EFFECTIVENESS OF PLAY-WAY METHOD OF TEACHING MATHEMATICS FOR CHILDREN WITH HEARING IMPAIRMENT

Vijayalakshmi (S)
Registration No: 07MSED05

A Dissertation Submitted in partial fulfillment of Master's Degree
(Master of Special Education-Hearing Impairment)
University of Mysore,
Mysore.

ALL INDIA INSTITUTE OF SPEECH AND HEARING
MANASAGANGOTHRI
MYSORE- 570006.
APRIL-2008

Certificate

This is to certify that this Dissertation entitled "Effectiveness of Play-Way method of teaching Mathematics for Children With Hearing Impairment" is a bonafide work in partial fulfillment for the degree of Master of special education (Hearing Impairment) of the student Registration No.07MSED05. This has been carried out under the guidance of a faculty of this institute and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

Place: Mysore

Date: April, 2008

V. Basavaraj

Dr. Vijayalakshmi Basavaraj
Director
All India Institute of Speech and Hearing

Declaration

This is to certify that this Dissertation entitled "Effectiveness of Play-Way method of teaching Mathematics for Children With Hearing Impairment" is a bonafide work in partial fulfillment for the degree of Master of special education (Hearing Impairment) of the student Registration No.07MSED05. This has been carried out under the guidance of a faculty of this institute and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

Mysore

April, 2008 Register No. 07MSED05

Table of Contents

LIST OF TABLES

LIST OF FIGURES

Chapter -I

Introduction

1.0 Introduction

"Real Education has to draw out the best from the boys and girls to be educated. This can never be done in packing ill- assorted and unwanted information in to the heads of the students. It becomes a loud weight crushing all originality in them in to mere automata ".

Mahatma Gandhi

The task of building an enlightened, strong and prosperous nation rests on the shoulders of its children who are to be cherished, nurtured and developed with tenderness and care. Education has always played this important role and has, there by, emerged as a natural characteristic of human societies. Education has been the torch bearer of humanity's most noble ideals. Schools education in recent times has emerged as an important segment of the total education system expected to contribute significantly to the individual as well as the national development processes.

Elementary education is the most crucial stage of education spanning the first eight years of schooling. The foundation for the development of personality, attitudes, social confidence, habits, learning skills and communicating abilities of pupils is laid in these years. The basic skills of 3 R's are acquired at this stage. The importance of quality of elementary education hardly needs any emphasis. If a child goes through good education at this stage never looks back in life for he has been prepared to exercise his initiative to overcome difficulties.

No nation can progress without education and enlightened citizen. Education in general and school education in particular occupies a pivotal position in shaping one's personality. The desirable type of school education which brings out the all round

development of a child is a must because it is during this period that child will be able to learn and understand things properly. A comprehensive, supportive constitutional and policy framework, back by a systematic build up resource capacity at both national and state levels has led to substantial, noteworthy educational achievements and gains. National Policy of Education (NPE) (1986) and revised NPE (1992) has a given all importance to strengthen elementary education in the country.

The NPE (1986) is a milestone in Indian education. Based on an in-depth review of the Indian educational system that has evolved through a consensual process, it provides a comprehensive frame work to guide the development of education. The operational effectiveness of the NPE was enhanced by a Programme of Action (POA) incorporating a detailed strategy of implementation, along with the assignment of specific responsibilities and financial and organizational support. The policy and its POA were up dated once again in 1992 through a consensual process involving all State Government resource organizations and educationists.

Mathematics is considered as the king of all sciences. Mathematics has no longer remained a mere subject of study. Today it has become the foundation of the present explosion in scientific knowledge and as a language for communication and thought processes. Mathematics has not only been useful in its own right but it has also enriched the world by helping in development of other fields of knowledge.

1.1 Definition of Mathematics

Before thinking about the teaching and learning of mathematics one must know, what is mathematics? In one of the dictionaries it has been given that mathematics is the science of number and space while the other has defined it as the science of

measurement, quantity and magnitude. These definitions clearly indicate that mathematics is an accepted science, which deals with the quantitative aspects of our life and knowledge. It helps us in drawing necessary conclusions and interpreting various ideas with useful meaning. In fact, mathematics has its own language, its own tools and mode of operations. That is why mathematics is taken as a chest filled up with so many valuable tools concerning with the operations like counting, measuring weighing, etc, and helps in proper understanding of the nature's work and complicated problems of life by converting them into it's language of signs and symbols.

Mathematics in the real sense is a science of space and quantity that helps us in solving the problems of life needing numeration and calculation. It provides opportunity for the intellectual gymnastic of the man's inherent powers. It is an exact science and involves high cognitive abilities and powers. It is in this sense that Courant and Robbins once tried to define mathematics in the following way:

"Mathematics as an expression of the human mind reflex the active will, the contemplative reason, and the desire for aesthetic perfection. Its basic element is logic and initiation, analysis and construction, generally and individually."

1.1.1 **Mathematics in Day-to-Day life**

We use mathematics in some way or the other in our day-to-day life. Whatever may be our profession, mode of living or daily routine, we can't live without mathematics. Right from an ordinary man to big landlords and businessmen from a small child to the mature adult and from a housewife to the manager of a big industrial concern, everybody utilizes mathematics. If mathematics is shutout from daily life, all civilization

comes to a stand still. In this world of today nobody can live without mathematics for a single day. Mathematics is intimately involved in every moment of everyone's life.

There is a definite need of mathematics in anybody's life-long planning and day-to-day planning. A human being is always after profitable and increasing returns. A mathematical approach is essential for any progress. Any approach devoid of mathematical considerations is likely to lead to failure. If anybody wants to make a success of his life, he must have access to mathematics.

Day-to-day evaluation in life or self-evaluation and overall life evaluation provide us assessment, judgment, guidance and direction for the future. This evaluation will have to be mathematical in nature to a great extent. Even the most ordinary citizen has got to calculate his wages and buy things from the bazaar. A person may be a house wife, farmer, laborer, shopkeeper, tailor, clerk, vendor, salesman, accountant, mason, driver, carpenter or booking clerk, some knowledge of mathematics is absolutely necessary for him. The entire atmosphere is surcharged with mathematics. The price rates, discounts, commissions, rebates, interests, taxes, shortage, production distribution, inflation etc., are the issues with which everybody is intimately concerned. There is no escape from mathematics intricacies of life and livelihood.

"Education is a process of living through continuous reconstruction of experiences. It is the development of all those capabilities in the individual which will enable him to control his environment and fulfill his possibilities."

-(DEWEY 1964)

Observing children learn is both a privilege and a challenge. The privilege is in watching a child's expression of bafflement change to one of comprehension, in finding a

child so involved in reading or observing or some other endeavor that it is difficult to gain his attention, on hearing a child enthusiastically sharing a new idea with his friend. The challenge comes in grapping with the problems of how to assist children in their learning and of what the content of the learning shall be (Hill, 1996).

It is in this context, one should view mathematics education today. Mathematics permeates all facets of our lives. Often mathematics in real life situations is not recognized until one stop and reflects. Children need help in recognizing that mathematics is all around them. They need the right kind of experiences in order to appreciate the fact that mathematics is a common human activity and that it is important to their present and future well-being.

The main goal of mathematics education in schools is the mathematisation of the child's thinking. Clarity of thought and pursuing assumptions to logical conclusions is central to the mathematical enterprise. The kind of thinking one learns in mathematics is an ability to handle abstractions, and an approach to problem solving (NCF, 2005).

Teaching-Learning Mathematics is both a challenging and stimulating endeavour because there are significant changes taking place in mathematics education. New insights, new materials, and of course, children who are growing up in a very different kind of society, dictate a different approach to teaching-learning.

1.1.2 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 mathematics 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 Philosophical and Psychological Support of Activity Methods in Elementary Stage

Mathematics teachers need to be familiar with the philosophy of teaching and learning. A philosophy of instruction provides guidance and direction for the teachers to implement quality instruction. Basically, there are two philosophies which are very important for teachers to know thoroughly.

The first, behaviorism, which emphasizes realism as a philosophy of education. Realists believe that the real world can be known as it truly is in whole or in part. They believe it can be described mathematically and scientifically with its many specifics. Behaviorism is used in teaching terminology to describe, prior to instruction, what students should learn and be able to do with its precise objects.

The second philosophy of education necessary for mathematics teachers to know and use is experimentalism. According to pragmatists, Education is a direction for self expression. The focus of pragmatic method of teaching is on the child-in-society and his activities there rather than the book, the teacher, the subject or exclusively the child in nature. Learning always occurs as a result of movement and activity. The teacher has to capitalize on activities of children to direct the teaching-learning process. Activity is the basis of all teaching. The child should be encouraged to discover and investigate the facts of life. Education must develop the laboratory habit of mind. The method of teaching should be experimental.

The heart of experimentalism is that human beings cannot know the real world as it exists but can know experiences only with experiences. There are problems in life and these needs to be solved for life to continue. In Elementary School mathematics, students need to experience life like situations where by answers are sought. Word problems are experienced by learners. School and society are one and not separate entities, according to experimentalists. People live in society and here is where problems to a student might well become problems for solution in the classroom.

According to naturalists, Education is a natural, not an artificial process. It is development from within, not an accretion from without. Pragmatists thought of curriculum in terms of activity and experience rather than knowledge to be acquired and facts to store. Pragmatists method of teaching also has a sound basis of experience.

Swiss psychologist Jean Piaget (1957) studied the thinking levels of children including his three children and his longitudinal study is referred to as "Genetic epistemological method". Following these experiments, Jean Piaget introduced the

theory of cognitive development. It is called 'schemata' or 'cognitive abilities' theory. Piaget speaks of four important intellectual stage of cognitive development,

1. Sensory-motor stage (0 to 2 years)
2. Pre-operational stage (2 to 7 Years)
3. Concrete operational stage (7 to 11 years)
4. Formal operational stage (11 years above)

Piaget's theory states that activity approach at the primary classes and concrete methods of illustration (like use of teaching learning materials, demonstration etc.) at the middle school level are to be advocated.

Jerome Bruner's (1966) theory of concept formation regards human brain as having three modes of representation. They are enactive, iconic and symbolic. Bruner emphasized the importance of structure in promoting cognitive learning. The learner develops understanding of concepts and principles. That is called "Discovery approach". He stressed activities approach.

Klausmeir's conceptual learning model (CLD Model) gives four levels of attaining the same concepts, concrete level, identity level, classificatory level, formal level. According to Robert Gagne concept formation is categorized into different skills that people should learn under five headings. They are attitudes, motor skills, verbal information, intellectual skill, and cognitive strategies. Gagne talks about two types of concepts concrete and abstract. He also stresses adopting activities as per the different levels of skill attainment.

1.3 Teaching - Learning strategies

The advantages of the activity based method are that through these method children

- Get opportunity to learn, not by rote but by doing experimenting, which leads to better understanding.
- Get opportunity to practice skills.
- Get opportunity to learn at their own pace and according to their own style of learning.
- Get opportunity to experiment, discover, create and construct their own knowledge.
- Develop a more sustained interest in learning.

"Children should be led to make their own investigations, and to draw their own inferences. They should be told as little as possible, and induced to discover as much as possible ".

Herbert Spencer

According to Gage and Berliner (1964). "… Learning is easiest, most meaningful and retained best when it takes place in a non threatening situation..."

Teachers have used a number of techniques to achieve non-threatening climate and the most commonly used techniques is the use of games. Many famous educationists have advocated teaching or rather 'achieving learning' through games. Games are very motivating and no child can remain aloof and they are also according to the child's nature. The child need not be forced to participate and learning comes as a by-product.

The child must be at the centre of all curriculum decisions. Every child passes through a sequence of stage of cognitive development and these stages of development

establish an uncompromisable baseline for setting goals and selecting instructional strategy for meaningful learning. Elementary age school children are, in the main, at the pre-operational and concrete operational stages of cognitive development and therefore they heavily depend on the use of their physical environment for concept formation. Learning of mathematical concepts is aided by the use of teaching strategies like number games that ensure the retention of basic concepts and skills and games make learning environment both adaptive and responsive.

Play is an important activity that comes naturally to all children in which they themselves utilize skills for translating their experiences in to understanding. Therefore games become one of the best media for learning for them. Game, as a medium of instructional strategy is optimal at childhood stage for it makes possible individualized instruction, learning by discovery and the freedom to follow one's inner bent of mind.

Often the formal rigid curriculum does not allow the child to find fun and joy in learning. Through plays and games children can be made to enjoy learning even difficult concepts and skills. Games can be used both at the initiation of a new teaching or as important tool for reinforcing what a child has already learnt. Games are selected with the purpose of developing specific skills and release tension, which contributes to emotional development. Above all the more effective teaching and learning takes place through the thoughtful selection of games.

National Curriculum Framework 1988, 2000 & 2005, have suggested activity methods for transacting curriculum at the elementary stage. According to NCF 2005, at the pre-primary stage, all learning occurs through play rather than through didactic communication. Encouraging children to use language to freely express one's thoughts

and emotions, rather than in predetermined ways, is extremely important at this and later stages. Having children develop a positive attitude towards, and a liking for mathematics at the primary stage is more important, if not more than the cognitive skills and concepts that they acquire. Apart from computational skills, stress must be laid on identifying, expressing and explaining patterns, on estimation and approximation in solving problems, on making connections, and on the development of skills of language in communication and reasoning.

Activity-Based methods of teaching-learning have become a trend in teaching-learning particularly at the Elementary School level. Activities incorporated in lessons have proved to be effective tools in an educational environment. Activities can be used to follow up lessons in several subject areas as already mentioned. Below a brief description regarding implications of activity-based method in mathematics curriculum is given.

1.3.1 Important Implication of Activity Method in Mathematics Curriculum

At the primary stage, students get the first taste of the power of mathematics through the application of powerful abstract concepts which compress previous learning and experiences. The learning at this stage also offers an opportunity to enrich student's spatial reasoning and visualization skills. An important consequence of such requirements is that school mathematics must be activity oriented.

In the Indian context, there is a concern which has an impact on all areas of school education, namely that of universalisation of schooling. This has two important implications for the discussion of curriculum especially in mathematics Firstly, schooling is a legal right, and mathematics being a compulsory subject of study, access to quality

mathematics education is every child's right. Keeping in mind the Indian reality, where few children have access to expensive materials, mathematics education must be affordable to every child, and at the same time, enjoyable. This implies that the mathematics taught is situated in the child's life reality and that for the system; it is not the subject that matters more than the child, but the other way about.

Secondly, in a country where nearly half the children drop out of school during the elementary stage, Mathematics curricula cannot be grounded only on preparation for higher secondary and university education. Even if we achieve our targeted universalisation goals, during the next decade, we will still have a substantial proportion of children exiting the systems after class VIII. It is then fair to ask what eight years of school Mathematics offers for such children in terms of the challenges they will face afterwards. School Mathematics takes place in a situation where

- Children learn to enjoy Mathematics.
- Children learn importance of Mathematics.
- Mathematics is a part of children's life experience which they talk about.
- Children pose and solve meaningful problems.
- Children use abstractions to perceive relationships and structure.
- Children understand the basic structure of Mathematics.
- Teachers expect to engage every child in class.

In approaches to planning, educational practice is still based on limited 'lesson plan' aimed at achieving measurable 'behaviors'; according to this view, the child is akin to a creature that can be trained, or a computer that produces 'outcomes', and presenting knowledge divided into bits of information to be memorized directly from the text or

through activities after 'motivating' children, and finally on evaluating to see if children remember what they have learnt. Instead, we need to view the child as constructing knowledge' all the time. This is true not only of 'cognitive subjects' such as Mathematics, but equally of values, skills and attitude.

This perspective on the learner may sound 'obvious', in fact, many teachers, evaluators, and textbooks writers, still lack the conviction that this can become a reality.

The term 'activity' is now a part of the register of most elementary school teachers, but in many cases this has just been grafted onto the 'Herbartian' lesson plan, still driven by 'outcomes' at the end of each lesson.

Activities could enable teachers to give individualized attention to children, and to make alteration a task depending on their requirements and variations in the level of interest. In fact, teachers could also consider involving children and older learners in planning the class work; such variety would bring tremendous richness to the class room process. It would also allow teachers to respond to the special needs of some children without making it seem as if it is an obvious exception. There is still not enough engagement on the part of the teacher with the learning of each child; children are treated en masse, and only those who are regarded as 'stars' or 'problematic' are noticed. All children would benefit from such attention.

Teachers need to understand how to plan lessons so that children are challenge to think and to try out what they are learning, and not simply repeat what is told to them. Giving a few problems in the name of 'activities' and 'play way' methods, a lot of learning is being diluted by giving children things to do that are far below their capability. One concern is that a focus on activities would become too time consuming

and make greater demands on teachers time. Certainly, doing activities requires that time be spent in planning and preparing for activities. Initially teachers need to make an effort to establish the classroom culture for activities and to establish the rules that will govern the space and use of materials.

1.3.2 Activities, Teaching - Learning Process and Experimenting

Teachers world over have been experimenting with active methods and a large variety of teaching-learning has been classified as activity. There are many types of activities through which pupils learn mathematics. The selection of activity depends on what is to be accomplished. Let it be activity should make a principle or idea more graphic, more interesting, and give pupils a chance to participate with their minds as well as with their hands.

In Mathematics projects, teachers and children are the main participants in the development of activities. A variety of teaching-learning activities go on. For example, group learning activities, self learning, individual activities, long term activities, and short term activities.

1.3.3 The function of Games as a Teaching Strategy

Games can be used not only to introduce interest and excitement in to the child's learning program, but to help the child attain a wide range of competencies - from basic intellectual skills to problem solving. A list of good reasons for the occasional use of 'game strategies' in the classroom would include the following:

- If appropriately designed, games can be used successfully with children who have special types of learning problems, such as some form of language deficiency.

- Games can be used to help the students who exhibit discipline and influence over their social environment by enabling them to switch from being passive consumers of information to being active decision makers.
- Games can provide desirable social interactions among children by encouraging co-operation and discussion with each other.
- Games can provide teachers with diagnostic information which they can use to help individual children to correct misconceptions or to fill gaps in their learning structure.
- Games can be used to integrate mathematics with other subject, and they also can be geared to conform to the particular interest of students.

1.4 Context, Need & Importance of the study

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 to observe 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 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.

Sarva Shikshana Abhiyaan (SSA 2000) being a National Policy, children with hearing impairment are exposed to the same instructional strategies used for normal hearing 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.

Many studies have stated that children with hearing impairment can learn mathematics in the same sequences as the hearing children learn, (Ray,2001; Gowramma, 2004; Nair, 2005) if appropriate method of teaching is used. Various studies states that children with disabilities (Gowramma 2005, Padmini 2004) acquire mathematical concepts effectively through an organized way of teaching which include concrete activity, and play way method.

So there is a need to,

> Develop a play-way method to provide strong mathematical basis among children with hearing impairment.

> Develop/adapt teaching/learning materials to suit the needs of children with hearing impairment.

> Compare the effectiveness of the play-way method of teaching mathematics between CWHI, children with normal hearing and children with other disabilities.

> Develop a concrete basis, for mathematics learning in different levels of schooling.

> To validate the effectiveness of the play way method for children with hearing impairment.

1.4.1 Statement of the Problem

How effective is the play-way method of teaching mathematics for children with hearing impairment?

1.4.2 Objectives of the study

The main aims of the study are as follow:

- To assess the performance of children with hearing impairment in number concept, addition and subtraction.
- To develop remedial instruction programme in a play-way method to teach number concept, addition and subtraction to children with hearing impairment.
- To find the effectiveness of play-way method in developing number concept, addition and subtraction among children with hearing impairment.

Chapter - II

Review of Literature

like early incidental learning and reinforcement, which are limited for CWHI, because ot 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 (1997) 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

Mousley and Kelly (1998) suggest that various 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.

2.1.1 Effectiveness of play-way method of teaching Mathematics

There have been several studies to study the effectiveness of the play-way method of teaching mathematics. Some of the studies and their findings are listed in this section.

According to Gowramma (2004) all children can learn mathematics when the activity based method is employed regardless of their physical impairment.

Panda, B.N (1995) conducted an experimental study on activity based teaching cum evaluation strategy for pupil achievement. The main objective of the study was to compare the effect of activity based teaching vs. traditional method on achievement. The result shows that the learning achievement of experimental group differs significantly from control group in every unit as well as over all achievement.

Nalagini, S (1991) conducted a study on effectiveness of using number games to teach arithmetic at primary level. The major objectives of this study were (i) to find the impact of the number games on primary school children in doing mathematical operations.

(li) To study the relationship between their academic performance and their family background including the economic and educational level of parents. The major findings include that neither education level nor the economic status of parents influence the arithmetic growth shown by the pupils. Also she found out that number game motivated child to develop the computational skills.

Rengarajan.V (1986) conducted a study on the impact of games on learning of addition in mathematics. The objective of the study was to teach addition unit in mathematics to pupils through games and to find the effect on academic achievement. The findings reveals that by learning mathematics through addition games bring improvement in the academic achievement and in the understanding of mathematics of the pupils can be affected. The research work further shows that there is no gender difference, both the boys and girls have benefited equally by learning mathematics through addition games.

Study by Onslow (1990) entitled 'overcoming conceptual obstacles through the qualified use of a game' found that conceptual obstacles like multiplication always makes bigger and division always makes smaller can be overcome by using a game called shell shocker. He also found out that discussion followed by the game focusing on alternate conceptions assist the learning process to a greater extent that when students only plan the game.

Kran, W. H (1982) on the study of 'Math learning games simple Vs complex' suggests that simple games that can be used to supplement instruction in a wide variety of mathematical topics and complex games ensure the mathematical skill in a greater factor and it provides motivation for the player to increase his mathematical skill.

2.1.2 Comparison of the performance of CWHI and normal hearing children

In this section studies related to the comparison of the performance of CWHI and children in the mainstream are discussed.

According to Gowramma (2004) hearing impairment is not directly affecting mathematics learning in CWHI and there is no significant difference in the performance of CWHI and normal hearing children at primary school stage.

Studies of mathematical achievement and understanding have generally concluded that there is no significant cognitive basis for major differences in mathematical performance between CWHI 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; 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 sequence (Zarfaty et al., 2004).

According to Ray, (2001) in mathematical process 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.

According to Ray (2001) hearing children are likely to hear mathematical concepts mentioned incidentally during any given day but for hearing impaired children the concept has to be deliberately brought to their attention in as many ways and as often as possible. He suggests - In order for deaf/hearing impaired children to develop cognitively, particularly in a mathematical sense, the learning environment must have a wide range of meaningful mathematical experiences that are visually engaging and hand-on. Activities should be purposeful and have relevance to everyday life so that they can be experienced in a context other than a purely mathematical one.

According to Meadow-Orlans (1980) mathematical concepts can be learnt by deaf/hearing-impaired children in the same sequence and manner as their hearing peers.

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". 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.

Studies in the preceding pages reveal that studies focusing particularly on the instructional strategies were limited. However, some studies were available on the number games strategy in the primary schools. The findings of these studies revealed

that children learn better when play way method is employed. This strategy has been found effective in improving the learning levels among students. The review also highlights that CHWI achieve on par with normal hearing children in mathematics.

2.2 Hypothesis

In the light of the review of literature the following hypothesis is formulated to test in the present study.

There will be a significant improvement in the performance of CWHI at the primary level when play-way method of teaching is employed in the following areas of mathematics assessed.

- Number Concept
- Addition
- Subtraction

Thus, the present study is an attempt to find out the effectiveness of play-way method as an instructional strategy on achievement in mathematics of primary school children with hearing impairment. The methodology adopted for the study including the research design, sample selected, tools used and the procedures used for data analysis are dealt in the following chapters.

Chapter - III

Method

3.0. 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. This chapter also includes the details regarding the intervention strategy employed in the study.

3.1. Sample

Children from grade I and II of a special school for children with hearing impairment were taken for the study. Since the study was conducted in the month of January and February, grade I students were very much exposed to school environment and were able to independently participate in the learning activities to which they were exposed in the study. Long absentees and those who were irregular during the course of intervention in both the grades were excluded.

Children from grade I and grade II were similar with reference to their language ability and academic performance according to school records and the opinion of the teachers. Hence they were considered as homogeneous group for the purpose of the intervention. The details are given below in the table.

Table 1: Details of number of children in the grades selected.

SUBJECTS	GRADES	AGE	TYPE OF HEARING LOSS	HEARING AID USED	LANGUAGE LEVEL
1	I	6	Severe	Body Level	Average
2	I	7	Severe	Body Level	Average
3	I	7	Profound	Body Level	Average
4	I	7	Profound	Body Level	Average
5	I	6	Moderately Severe	BTE	Average
6	II	9	Severe	BTE	Average
7	II	8	Profound	Body Level	Average
8	II	9	Profound	Body Level	Average
9	II	9	Profound	Body Level	Average
10	II	9	Profound	Body Level	Average

These 10 students served as sample to achieve the objectives. To all these 10 students Arithmetic Diagnostic Test (ADT, Ramaa 1990) was administered individually to check their Arithmetic ability. The scores were tabulated for analysis.

3.2 Description of the tool

The following sub-units explains the different test, tools and materials used for the study.

3.2.1 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 (operational) - 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.

Since the test was used for assessing the baseline of the children, only one item in every criterion measure, was administered at the pre-test stage. At the end of intervention post-test was performed with the parallel item of the tool for every criterion measured.

Items specified for the respective grade levels only were administered during pre-test and post-test. The tool gives the table showing items suitable for each grade.

3.2.2. Materials used and prepared by the Investigator:

Teaching-learning materials, both naturally available and manually prepared were used to teach Number Concept, Addition and Subtraction. Some of the Teaching-Learning materials were prepared and some were adapted based on the materials and method suggested by Gowramma (2004) and Padmini (2007). The table below shows the materials used to teach the above-mentioned concepts.

Table 2: Details of materials used / adapted and prepared by the investigator.

Sl. No.	**Concept**		**Materials**	
1	**Number Concept**		**Naturally available materials**	**Manually prepared materials**
	i	Numbers to words	Stones Leaves Match sticks Flowers	Flash cards Charts
	ii	Words to Numbers		
	iii	Ascending order		
	iv	Descending order		
2	**Addition**		Stones Leaves Match sticks Flowers	Flash cards Currency Models
	1	Operations		
	2	Word Problems		
3	**Subtraction**		Stones Leaves Match sticks Flowers	Flash cards Currency Models
	1	Operations		
	2	Word Problems		

3.3 Procedure for collection of data

This section gives an overview of the method of collection of data and techniques of analysis of the data to achieve the various objectives of the study.

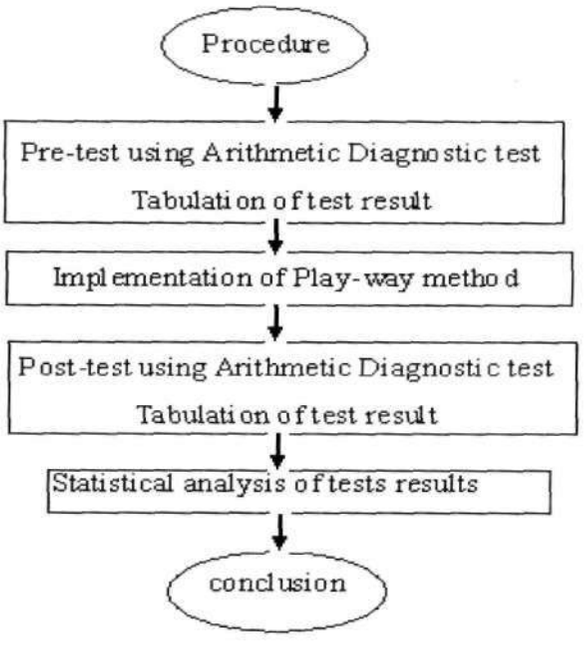
A pre-test was conducted using ADT. The performance was assessed based on the scoring procedure suggested in the tool.

Intervention was provided to students in both the grades in a play way method. It included strategies and materials to improve - Number concept, Addition and Subtraction through concrete activities, mental mathematics, daily quantitative skills and mathematical logic.

Post-test was conducted using the 2nd set of questions (the parallel version) given in ADT. The performance was assessed based on the scoring procedure suggested in the tool.

The following flow chart shows the details of the procedure adapted in the study:

Figure 1: Flow chart showing process of the study



3.4 Administration of the Play-Way method

3.4.1 Intervention

The material adapted to try out on CWHI was administrated to them on a daily basis. Permission from school to carry out the activity was obtained. Intervention - made use of the Philosophical / Psychological principles and strategies (mentioned in section 1.2 & 1.3 of Chapter-I). Some of the general principles/strategies suggested by various researchers were also kept in mind while planning and administrating. They are given below.

- > Teaching proceeded from concrete, semi-concrete to abstract.
- > Meaningful learning was stressed at each stage.
- > Concepts were taught as application to daily life.
- > To develop quickness and accuracy enough exercise was given.
- > Several representations of similar problem was used for concept clarity.

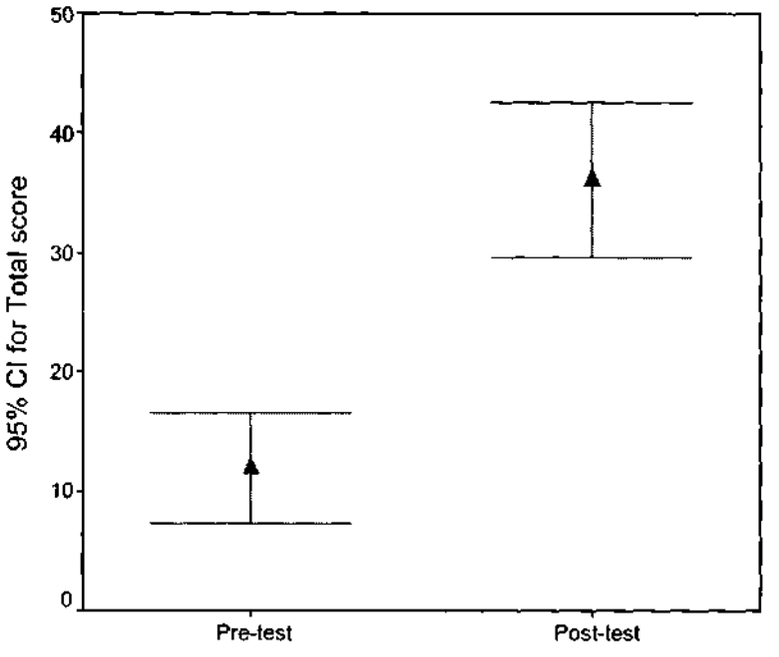
3.4.2 Analysis of the data

Both quantitative and qualitative analysis were done, which aimed at comparing the mean performance of pre-test and post-test and improvement in percentage of all the cases in each of the item of pre test and post test. The details are given in the next chapter.

Chapter - IV

Analysis and Interpretation of the data

Figure 2: Mean performance on pre-test and post-test in Total Score



The graph also shows the significant difference between the performance of the students in pre-test and post-test in total score. The scores of the CWHI in pre-test ranges between 5 and 26 whereas in post-test the scores ranges between 20 and 45. Hence the play-way method of teaching is effective in teaching total score to the CWHI.

4.1.2 Mean performance on pre-test and post in Number Concept:

The quantitative analysis further attempted to see the performance in number concept, addition and subtraction separately tables and graphs below show the results.

Table 4: Mean performance on pre-test and post-test in Number Concept

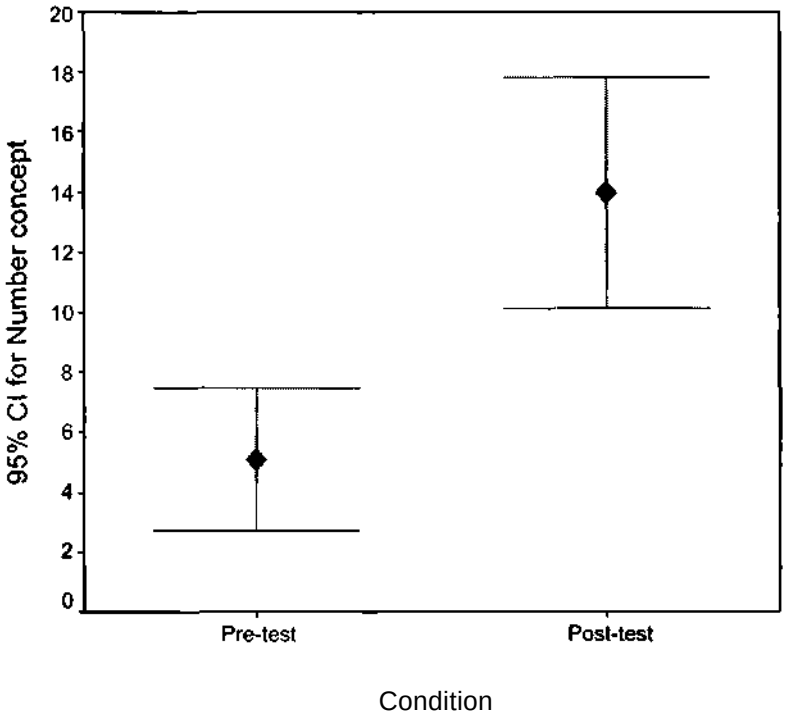
	Mean	**Std. Deviation**	**t-score**
Pre-test	**5**	**3.367**	**5.733***
Post-test	**14.5**	**5.522**	

* t is significant at 0.01 level

The table 4 shows that there is significant improvement in the number concept from pre-test to post-test.

The obtained "t" value is more than the expected value at 0.01 level of significance. This indicates that there is significant mean difference between pre-test and post-test in number concept. Children performed better at the post-test stage in number concept.

Figure 3: Mean performance on pre-test and post-test in Number Concept



The graph also shows that there is significant difference between the performances of the students in pre-test and post-test in number concept. The scores of the CWHI in pre-test ranges between 2 and 8 whereas in post-test the scores ranges between 10 and 20. Hence the play-way method of teaching is effective in teaching number concept to the CWHI.

4.1.3 Mean performance on pre-test and post-test in Addition

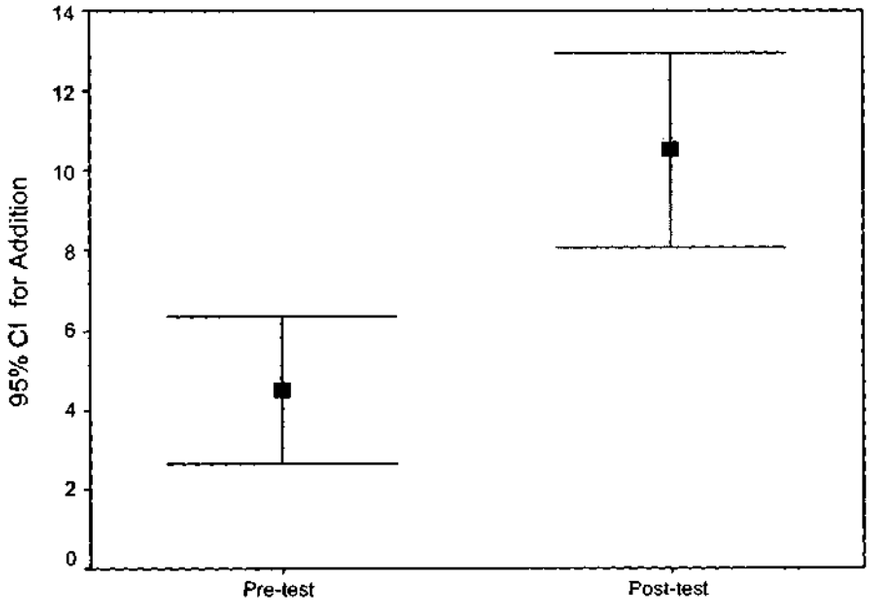
Table 5: Mean performance on pre-test and post-test in Addition

	Mean	**Std. Deviation**	**t-score**
Pre-test	**4.5**	**2.59**	**6.708***
Post-test	**10.5**	**3.37**	

* t is significant at 0.01 level

The obtained "t" value is more than the expected value at 0.01 level of significance. This indicates that there is significant mean difference between pre-test and post-test in addition.

Figure 4: Mean performance on pre-test and post-test in Addition



The table 5 shows that there is a significant improvement in the performance of the cases in addition from pre-test to post-test.

The graph shows that there is significant difference between the performance of the students in pre-test and post-test in addition. The scores of the CWHI in pre-test

ranges between 2 and 6 whereas in post-test the scores ranges between 8 and 14. Hence the play-way method of teaching is effective in teaching addition to the CWHI.

4.1.4 Mean performance on pre-test and post-test of Subtraction

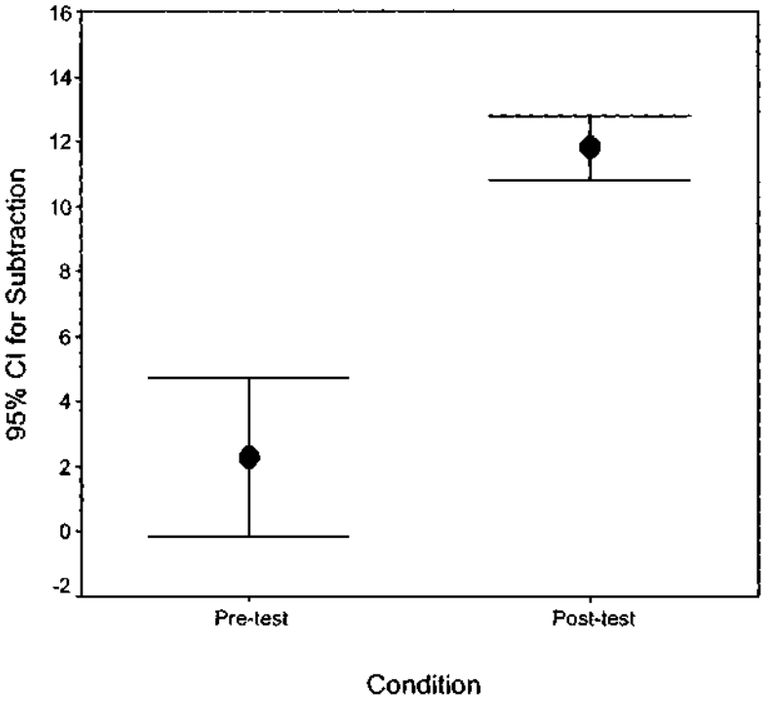
Table 6: Mean performance on pre-test and post-test of Subtraction

	Mean	**Std. Deviation**	**t-score**
Pre-test	**2.2**	**3.12**	**7.603***
Post-test	**11.8**	**1.398**	

* t is significant at 0.01 level

The obtained "t" value is more than the expected value at 0.01 level of significance. This indicates that there is significant mean difference between pre-test and post-test in subtraction.

Figure 5: Mean performance on pre-test and post-test in Subtraction



The table 6 shows that there is significant improvement in the cases in the subtraction from pre-test to post-test.

The graph shows that there is significant difference between the performance of the students in pre-test and post-test in subtraction. The scores of the CWHI in pre-test ranges between 0 and 4 whereas in post-test the scores ranges between 9 and 14. Hence the play-way method of teaching is effective in teaching subtraction to the CWHI.

In the light of the analysis discussed in section 4.1 above, the hypothesis formulated in the study "There will be a significant improvement in the performance of CWHI at the primary level when play-way method of teaching is employed in the following areas of mathematics assessed.

- Number Concept
- Addition
- Subtraction" is accepted

4.2 Qualitative Analysis

Further analysis compared the performance in percentage for each case, in pre-test and post-test on different criterion measures assessed.

T4.2.1 Percentage in pre-test and post-test in number concept - counting

Table 7: Percentage Score in Counting in the Pre-test & Post-test.

Subjects	Percentage in pre-test	Percentage in post-test
1	100%	100%
2	100%	100%
3	100%	100%
4	100%	100%
5	100%	100%
6	100%	100%
7	100%	100%
8	100%	100%
9	100%	100%
10	100%	100%

4.2.2. Percentage in pre-test and post-test in number concept - writing numbers in words

Table 8: Percentage Score in Writing Numbers in Words in the Pre-test & Post-test.

Subjects	Percentage in pre-test	Percentage in post-test
1	0%	33%
2	0%	66.7%
3	0%	33%
4	0%	66.7%
5	33%	100%
6	33%	100%
7	33%	100%
8	33%	66.7%
9	33%	100%
10	0%	33%

4.2.3. Percentage in pre-test and post-test in number concept - writing words for the numbers

Table 9: Percentage Score in Writing words for the Numbers in the Pre-test & Post-test.

Subjects	Percentage in pre-test	Percentage in post-test
1	33%	66.7%
2	0%	66.7%
3	0%	66.7%
4	0%	66.7%
5	33%	66.7%
6	33%	100%
7	33%	66.7%
8	0%	33%
9	33%	66.7%
10	0%	66.7%

4.2.4 Percentage in pre-test and post-test in number concept - Arranging in sequence.

Table 10: Percentage Score in Arranging in Sequence in the Pre-test & Post-test.

Subjects	Percentage in pre-test	Percentage in post-test
1	0%	100%
2	0%	20%
3	0%	20%
4	0%	20%
5	60%	60%
6	0%	100%
7	0%	100%
8	0%	33%
9	66.7%	66.7%
10	0%	20%

4.2.5 Percentage in pre-test and post-test in number concept - Arranging ascending order

Table 11: Percentage Score in Arranging in Ascending order in the Pre-test & Post-test.

Subjects	Percentage in pre-test	Percentage in post-test
1	0%	100%
2	0%	20%
3	20%	80%
4	0%	80%
5	100%	100%
6	100%	100%
7	40%	100%
8	0%	20%
9	0%	100%
10	0%	80%

4.2.6 Percentage in pre-test and post-test in number concept - Greater and Lesser concept

Table 12: Percentage Score in Greater and Lesser in the Pre-test & Post-test.

Subjects	Percentage in pre-test	Percentage in post-test
1	0%	100%
2	0%	40%
3	0%	40%
4	0%	40%
5	0%	100%
6	0%	100%
7	0%	100%
8	0%	40%
9	0%	100%
10	0%	40%

4.2.7 Percentage in pre-test and post-test in Addition - Single Digit

Tablel3: Percentage Score in Addition - Single Digit in the Pre-test & Post-test.

Subjects	Percentage in pre-test	Percentage in post-test
1	50%	100%
2	100%	100%
3	50%	100%
4	50%	100%
5	100%	100%
6	100%	100%
7	100%	100%
8	50%	50%
9	100%	100%
10	50%	50%

4.2.8 Percentage in pre-test and post-test Addition - Double Digit

Table 14: Percentage Score in Double Digit Addition in the Pre-test & Post-test.

Subjects	Percentage in pre-test	Percentage in post-test
1	25%	100%
2	50%	100%
3	25%	25%
4	25%	75%
5	0%	100%
6	25%	100%
7	100%	100%
8	0%	25%
9	50%	100%
10	25%	50%

4.2.9 Percentage in pre-test and post-test horizontally arranged addition

Table 15: Percentage Score in Horizontally arranged Addition in the Pre-test & Post-test.

Subjects	Percentage in pre-test	Percentage in post-test
1	0%	100%
2	0%	100%
3	0%	100%
4	0%	100%
5	0%	100%
6	0%	100%
7	0%	100%
8	0%	100%
9	0%	100%
10	0%	100%

4.2.10 Percentage in pre-test and post-test addition word problem

Table 16: Percentage Score in Addition Word Problem in the Pre-test & Post-test.

Subjects	Percentage in pre-test	Percentage in post-test
1	0%	0%
2	0%	50%
3	0%	0%
4	0%	66.7%
5	0%	100%
6	0%	66.7%
7	0%	80%
8	0%	0%
9	0%	80%
10	0%	66.7%

4.2.11 Percentage in pre-test and post-test Single digit subtraction

Table 17: Percentage Score in Single Digit Subtraction in the Pre-test & Post-test.

Subjects	Percentage in pre-test	Percentage in post-test
1	0%	100%
2	100%	100%
3	50%	100%
4	100%	100%
5	0%	100%
6	0%	100%
7	100%	100%
8	0%	100%
9	100%	100%
10	0%	100%

4.2.12 Percentage in pre-test and post-test double digit subtraction

Table 18: Percentage Score in Double Digit Subtraction in the Pre-test & Post-test.

Subjects	Percentage in pre-test	Percentage in post-test
1	0%	87.5%
2	0%	100%
3	25%	100%
4	25%	50%
5	0%	100%
6	0%	100%
7	85%	100%
8	0%	75%
9	0%	87.5%
10	0%	75%

4.2.13 Percentage in pre-test and post-test horizontally arranged subtraction

Table 19: Percentage Score in Horizontally arranged Subtraction in the Pre-test & Post-test.

Subjects	Percentage in pre-test	Percentage in post-test
1	0%	100%
2	50%	100%
3	0%	100%
4	50%	100%
5	0%	100%
6	0%	100%
7	50%	100%
8	0%	100%
9	50%	100%
10	0%	100%

4.2.14 Percentage in pre-test and post-test subtraction word problem

Table 20: Percentage Score in Subtraction Word Problem in the Pre-test & Post-test.

Subjects	Percentage in pre-test	Percentage in post-test
1	0%	0%
2	0%	66.7%
3	0%	33%
4	0%	33%
5	0%	0%
6	0%	0%
7	0%	0%
8	0%	66.7%
9	0%	0%
10	0%	66.7%

From tables 7 through 20 it is observed that for some of the items the performance was at 100% in pre-test stage itself. However in many other higher concepts as observed in all the three areas of number concept, addition and subtraction the performance of all the 10 children was very poor at the pre-test stage. In the post-test stage it can be observed that all the subjects did the majority of items correctly. Still performance in some items needs improvement where they have performed much below the expected level. Mousely & Kelly (1998) observed that CWHI experience difficulties while solving mathematics problems.

4.3. Findings and discussion related to the pre-test and post-test performance of children with hearing impairment

4.3.1 Quantitative Analysis

The post-test performance of the CWHI was compared statistically with the performance of pre-test performance of the CWHI, for the areas of arithmetic assessed. It was noticed that the CWHI performed better in the post-test after remediation in all the areas of arithmetic assessed. Similar improvement in arithmetic performance was noticed among children with other disabilities by Gowramma (2004) and Padmini (2005). Ray (2001), observed better performance among CWHI when activity based method was used to teach arithmetic.

The better performance of CWHI in post-test stage, compared to pre-test, suggests that, if better learning opportunity / method are provided to CWHI they can improve their performance further. Play way method / activity based method of teaching was found to be effective to teach arithmetic to elementary level children by Golren (1979); Nalagini, S (1991) and Panda, (1995).

4.3.2. Qualitative Analysis

a. Number concept:

All the ten subjects showed significantly better performance on post-test at the end of the remedial programme in number concept.

In the counting item, 100% of subjects were able to perform the items in the pre-test level itself.

At the pre-test level most of the cases had no idea about the concepts such as writing the numbers in words, writing words for the numbers, arranging in ascending order, concept of greater and lesser numbers and writing the missing numbers in a sequence. Post-test performance showed significant improvement in the performance of the above mentioned concepts.

b. Addition:

All the ten subjects showed significantly better performance on post-test at the end of the remedial programme for all the items in the section of addition.

At the pre-test level, all the subjects were found to be below grade level in their performance while doing addition sums. After remediation, their grade level rose to the expected levels, expected for these children.

The percentage of items on single digit addition rose from 75% to 90% from pre-test to post test.

Only around 32% of the item on- two digit addition were performed correctly in pre-test stage. An improvement was observed at the post-test level as 78% of the items were done correctly.

In the pre-test, the item on addition of numbers horizontally were done by any of the children. In the post-test, all the children were able to add the item in this section.

In problem solving (simple statement problem) involving simple addition there was an improvement from 0% to 52% .

c. Subtraction:

All the ten subjects showed significantly better performance at the end of the remedial programme in Subtraction of numbers.

At the pre-test level, all the subjects were found to be below grade level in their performance in subtraction. After remediation, their grade level rose to grade levels, which was the maximum level, expected for these children.

The performance on the items on single digit addition rose from 45% to 100% from pre-test to post test.

Around 15% of the item on - two digit subtraction were done correctly in pre-test. It was observed at the post-test level, 86% of the items were done correctly.

In the pre-test, only 20% the items on subtraction of numbers horizontally were done by the children. In the post-test, all the children were able to subtract all the items in this section.

In problem solving (simple statement problem) involving simple subtraction there was an improvement from 0% to 27%. Since the post-test performance is below the mastery level here, intensive intervention has to be provided for some more days.

Intervention strategies using presenting mathematics problems visually has been observed to be successful which provides clear direction to use support strategies to ensure success in mathematics performance among CWHI. (Nunes & Moreno 1997). Mousely & Kelly (1998) noticed that internalization and application of new knowledge

are enhanced by practice, active participation, interactive discussion and evaluative feedback.

Chapter - V

Summary

&

Conclusion

5.1 Major findings and their interpretation

The data was analysed and detailed findings are discussed in Chapter IV. Here a brief account of the findings and their interpretation are given.

- Though the students were not using hearing aid there was a significant improvement in the post-test stage after remediation.
- There was significant improvement in the post-test stage in number concept, addition and subtraction.
- Play-way method is very much effective in teaching in mathematics concepts such as number concepts, addition and subtraction.
- Performance in Number concept was 100% both in pre-test and post-test stages but as the complexity of the items increased in the items in Number concept the performance level decreased both in pre-test and post-test level.
- Performance in Addition of easy items was almost 100% both in pre-test and post-test stages but in difficult items like double-digit addition with carry over almost 90% performance was achieved in post-test stage.
- Performance in Subtraction of easy items was almost 100% both in pre-test and post-test stages but in difficult items like double-digit subtraction with borrowing and horizontal subtraction almost 90% performance was achieved in post-test stage.
- Performance in word problems was 0% in pre-test level. Inspite of intervention there was no significant improvement at post-test stage also. This could be

because of interference of language in the problem. Further analytical thinking and problem solving capacity should be developed in children to achieve mastery.

- In the post-test stage it was observed that all the subjects did the majority of items correctly. Still performance in some items needs improvement where they have performed much below the expected level.

5.1 Educational implications

- The method of the teaching utilized in the present study will develop interest and motivation to learn the concept as the concepts are learnt meaningfully.
- Intervention by providing opportunity to generalize the academic learning will be useful at all the levels of education.
- The grade level discrepancy increases if intervention is not given. So early identification and proper intervention is mandatory to achieve success in academic subjects.
- Since the effectiveness of the remedial arithmetic programme was observed, it is suggested that, the teachers and parents should make use of the remedial arithmetic programme of the sort, developed in the study in remediating the specific difficulties faced by children.
- Play-way method must be employed to teach mathematics in all the grades especially in the elementary school stage.
- Play-way method can also be employed to teach other subjects.

- Play-way method of teaching mathematics can be effectively used in inclusive setups as children at the elementary level learn effectively through activity-based methods.
- The remedial arithmetic programme though developed for CWHI can be used for other children who have difficulties in arithmetic for various other reasons.
- Repetition of mathematics concepts to retain them. Mousely & Kelly (1998)

References

References

- Barry O. (1990). 'Overcoming conceptual obstacles through the qualified use of a game' as cited in Nalagini, S (1991). 'Effectiveness of using number games to teach arithmetic at primary level', Mysore, University of Mysore.
- Barton, B. (1995). 'Cultural issues in NZ mathematics education'. In J. Neyland (Ed.), *'Mathematics Education: A handbook for teachers*', Wellington: Wellington College of Education. Vol. 2 (pp. 150 - 164).
- Boocock and Schild (1968), as cited in Nalagini, S (1991). 'Effectiveness of using number games to teach arithmetic at primary level', Mysore, University of Mysore.
- Bruner, V. (1966) 'On cognitive growth', in studies in cognitive growth, New York: John Wiley and Sons.
- Cherry Holmes (1966), as cited in Nalagini, S (1991). 'Effectiveness of using number games to teach arithmetic at primary level', Mysore, University of Mysore.
- Ediger M. (2005). "Developing the Mathematics Curriculum, the S.I.T.U *Council of Educational Research,* Chennai, 2005, (1-15).
- Flexer (1999), as cited in Nalagini, S (1991). 'Effectiveness of using number games to teach arithmetic at primary level', Mysore, University of Mysore.
- Gage and Berliner (1964), as cited in Nalagini, S (1991). 'Effectiveness of using number games to teach arithmetic at primary level', Mysore, University of Mysore.
- Golren, (1979). 'The study of sharing teaching ideas through proper games', as cited in Nalagini, S (1991). 'Effectiveness of using number games to teach arithmetic at primary level', Mysore, University of Mysore.
- Golren, N. (1979). On the study of sharing teaching ideas through proper games', as cited in Nalagini, S (1991). 'Effectiveness of using number games to teach arithmetic at primary level', Mysore, University of Mysore.

- Gowramma. I. P. (2004). 'Development of Remedial instruction program to teach children with dyscalculia in primary school' Chetana publishers, Mysore.
- Gowramma. I. P. (2005). 'Analysis of Difficulties Experienced by Children With Hearing Impairment while doing mathematics', Unpublished Research Project Report, AIISH, Mysore.
- Gowramma. I. P., (2007). 'Analysis of Stress Among Parents of children with Hearing Impairment' Chennai, University of Madras.
- Haynes, M. (1999). 'The mathematical world of the infant and toddler', In Proceedings of the seventh Early Childhood Convention, Vol 2 (pp. 140 - 148). Nelson, New Zealand.
- Kran, W. H. (1982). 'On the study of 'Math learning games simple Vs complex', as cited in Nalagini, S (1991). 'Effectiveness of using number games to teach arithmetic at primary level', Mysore, University of Mysore.
- Lakshmi and Hee (2005). 'Activity - Based Teaching for effective Learning', ITE teachers Conference as cited in Nalagini, S (1991). 'Effectiveness of using number games to teach arithmetic at primary level', Mysore, University of Mysore.
- Math-Magic (2006), Class3, Text book in Mathematics for class III, NCERT.
- Meadow-Orlans, K. (1980). 'Deafness and child development', Berkeley (Ed), CA: University of California Press.
- Mousley and Kelly (1998), as cited in Nalagini, S (1991). 'Effectiveness of using number games to teach arithmetic at primary level', Mysore, University of Mysore.
- Nair, P. G. (2005). 'A study of effectiveness of individualized instructional material on mastery of mathematical concepts related to time in children with hearing impairment', Mumbai, University of Bombay.
- Nalagini, S (1991). 'Effectiveness of using number games to teach arithmetic at primary level', Mysore, University of Mysore.
- National Curriculum Assessment (1993). 'Core Subjects Standard Assessment Tasks for 1993 Reference notes', A supplement for the Hearing Impaired, London, School Examination and Assessment Council.

- National Curriculum Framework (2005). NCERT, 2005
- Nunes, T. & Moreno, C. (1997). 'Is Learning impairment a cause of difficulty in learning mathematics?' Report to Nuffield foundation.
- Nunes, T. & Moreno, C. (1998).' Is hearing impairment a cause of difficulties in learning mathematics?' In Donalan, C. (Ed). *The development of mathematical skills* (pp227-254).
- Nunes, T. & Moreno, C. (2002). "An intervention program for mathematics, *Journal of Deaf Studies and Deaf Education, 7 (2).*
- Nunes, T. and Moreno. C. (1997) 'Is hearing impairment a cause of difficulty in learning mathematics?' Report to Nuffield foundation.
- Nunes, T., & Bryant, P. (1996). 'Children Doing Mathematics', Oxford: Blackwell.
- Nunes, T., & Moreno, C. (1997). 'Solving word problems with different ways of representing the task. Equals', *Mathematics and Special Educational Needs, 2,* 15-17.
- Nunes, T., & Moreno, C. (1998). "The signed algorithm and its bugs. Educational Studies in Mathematics'135, 85-92.
- Onslow, (1990). 'Overcoming conceptual obstacles through the qualified use of a game', as cited in Nalagini, S (1991). 'Effectiveness of using number games to teach arithmetic at primary level', Mysore, University of Mysore.
- Padmini, T. (2007). "Nagunagutha Ganitha", 'Sarva Sikshna Abhiyaan', Mysore.
- Panda, B. N. (1995). "Experimental study on activity based teaching cum evaluation strategy for pupil achievement" as cited in Nalagini, S (1991). 'Effectiveness of using number games to teach arithmetic at primary level', Mysore, University of Mysore.
- Pau, S. (1995) 'The deaf child and solving the problems of arithmetic', *American Annals of the Deaf 140 (3),* pp-2 87-290.
- Pau, S. (1995). 'The deaf child and solving problems of arithmetic: The importance of comprehensive reading', *Education and Deafness, 15,* 4-8.
- Piaget, J. (1952). 'The origin of intelligence in children', New York: International University Press.

- Piaget, J. (1957). 'Genetic epistemological method', as cited in Nalagini, S (1991). 'Effectiveness of using number games to teach arithmetic at primary level', Mysore, University of Mysore.
- Ramaa, S. (1994). 'Arithmetic Diagnostic Test for Primary School Children', Mysore, Chethana Publishers.
- Rao M. P. (1991). 'Activity based method of teaching and learning of Environmental Science', NCERT, (1-15).
- Ray, E. (2001). 'Discovering mathematics: The challenges that deaf/hearing-impaired children encounter', Retrieved from www.ace.ac.nz/doclibrary/acepapers on dated 25/02/2008 .
- Rengarajan, V. (1986). 'Conducted a study on the impact of games on learning of addition in mathematics', as cited in Nalagini, S (1991). 'Effectiveness of using number games to teach arithmetic at primary level', Mysore, University of Mysore.
- Sceman, (1966). 'Simulation games have a positive effect on the student's', as cited in Nalagini, S (1991). 'Effectiveness of using number games to teach arithmetic at primary level', Mysore, University of Mysore.
- Spencer, E.F. & Smith, R. (1969). 'Arithmetic skills', in Smith, R., *'Teaching diagnosis of educational difficulties'*, Columbus, OH: Charles E. Merrill Publishing Co.
- Swanwick, Oddy and Roper, (2005), as cited in Nalagini, S (1991). 'Effectiveness of using number games to teach arithmetic at primary level', Mysore, University of Mysore.
- Titus, J. C. (1995). 'The concept of fractional number among deaf and hard of hearing Students'. *American Annals of the Deaf, 140,* 255-261.
- Westwood, P. (2003). 'Common Sense Method for children with special educational needs', fourth Edition.
- Wood, D., Wood, H., Griffith, A. & Howarth, I. (1986). 'Teaching and talking with deaf children', New York: Wiley.
- Wood, D; Wood, H; and Howarth, P (1983) 'The mathematical achievements', *British Journal of Educational Psychology, 54,* 254-264.

• (Hill, 1996). As cited in Gowramma. I. P. (2005). 'Analysis of Difficulties Experienced by Children With Hearing Impairment while doing mathematics', Unpublished Research Project Report, AIISH, Mysore.