage of students committing each error under different skills of mathematics assessed in the three schools selected. At this stage, qualitative analysis is restricted to error analysis. Common errors committed while doing mathematics by two groups of CWHI and the normal children were analysed . The analysis aimed at comparing the percentage of children committing each type of error in different areas of mathematics assessed in the selected schools. The results are shown in the following tables and graphs.

Table 3.9: Showing the percentage of students committing errors in Number concept.

Error	Percentage of students in			Z value (from Equality of proportions) for			There is no significant difference between
	SSB	SSA	NSE	SSB& SSA	SSB& NSE	SSA & NSE	
N1	83.33	95.83	87.50	-1.28*	-.31*	.98*	All the schools
N2	91.67	37.50	81.25	3.08	.78*	-2.72	SSB & NSE
N3	100.00	79.17	12.50	1.70*	4.58	4.14	SSB & SSA
N4	91.67	37.50	31.25	3.08	3.20	.41*	SSA & NSE

* 1.96 < Z < 1.96, hence there is no significant difference.



Nl—> Splitting the numbers while writing.

N2—> Substituting some other digit.

N3—>Omits a digit.

N4—• Did not attempt.

Findings:

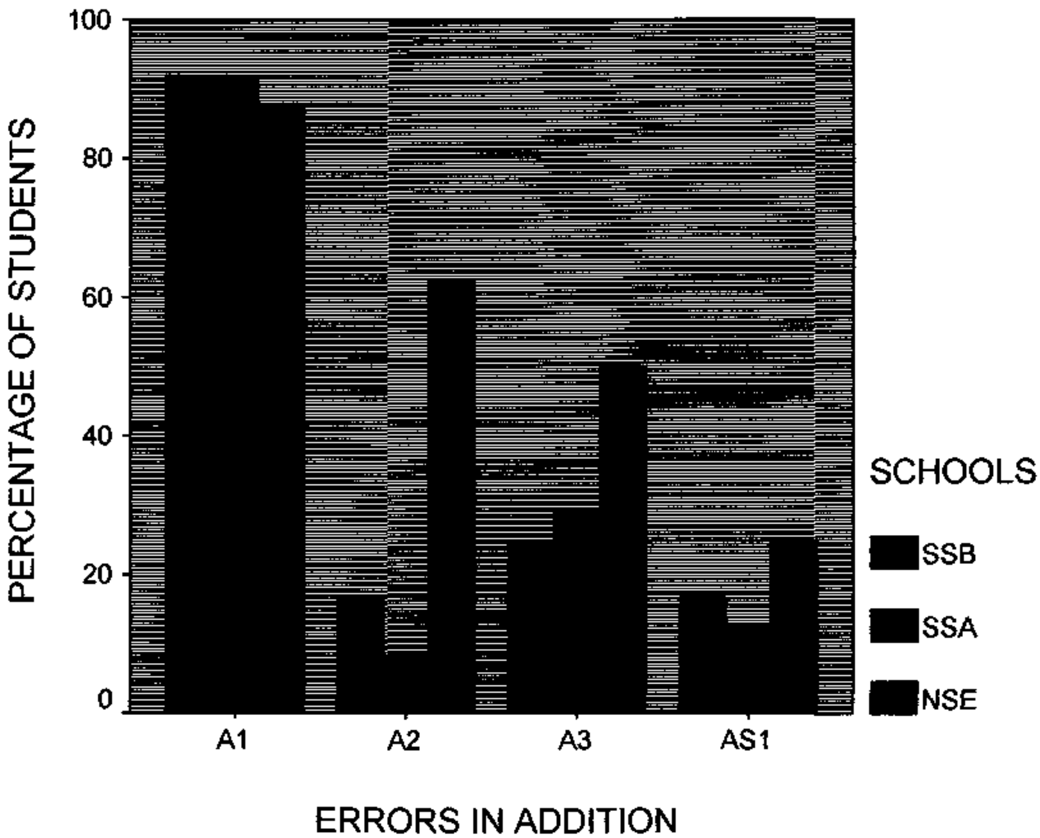
1 There is no significant difference between the percentage of students committing the error N1.

2 The other three errors are committed by children from all the schools. But in each error the significance level is different for different pairs as shown in the above table and the graph. There is no indication that the errors are committed by children in special schools only.

Table 3.10: Showing the percentage of errors committed in Addition.

Error	Percentage of students in			Z value (from Equality of proportions) for			There is no significant difference between
	SSB	SSA	NSE	SSB& SSA	SSB& NSE	SSA& NSE	
Al	91.67	91.67	87.50	.00*	.35*	.43*	All the schools
A2	16.67	8.33	62.50	.75*	-2.43	-3.66	SSB & SSA
A3	25.00	29.17	50.00	-.26*	-1.34*	-1.33*	All the schools
AS1	16.67	12.50	25.00	.34*	-.53*	-1.02*	All the schools

* 1.96 < Z < 1.96, hence there is no significant difference.



Al—> Number fact problem.

A2—> Does not carry over to higher place.

A3—> Did not attempt as the difficulty level increased.

*AS1—> Did not attempt.

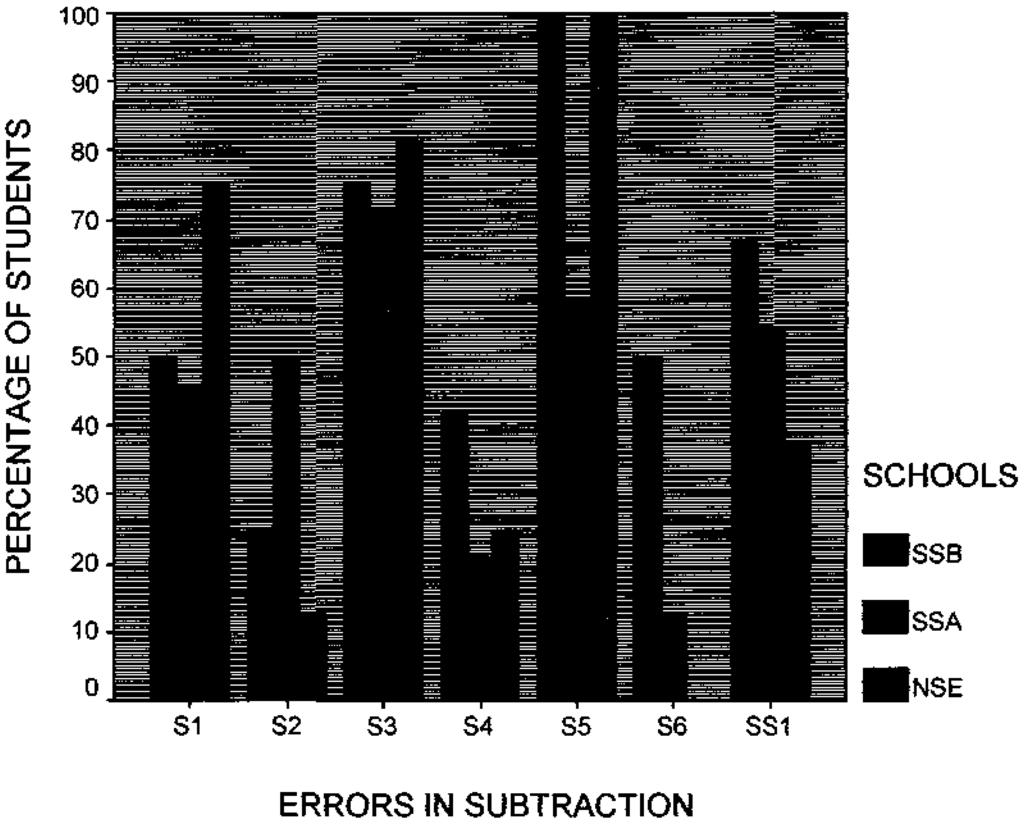
Findings:

1. Except for the error A2, there is no significant difference between the percentages of children committing the other errors.
2. The percentage of children committing the error A2 is more in the normal school

Table 3.11: Showing the percentage of errors committed in Subtraction.

Error	Percentage of students in			Z value (from Equality of proportions) for			There is no significant difference between
	SSB	SSA	NSE	SSB& SSA	SSB& NSE	SSA& NSE	
SI	50.00	45.83	75.00	.24*	-1.37*	-1.83*	All the schools
S2	25.00	50.00	12.50	-1.43*	.85*	2.44	SSB& SSA SSB&NSE
S3	75.00	70.83	81.25	.26*	-.40*	-.75*	All the schools
S4	41.67	20.83	25.00	1.32*	.93*	-.31*	All the schools
S5	100.00	58.33	100.00	2.63	Equal	-2.98	SSB&NSE
S6	50.00	12.50	.00	2.45	3.19	1.47*	SSA & NSE
SSI	66.67	54.17	37.50	.72*	1.53*	1.03*	All the schools

* 1.96 < Z < 1.96, hence there is no significant difference.



SI—> Adding the numbers

S2—> Writes one of the digits as answer.

S3—> Subtracts lesser number from greater no.

S4—> Writes zero when they cannot subtract.

S5—> Did not attempt as the difficulty level increased.

S6—> Errors in borrowing when zero is present.

*SS1—> Adding all the numbers

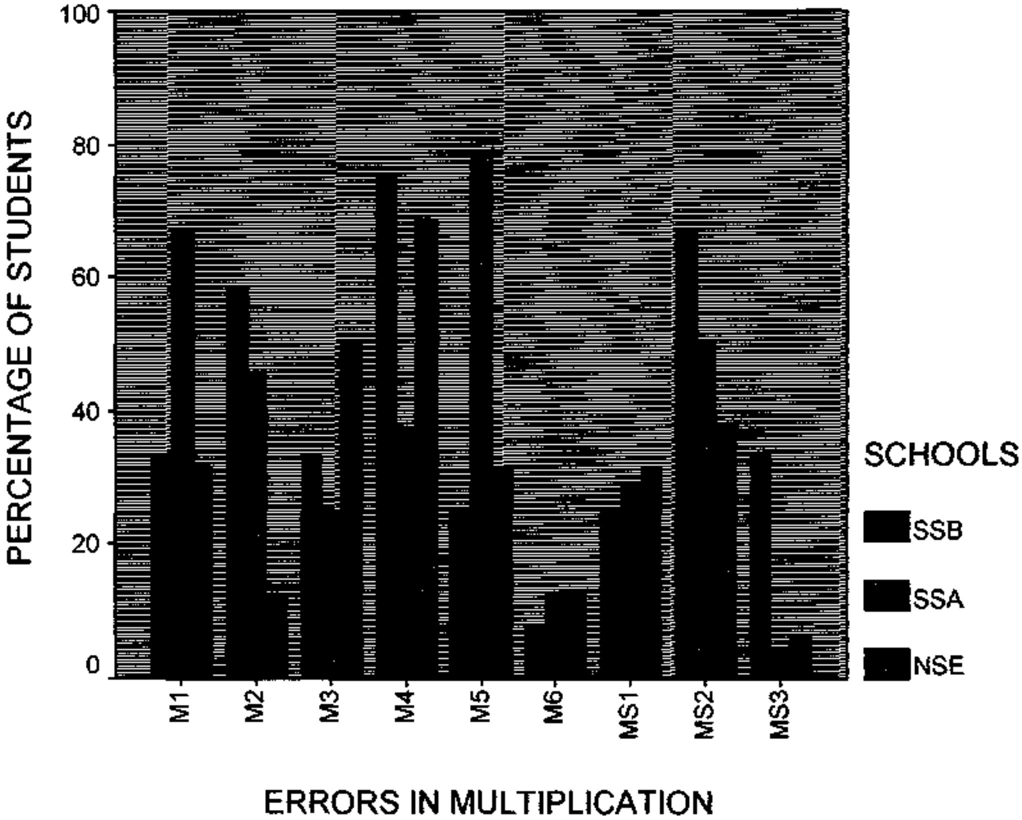
Findings:

1. There is no significant difference in the percentage of children committing the error SI, S3, S4 and SSI.
2. The other errors are also committed by the children in all the schools, though the percentage varies as shown in the above table and the graph.

Table 3.12 Table showing the percentage of errors committed in Multiplication

Error	Percentage of students in			Z value (from Equality of proportions) for			There is no significant difference between
	SSB	SSA	NSE	SSB & SSA	SSB & NSE	SSA & NSE	
Ml	33.33	66.67	31.25	-1.90*	.12*	2.20	SSB & SSA SSB & NSE
M2	58.33	45.83	12.50	.71*	2.57	2.21	SSB & SSA
M3	33.33	25.00	50.00	.53*	-.88*	-1.62*	All the schools
M4	75.00	37.50	68.75	2.12	.36*	-1.94*	SSB& NSE SSA & NSE
M5	25.00	79.17	31.25	-3.14	-.36*	3.03	SSB & NSE
M6	8.33	12.50	12.50	-.38*	-.35*	.00*	All the schools
MSI	25.00	29.17	31.25	-.26*	-.36*	-.14*	All the schools
MS2	66.67	50.00	37.50	.95*	1.53*	.78*	All the schools
MS3	33.33	4.17	6.25	2.39	1.85*	-.30*	SSB & NSE SSA & NSE

1.96 < Z < 1.96, hence there is no significant difference.



Ml—> Could not perform multiplication involving more than one digit.

M2—> Did not know multiplication when zero was present.

M3 —> Number fact problem.

M4 —> Did not attempt.

M5 —> Could not perform multiplication involving more than two multiplicands.

M6 —> Adding the numbers

*MS1 —> Adding the numbers

*MS2—> Did not attempt

*MS3—> Did not know multiplication involving more than one digit.

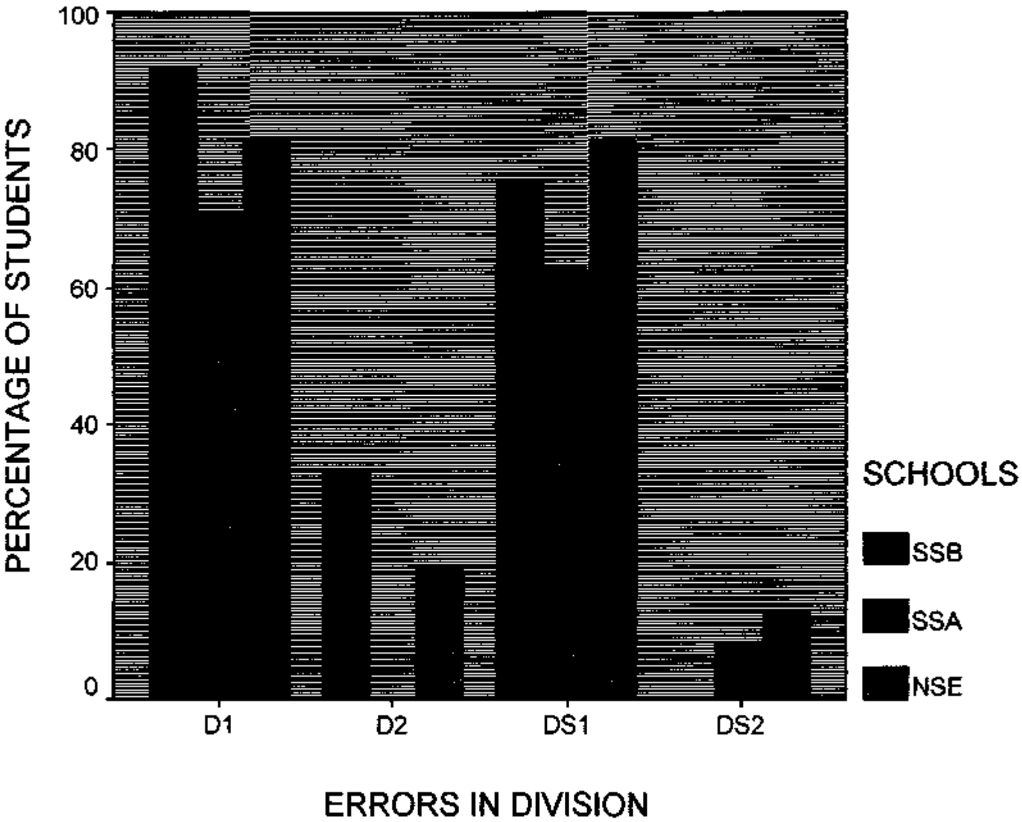
Findings:

1. There is no significant difference between the errors M3, M6, MSI and MS2
2. The children commit the other errors from different schools as indicated in the above table and graph.

Table 3.13 Table showing the percentage of errors committed in Division.

Error	Percentage of students in			Z value (from Equality of proportions) for			There is no significant difference between
	SSB	SSA	NSE	SSB & SSA	SSB & NSE	SSA & NSE	
Dl	91.67	70.83	81.25	1.42*	.78*	.75*	All the schools
D2	33.33	.00	18.75	3.00	.88*	2.21	SSB & NSE
DS1	75.00	62.50	81.25	.75*	-.40*	1.27*	All the schools
DS2	.00	8.33	12.50	-1.03*	-1.27*	.43*	All the schools

* $1.96 < Z < 1.96$, hence there is no significant difference.



Dl—> Did not attempt.

D2—> Multiplying the numbers

***DS1—>** Did not attempt.

***DS2—>** Lack of concept (Deficiency).

** indicate errors in statement problems involving the particular operation.*

Findings:

1. Except for the error D2 there is no significant difference between the percentages of children committing the other errors.
2. Children did not commit error D2 in one of the special school SSA
3. Children did not commit error D4 in the other special school SSB
4. Many children from all the three schools did not attempt most of the items in the test, both in numerical (Dl) as well as statement problems (DS1).

DISCUSSION:

From the above analysis it is evident that children in all the three schools with no significant difference commit some of the errors. But there are certain errors, which are committed by children from all the schools but the percentage is significantly different. There are few errors, which are not committed by children in some schools. But nowhere it indicates that children with hearing impairment commit the errors in greater percentage or vice versa. Though division is the most difficult of the four fundamental operations, it seems there are lesser number of errors. But in reality, students have not attempted most of the items in that section. It was observed that none of the children with dyscalculia had attempted any of the items in division from grades 3 and 4 and normal children of the same grades exhibited similar errors as noticed in the present study. (Gowramma 2005) Thus, it is clear that as the difficulty level of the concept increases, children find it difficult to comprehend the same. As the maturity level increases they understand the concepts. This is common for all the children.

3.2.2 Qualitative analysis comparing the frequency of each error committed by all the children in three schools selected.

Qualitative analysis in section 3.2.1 gives the details about the number of students committing an error. There is no indication of uniform pattern of significant difference in the errors in favour of normal hearing children. Since it does not show the number of times the same error is being committed by each student, it was attempted to calculate the possibility of committing the error and it was compared with the frequency of the error committed by all the students from a school. It was added together for each school separately. Keeping the total frequency of normal school as baseline, total frequencies of two special schools were compared separately for each error. Number of times normal children committed the error was compared with the number of times children in the other two special schools committed the same error. This was calculated using compound proportion.

One example of calculating the same is given below.

Example of the working out of the steps for calculating the number of times the students in SSB could commit the errors, when compared to normal students is given below.

Data:

Possibility of committing the error Nl by a student: 12

No. of students committing the error Nl in NSE : 14

Possibility of committing the error by all the students in NSE: 14X12=168

Total frequency of the error committed by NSE: 14

No. of students committing the error in SSB: 10

Possibility of committing the error by students in SSB: 10X12 = 120

Therefore, no. of times SSB could commit compared to NSE: ?

14----> 168 —> 14

10—> 120 —>?

$$\frac{10}{14} \times \frac{120}{168} \times 14 = 7.14\text{-}7$$

The school SSB could commit the error Nl 7 times compared to NSE, who have committed 10 times. This indicates that children in SSB have committed the particular error in higher magnitude compared to normal children.

The tables 3.14 to 3.18 gives the details of this analysis for all the subgroups specified in the diagnostic test, namely number concept, addition, subtraction, multiplication and division

Table 3.14: Number of students committing the errors in Number concept along with frequencies and possibilities of the error. (Table a & b)

table-a

Sl.no.	Error	SSA N=12		SSB N=24		NSE N=16		Possibility of committing the error by a studnet
		No. of Students committing the error	Total frequency of the error commited by them	No. of Students committing the error	Total frequency of the error commited by them	No. of Students committing the error	Total frequency of the error committed by them	
1	N1	23	69	10	36	14	14	12
2	N2	9	13	11	26	13	20	15
3	N3	19	37	12	46	2	2	10
4	N4	9	42	11	72	5	18	42

Table- b

Sl.no.	Errors	SSA		SSB	
		Total frequency of the error committed by them	No. of times they could commit based on Normal school (NSE)	Total frequency of the error committed by them	No of times they could commit based on Normal school (NSE)
1	N1	69	38	36	7
2	N2	13	10	26	14
3	N3	37	181	46	72
4	N4	42	58	72	87

Table No. 3.15 Number of students committing the errors in Addition along with frequencies and possibilities of the error. (Table a & b)

table-a

Sl.no.	Error	SSA N=12		SSB N=24		NSE N=16		Possibility of committing the error by a student
		No. of Students committing the error	Total frequency of the error committed by them	No. of Students committing the error	Total frequency of the error committed by them	No. of Students committing the error	Total frequency of the error committed by them	
1	A1	22	42	11	53	14	48	40
2	A2	2	18	2	12	10	60	20
3	A3	7	10	3	6	8	20	40
4	AS1	3	7	2	3	4	13	4

table–b

Sl.no	Error	SSA		SSB	
		Total frequency of the error commited by them	No. of times they could commit based on Normal school (NSE)	Total frequency of the error commited by them	No. of times they could commit based on Normal school (NSE)
1	A1	42	119	53	30
2	A2	18	2	12	2
3	A3	10	15	6	3
4	AS1	7	7	3	3

Table No. 3.16 Number of students committing the errors in Subtraction along with frequencies and possibilities of the error. (Table a & b)

table-a

Sl. no.	Error	SSA N=12		SSB N=24		NSE N=16		Possibility of committing the error by a student
		No. of Students committing the error	Total frequency of the error committed by them	No. of Students committing the error	Total frequency of the error committed by them	No. of Students committing the error	Total frequency of the error committed by them	
1	S1	11	40	6	22	12	67	42
2	S2	12	24	3	5	2	17	42
3	S3	17	44	9	50	13	40	23
4	S4	5	16	5	40	4	12	23
5	S5	14	132	12	94	16	230	24
6	S6	3	13	6	10	0	0	6
7	SS1	13	60	8	44	6	23	6

table–b

Sl.no	Error	SSA		SSB	
		Total frequency of the error commited by them	No. of times they could commit based on Normal school (NSE)	Total frequency of the error commited by them	No.of times they could commit based on Normal school (NSE)
1	S1	40	56	67	17
2	S2	24	42	17	38
3	S3	44	68	40	19
4	S4	16	19	12	19
5	S5	132	176	230	129
6	S6	13	0	0	0
7	SS1	60	108	23	41

Table No. 3.17 Number of students committing the errors in Multiplication along with frequencies and possibilities of the error. (Table a & b)

table-a

Sl.no.	Error	SSA N=12		SSB N=24		NSE N=16		Possibility of committing the error by a student
		No. of Students committing the error	Total frequency of the error committed by them	No. of Students committing the error	Total frequency of the error committed by them	No. of Students committing the error	Total frequency of the error committed by them	
1	M1	16	61	4	40	5	36	10
2	M2	11	25	7	11	2	3	8
3	M3	6	11	4	5	8	19	20
4	M4	9	72	9	163	11	111	26
5	M5	19	44	3	3	5	16	10
6	M6	3	26	1	6	2	7	26
7	MS1	7	35	3	18	5	23	8
8	MS2	12	54	8	40	6	17	6
9	MS3	1	1	4	8	1	1	4

table–b

Sl.no	Error	SSA		SSB	
		Total frequency of the error committed by them	No.of times they could commit based on Normal school (NSE)	Total frequency of the error committed by them	No. of times they could commit based on Normal school (NSE)
1	M1	61	369	40	23
2	M2	25	91	11	37
3	M3	11	11	5	5
4	M4	72	74	163	74
5	M5	44	231	3	6
6	M6	26	16	6	2
7	MS1	35	45	18	8
8	MS2	54	68	40	30
9	MS3	1	1	8	16

Table No. 3.18 Number of students committing the errors in Division along with frequencies and possibilities of the error. (Table a & b)

table–a

Sl.no.	Error	SSA N=12		SSB N=24		NSE N=16		Possibility of committing the error by a student
		No. of Students committing the error	Total frequency of the error committed by them	No. of Students committing the error	Total frequency of the error committed by them	No. of Students committing the error	Total frequency of the error committed by them	
1	D1	17	173	11	91	13	55	24
2	D2	0	0	4	8	3	10	4
3	DS1	15	89	9	58	13	60	8
4	DS2	2	7	0	0	2	17	9

table–b

Sl.no.	Error	SSA		SSB	
		Total frequency of the error committed by them	No.of times they could commit based on Normal school (NSE)	Total frequency of the error committed by them	No. of times they could commit based on Normal school (NSE)
1	D1	173	94	91	39
2	D2	0	0	8	18
3	DS1	89	80	58	29
4	DS2	7	17	0	0

Findings

The tables 3.14 to 3.18 show that both hearing as well as hearing impaired children commit different errors in different magnitude. There is no uniform pattern observed to show any one school either special or normal committing all the errors lesser or greater number of times.

Discussion

There is neither quantitative nor qualitative difference in the performance of children with hearing impairment and normal hearing children. The pattern of errors exhibited by different groups of children is suggestive of the fact that, it is not only CWHI but also normal children who face similar problems in acquiring the concept and skill of mathematics. Ray (2001), Titus (1995), Pau (1995), Wood et al (1986) observed that early mathematical experience and language is essential factors for good mathematics performance. Wood et al (1986) observed that the wordiness of mathematics create difficulty for hearing as well as for those with hearing loss. Long ago in 1953, Myklebust concluded that CWHI are not generally inferior to hearing children in intelligence as concluded by Pintner (1940).

Meadow and Orlans (1980) states that hearing impaired children can learn mathematical concepts in the same sequence and manner as their hearing peers.

Sensory impairment per se will not have any debilitating effect on academic learning. Rather it is other factors like early mathematical experience, teaching method and above all the psychological factors, which play a role in acquiring mathematical concepts and procedures rather than just sensory handicap, (Gowramma and Ramaa 2004). Ramaa and Gowramma (2004) compared the performance of children with visual impairment, normal children and children with dyscalculia and observed that children with visual impairment performed on par with normal children and their performance was much better than children with dyscalculia. The results of this study also shows that hearing impairment is not directly affecting mathematics learning in school. Their performance is in no way inferior to the performance of normal children in most of the areas of mathematics assessed. According to Mykleburst (1975) non-verbal learning disturbance may be more debilitating than the verbal for mathematics. A child's non-verbal perceptions are required to form basic concepts necessary for mathematics concepts like line, size, distance and weight, and also to acquire spatial orientation to learn right, left and direction, which are essential pre-requirements for mathematics. CWHI need not necessarily lay behind these important concepts, as they are good at non-verbal concept formation. Gowramma (2005) observed similar errors as noticed in the present study in children with dyscalculia. However the percentage of children with dyscalculia exhibiting most of the errors were very high compared to normal children in her study.

Major findings and their implications:

- There is no significant difference in the performance of normal children and children with hearing impairment in mathematics.
- There is no uniformity in terms of the performance of all the five groups of children with or with out hearing impairment in different areas of mathematics assessed.
- It is observed that children with hearing impairment commit basic errors in mathematics.
- Most of the basic errors are noticed among normal children also with not much of deviation.
- There are certain errors which are committed by hearing impaired children more than the normal children and vice-versa
- There are certain errors which are committed by normal children more number of times than the hearing impaired children and vice versa.
- As the difficulty level of the concept increases number of children attempting the same decreases. Most of the children in the present study did not attempt items in the division section.

The focus on hearing loss and communication has diverted the attention of special educators away from other crucial classroom factors such as the quality of the teaching and individual learning strategies and experiences. Review of related literature in chapter I, section 1.2.5 shows that there is no cognitive deficit among children with hearing impairment. This study also shows that CWHI perform on par with normal children. This suggests a clear and positive direction to educators to provide mathematical experience to young children with hearing impairment without showing undue concern to the physical dimension of their handicap. In the present study even in the statement problems, which is mainly language based, there is no indication to say that CWHI had more difficulty. This implies that early mathematical experience and continued training is essential not only to children with hearing impairment but also for normal children to learn the concept of mathematics. By making use of appropriate adaptation in the teaching procedure CWHI can be taught mathematics effectively

CONCLUSION

Learning mathematics is important for all children even if they grow up depending on computers and pocket calculators for the simplest of mathematical operations. It is immaterial whether they become mathematicians or accountants, all children will benefit from a firm grasp of numbers that can be manipulated.

How students with hearing impairment perform in mathematics in college is in large part a result of how well they have been prepared in mathematics during their first 12 years of schooling (Stewart and Kluwin 2001). Knowing the types of errors and their magnitude helps the teacher to tackle the problem at the right time and gives guidelines to professionals to plan remedial instruction programmes to reduce the errors. There is a need for adapting appropriate strategies to teach mathematics by primary school teachers, both inclusive and special. After remediation, children with dyscalculia were able to perform on par with their grade peers, (Gowramma, 2002, 2005). This may be attributed to the systematic remedial instruction based on the most appropriate principles and strategies. It can be hypothesised that children with hearing impairment can overcome some of the basic errors significantly if such a systematic approach is followed to teach them.

There is a need to enrich the curriculum for enabling teachers to acquire knowledge and competency in teaching mathematics scientifically. Remedial instruction materials have to be developed and validated experimentally for normal as well as for children with hearing impairment. Future research should continue the development of these measures and the exploration of their use for supporting elementary school teachers.

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APPENDIX-I

ARITHMETIC DIAGNISTIC TEST FOR PRIMARY SCHOOL CHILDREN

1. Number Concept

a) The number of balls below is.............

0 0 0 0 0

0 0 0 0

O

b) The number of balls below is.............

O O O O O O

0 0 0 0 0

0 0 00

0 0 0

2. Write the following numbers in words.

a) 4 ________________ b) 370 ________

0 ________________ 108 ________

29 ________________ 214 ________

96 ________________ 541 ________

07 ________________ 780 ________

c) 1008 ________

3024 ________

5620 ________

6307 ________

8900 ________

j

3. Write the following in numbers (The child can read himself or the teacher can dictate)

Five, Zero__________, Fifty six__________, Sixty nine__________, Seventy one__________, One hundred and six__________, Three hundred and fourteen __________, Four hundred and eight______, Six hundred and fifteen__________ ______, Eight hundred and fifty one__________, One thousand and six________ - , Two thousand and fifty two__________, Four thousand five hundred and thirty__________, Five thousand two hundred and none__________, Nine thousand three hundred__________,

4. Write the numbers that fall in between the following numbers in a correct sequence.

a) 6, 7,__________,__________10.

b) 26,27,__________,__________30,__________,__________33.

c) 109,110__________,__________,__________,114,__________, ___ ____________________iio__________191

, , ,117, ,iz.i.

d) 1022,__________,__________,__________,__________,__________, 1028,__________,__________,__________, 1032.

4. Write any 5 numbers that are

a) Lesser than 12__________,__________,__________,__________,

b) Greater than 96__________,__________,__________,__________, ___

5. Arrange the following sets of numbers in an increasing order (if the child can not understand an example can be given)

a) 2,1,6,4,3,____________________

b) 28, 32, 14, 98, 64,____________________

c) 103,390,309,121,____________________

d) 6049, 2234, 6120, 2078,____________________

ARITHMETIC PROCESSES

ADDTION

I. Add the following numbers:

a) 6 4 b) 7 8

3 5 6 4

c) 3 5 d) 4 6

2 6 0 7

4 3 2 0

____ ______ ______ ______

____ ______ ______ ______

e) 15 27 f) 24 56

21 32 37 28

____ ______ ______ _____

____ ______ ______ _____

g) 82 95 h) 96 85

34 63 47 69

____ _____ _____ _____

____ _____ _____ _____

i) 53 32 j) 42 78

62 25 23 93

24 46 50 20

___ ____ ______ _____

___ ____ ______ _____

k) 56 65 904 830

20 30 817 953

44 77 653 417

____ _____ ______ ______

____ _____ ______ ______

m) 1234 2344 9876 4321

3575 5753 8765 9876

6001 6006 7654 7654

4321 8765

---- -----

II. Add the following numbers:

a) 6 + 3 + 2 =________ b) 46 + 37 + 28=________

7 + 4 + 3=________ 27 + 45 + 33=________

c) 124 + 38 + 9 =________ d) 3235 + 138 + 29 + 2 =________

213 + 49 + 9 =________ 4346 + 271 + 59 + 5=________

III. Write the following set of digits in an increasing order:

A	B
8 + 6 =________	9 +5 =________
16 + 3=________	17 + 2 =________
11+6 =________	12 + 5=________
20 + 3 =________	20 + 6________

IV . Solve the following problems:

1. a) Ramu could save Rs. 15/- out of the pocket money received from his father. His Uncle gave him Rs. 10/- this morning. How much does Ramu have now?

   b) Somu could save Rs. 25/- out of the pocket money received from his father, his brother gave him Rs. 12/- this morning. How does Somu have now?

2. a) Mysore is on the way to Bangalore from Chamarajanagar. Chamaraja nagar is 38 miles away from Mysore, and Mysore is 87 miles away from Bangalore. How far is Bangalore from Chamaraja Nagar?

   b) Chamaraja nagar is on the way to Ooty from Chamaraja nagar. Ooty is 160 miles away from Chamaraja nagar. Mysore is 38 miles away Chamaraja nagar. How far is Ooty from Mysore?

SUBTRACTION

I. Subtract the following:

a) 4 5 b) 5 6

4 5 2 4

___ ____ _____ ____

___ ____ _____ ____

c) 76 78 d) 84 92

32 45 60 40

____ _____ ____ _____

____ _____ ____ _____

e) 73 72 92 81

54 45 87 76

___ ______ _____ ______

___ ______ _____ ______

g) 694 785 h) 579 957

___ ___ ___ ___ 531 641 406 604

___ ___ ___ ___

i) 8605 7504 j) 9764 7693

___ ___ ___ ___ 6523 5412 3817 4825

_____ _____ _____ _____

II. Find the following:

1. 7_4 =________________________ 8-5=________
2. 12-10 =________________________ 25-20 =________
3. 15-7 =________________________ 18-9 =________
4. 342-39 =________________________ 476-57 =________
5. 5296-122 =________________________ 6384-233=________
6. 6084-729 =________________________ 7095-839 =________

III. Write the following set of digits in a decreasing order:

A	B
20-8 =________________	30-8=________
15-2 =________________	22-9 =________
25-6 =________________	15-1=________
9-1=________________	9-2=________

IV . Solve the following problems:

1. 8 + 4 - 5 =________________________ 2.18 + 14-15=________

   9 + 5 - 6 =________________________ 19+15-16 =________

3. 19+14+15-10-7 =________

   16+13 + 12-10-8 =________

4. 105-25 + 25=________________________ 5. 110-15-45=__________

205-35 + 35=________________________ 120-25-55=__________

IV . Solve the following problems:

1. a) Savithri had Rs. 25/- with her, she spent Rs. 21/- this afternoon. How many rupees are left with her now?

   b) Gayathri had Rs. 35/- with her, she has spent Rs. 29/- this afternoon. How many rupees are left with her now?

2. a) There are 50 students in section "A" of standard VIII. Among them 23 are girls. How many boys are there in that class?

   b) There are 80 students in section "B" of standard VIII. Among them 32 are girls. How many boys are there in that class?

3. a) Gopal is going to his Uncle's place which is 84 miles away from his home town. He has already travelled 48 miles. How many more miles he has to travel?

   b) Venu is going to his brother's place which is 96 miles away from his hometown. He has already travelled 42 miles. How many more miles he has to travel?

VI. Solve the following problems:

a) 15+________= 25
25+________= 23

b) 18 + 3 +________= 26
17 + 2 +________= 23

c) 108________= 96
205________=194

d) 95________+15 = 100
85________+ =100

e) 5 ___ 6 ___
___ 4 ___ 3
________ ________
9 7 9 7

f) 1 8 — 2 7 —
— — 5 — — 6
________ ________
2 0 7 3 0 8
________ ________

MULTIPLICATION

I. Multiply the following numbers:

a) 7X2 =________ 6X3=________
b) 5X4 =________ 5X6 =________
c) 6X0 =________ 8X0 =________
d) 21X7 =________ 31X7 =________
e) 91X20 =________ 91X40 =________
f) 70X8=________ 80X8 =________
g) 4X6X3=________ 6X4X3=________
h) 8X7X4 =________ 8X6X3=________
i) 428X2 =________ 481X2=________
j) 586X14 =________ 658X14=________
k) 673X236 =________ 736X326 =________
1) 5486 X 5 =________ 6845 X 5 =________
m) 6095X81=________ 90965X81=________

II. Solve the following problems:

1. a) There are 10 rows of seats in a classroom. Each row can accommodate 6 students. How many students can sit in that classroom?

b) There are 12 rows of seats in a classroom. Each row can accommodate 8 students. How many students can sit that classroom?

2. a) Each page has 21 lines. There are 125 pages altogether. How many lines are there in that book?

b) Each page has 32 lines. There are 120 pages altogether in a book. How many lines are there in that book?

3. a) Each candy bar 10 paise. Sita is having 65 paise with her. In order to buy 8 candy bars how many more paise is needed by Sita?

b) Each piece of sweet costs 20 paise. Geetha, is having 130 paise. In order to buy 10 pieces of sweet piece how many more paise is needed by her?

DIVISION

I. Divide the following:

a) 5 divided. 1 =------——————6 divided1 =——

b) 10divided5=——————20divided 5=------

c) 72 divided 8 =————————————72 divided 9 =——

II. a) 3)95 (4)86(

b) 7) 473 (8) 471 (

c) 9) 8483 (6) 5175 (

d) 7) 7007 (6) 6006 (

e) 21) 106 (23) 116 (

IV . Solve the following problems:

1. a) There are 59 boys in a classroom. How many groups of 7 boys can be formed out of them? How many boys will be left out?

   b) There are 76 boys in a classroom. How many groups of 8 boys can be formed out of them?

2. a) How many 25 paise coins you can get in exchange for 180 paise and how many paise will be left out?

   b) How many 50 paise coins you can get in exchange for 235 paise and how many paise will be left out?

3. a) Seven days make a week. How many full weeks are there in 154 days?

   b) Seven days make a week. How many full weeks are there in 105 days?

4. a) Rama is having seven 50 paise coins. He wants 10 paise coins only. How many 10 paise coins can he get?

b) Shama is having seven 25 paise coins. He wants 5 paise coins only. How many 5 paise coins can he get?

APPENDIX-II

List of common errors noticed in the study:

Errors in number concept

Splitting the numbers while writing
Substitute some other digit
Omits a digit
Did not attempt as the difficulty level increases

Errors in addition

Does not carry over digit to higher place
Number fact problem
Did not attempt if numbers are greater than 2 digits

Errors in statement Problems-addition

Subtracting the numbers
Adding 'all' the numbers
Did not attempt as the difficulty level increases

Errors in subtraction

Adding the numbers
Writes one of the numbers as an answer
Subtracts lesser number from greater no.
Writes zero when they can't subtract
Did not attempt if numbers are greater than 2 digits
Errors in borrowing when zero is present

Errors in statement problems-subtraction

Adding all the numbers
Did not attempt
Error in borrowing when zero is present

Errors in multiplication

Deficiency/lack of concept
Could not perform multiplication involving more than one digit
Did not know multiplication when zero is present
Number fact problem
Did not attempt
Could not perform multiplication involving more than two digits
Adding the numbers

Errors in statement problems-multiplication

Adding all the numbers
Did not attempt
Did not know multiplication when zero is present
Problem when one of the multiplicand is more than one digit

Errors in division

Committed procedural mistakes while doing
Did not attempt
Multiplying the numbers

Errors in statement problems-division

Did not attempt
Lack of concept/Deficiency