

Study of The Effectiveness of Computer Aided Instruction for Teaching the Concept of Place-Value to Primary School Children With Hearing Impairment

Ms. P. V. Ramanakumari [1]

Ms. P. V. Manjula [2]

Abstract:

Computer can play vital role in learning process as it can work with the imagination of students. The concept of Place value is a fundamental mathematical concept in the students' mathematics learning. A conceptual analysis and explication of the concept of "place-value" points to a more effective method of teaching it.

Pupil with hearing loss face many problems in the learning process. Their inability to hear or the hearing of little sound and speech initiate's adverse academic implications that leads to their underperformance. Lack of adequate input brings about a delay in abstract reasoning necessary for effective academic performance. Computer assisted instruction plays very important role in this situation.

The present study aimed at developing computer aided instruction (CAI) for teaching the concept of place value to primary school children with hearing impairment and also studying its effectiveness in teaching the concept. Two matched groups, one using CAI and the other in the traditional method were employed in the study. The pre- and post- test carried out on the two groups showed that the group which used computer assisted learning program performed significantly better than the group that used traditional methods in both the speed of learning as well as practical usage of the concept.

Keywords: Hearing impairment, Computer Aided Instruction, Place value, Technological strategies

Article History: Submitted: 18th May, 2020, Revised: 18th June, 2020, Accepted: 19th June, 2020,
Published: 30th June, 2020.

I. INTRODUCTION

“Education is the harmonious and progressive development of all the innate powers and faculties of man- physical, intellectual and moral”.

Pestalozzi

Education is very important in all stages of human life. Education has been the torch bearer of humanity's most noble ideals. School 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, he will never look back in life for he has been adequately prepared to exercise his initiative to overcome difficulties.

Technology means the systematic application of scientific or other organized knowledge to a practical task. Educational technology is the use of technology to improve education. It is a systematic, iterative process for designing instruction or training used to improve performance. Educational

technology is sometimes also known as instructional technology or learning technology (Wikipedia: Educational technology).

Educational technology is based on theoretical knowledge from different disciplines (communication, psychology, sociology, philosophy, artificial intelligence, computer science, etc.) plus experiential knowledge from educational practice (Natalie Descryver).

Educational Technology has developed into a wide, independent discipline, encompassing several definitions and practices; some of which may be conflicting and contradicting. Educational Technology can be considered either as a design science or as a collection of different research interests addressing fundamental issues of learning, teaching, and social organization. Nevertheless, there are a few fundamental principles that are to govern the practices of Educational Technology. (Alessi & Stanley, 2001):

- 1) Use of technology is principled: Technology means the systematic application of scientific knowledge to practical tasks. Therefore, Educational Technology is based on theoretical knowledge drawn from different disciplines (communication, education, psychology, sociology, philosophy, artificial intelligence, computer science, etc.) plus experiential knowledge drawn from educational practice.

[1] Special Educator, Department of Special Education, All India Institute of Speech and Hearing, Manasagangothri, Mysuru Email: pvrmanakumari@gmail.com

[2] Special Educator, Department of Special Education, All India Institute of Speech and Hearing, Manasagangothri, Mysuru Email: appajimanjula9@gmail.com

- 2) Educational Technology aims to improve education. Technology should facilitate learning processes and increase performance of the educational system(s) as it relates to effectiveness and/or efficiency.

National Policy on Education (1986), recommends that, "Educational Technology will be employed in spreading of useful information, training and retraining of teachers to improve quality, sharpen awareness of art and culture, inculcate abiding values etc., both in the formal and non-formal sectors.

Presence of hearing impairment in the early childhood has an adverse effect on speech and language development. Impairment in the development of speech, language, and oral communication skills will in turn hinder the educational development of the children. Paul and Jackson (1993) reported that differences in language abilities consequent to hearing impairment affects a student's ability to perform in traditional academic areas. The delay in educational achievement of children with hearing impairment (CWHI) compared to their hearing peers has been noted to occur since the educational system is highly language based. Paul and Quigley (1994) reported that students with complete or partial hearing impairment have considerable difficulty succeeding in an educational system that depends primarily on spoken word and written language to transmit knowledge. According to Flexer (1999), irrespective of the degree of impairment, hearing loss if unmanaged can have a negative impact on the development of academic competencies. A decade before this, Greenberg and Kusche (1989) and Martin (1985) had observed that children with mild-to-moderate hearing loss achieve below expectations, based on their performance on a test of cognitive ability.

Mathematics is the abstract study of topics such as quantity (numbers), structure, space, and change. It is referred to as "the Queen of the Sciences" (Carl Friedrich Gauss (1777–1855)). Mathematics is part and parcel of our life. Learning mathematics not only helps in understanding other subjects but trains one's mind to think logically and rationally. It develops problem solving ability in day to day life and to think precisely. Learning mathematics demands different faculties of mind. A student may be good in performing calculation but may have difficulty in solving problems in geometry which demands lot of logical thinking or vice versa.

The constructivist approach to learning mathematics relies on children developing their own unique understanding of mathematics and places emphasis on how children "come to know" (Begg, 1995: 1). Hearing impairment in children does not only make it difficult for them to communicate with other people; it also slows down, or even prevents altogether, their learning. Meadow-Orlans (1980) states that mathematical concepts can be learnt by hearing-impaired children in the same sequence and manner as their hearing peers, and this raises the issue of differences for hearing and hearing-impaired children in terms of how their learning environment caters for this 'coming to know'. However, various factors may prevent children with hearing impairment from successfully constructing mathematical knowledge, including the following:

- They may lack general vocabulary and the basic mathematical vocabulary needed to be able to understand math concepts/processes. Hearing children are exposed to language from birth and have an understanding of everyday language. This serves as a base for developing an understanding and use of mathematical language. It is more difficult for children who are hearing impaired to acquire language and learning from their environment incidentally (from overhearing conversations of others in their environment, on TV, on the radio). Without this incidental learning, a child who is hearing impaired may not develop even beginning math concepts such as "in front of/behind" or "heavy/light" without being formally taught.
- Communication with others may be difficult. If the child and others in the environment cannot communicate with each other effectively, they will not be able to engage in mathematical processes such as problem solving, developing logic and reasoning, and communicating mathematical ideas. Problem solving is especially difficult for children who are hearing impaired, as a sound language base is necessary for putting observations into words or making predictions. Without communication skills, the child can be isolated in the learning environment and unable to participate in group activities and discovery (Ray, 2001).
- Cognitive development may be delayed. Research shows that children who are hearing impaired have normal intellectual potential (Meadow, 1980). However, for normal cognitive development to occur, particularly in a mathematical sense, a child must be introduced to a diversity of mathematical experiences along with a rich language base (Ray, 2001). This does not always occur in the home and in the educational setting.

Unlike other science subjects, most of the students have difficulty in learning mathematics because mathematics is abstract in nature. For children with hearing impairment understanding abstract concepts is much more difficult.

The primary reason for the above mentioned difficulties is that the traditional instructional processes in our classrooms are primarily verbal in nature. Generally, 80% of the instructional time in traditional learning environments consists of teachers talking to the class and/or reading from textbooks and writing on boards.

Use of technology that engages and conveys information through alternate senses and modalities will help alleviate these problems faced by children with hearing impairment in the learning environment. Use of appropriate educational technology in the teaching-learning process will enable them in the following ways:

- Better comprehension of the knowledge imparted in the teaching-learning process.
- Better remembrance and retention of the knowledge gained from the teaching-learning process, and
- Reproducing the learnt knowledge in a way that is comprehensible to the teacher and others in the learning environment and outside.

According to National Curriculum Framework (NFC) 2005, developing children's abilities for mathematization is the main goal of mathematics education. The narrow aim of school mathematics is to develop 'useful' capabilities, particularly those relating to numeracy—numbers, number operations, measurements, decimals and percentages. The higher aim is to develop the child's resources to think and reason mathematically, to pursue assumptions to their logical conclusion and to handle abstraction. It includes a way of doing things, and the ability and the attitude to formulate and solve problems.

Some problems in school Mathematics education

- A majority of children have a sense of fear and failure regarding Mathematics. Hence, they give up early on, and drop out of serious mathematical learning.
- The curriculum is disappointing not only to this non-participating majority, but also to the talented minority by offering them no challenges.
- Problems, exercises and methods of evaluation are mechanical and repetitive, with too much emphasis on computation. Areas of Mathematics such as spatial thinking are not developed enough in the curriculum.
- Teachers lack confidence, preparation, and support.

Any concept in mathematics can be explained with the help of pictures and this visual representation can help one to understand the concept easily. Place value is a fundamental mathematical concept in the students' mathematics learning, and it has long captured the attention of researchers. Deemed as "one of the most important arithmetic concepts to be learned by children in the early elementary grades," (Sharma, 1993, p.3), place value refers to children's flexibility with numbers and their ability to perform mental mathematics (Gersten & Chard, 2001).

Children who do not have a secure understanding of place value will have a terrible time with adding or subtracting larger numbers, regrouping, estimating, and later skills of multiplication, and division. They will have a hard time getting a practical sense of how much a number refers to, and may have poor number sense skills.

Children may face the following problems while learning the concept of place value –

- When grouping objects by 10s, children may forget to stop at 10 and keep going. Once they realize it, they have to stop and start over again.
- Not knowing when to count by 1s, and when to count by 10s - When children are finding out "how many tens" there are before writing a number, they are expected to count by 1s. ("One, two, three... tens.") When they are counting up the whole number at the end, they are expected to count by tens first, then add on the ones ("Ten, twenty, thirty, thirty-one, and thirty-two.")
- Feeling that the larger numeral is a bigger quantity no matter where it is located. In the number 27, they think the 7 is bigger than the 2 (20).
- Understanding that there are tens and ones, but getting confused about which one goes where.
- Just finding the whole concept downright confusing.

The above mentioned problems may cease the child's interest in learning the concept of place value in particular and learning mathematics in general. For overcoming the above said problems computer aided instruction (CAI) can be used. Many of the computer assisted instruction instruments for mathematics are games. The games are designed to help the students learn math in a fun and entertaining way. This type of instruction gives a visual demonstration and better explanation of how to understand mathematics.

Computer technology holds promise for improving student achievement and teacher quality in educational programmes at all levels. CAI brings with it several potential benefits as a teaching-learning medium. These include self-paced learning, self-directed learning, the exercising of various senses and the ability to represent content in a variety of media.

With self-paced learning, learners can move as slowly or as quickly as they like through a program. If they want to repeat some task or review some material again, they can do so as many times as they choose. The program will not tire or complain about repetitions. Learners can skip over a topic if information is already known, making the learning process more efficient.

With self-directed learning, learners can decide what they want to learn and in what order. Computer educational systems typically incorporate functions such as:

- Assessing student capabilities with a pre-test
- Presenting educational materials in a navigable form
- Providing repetitive drills to improve the student's command of knowledge
- Providing game-based drills to increase learning enjoyment
- Assessing student progress with a post-test
- Routing students through a series of courseware instructional programs.
- Recording student scores and progress for later inspection by a courseware instructor

Thus, the present study is an attempt to find out the effectiveness of computer aided instruction for teaching the concept of place value to primary school children with hearing impairment.

II. METHOD

The present study was a pre-experimental research to find the effectiveness of computer aided instruction for teaching the concept of place value to primary school children with hearing impairment.

Tools

Two types of materials were developed:

- Test material for evaluating pre- and post- interventional knowledge of child-participants.
- Computer aided instruction on the concept of place value.

Test materials

The test material included two equivalent, parallel versions for pre and post test, respectively. Each test was for a

maximum score of 25 marks. The items covered five major sub-concepts related to the principal concept of place value, which are as follows:

- Grouping in tens
- Finding units and tens
- Expressing in expansion form
- Addition with carry forward
- Subtraction by borrowing

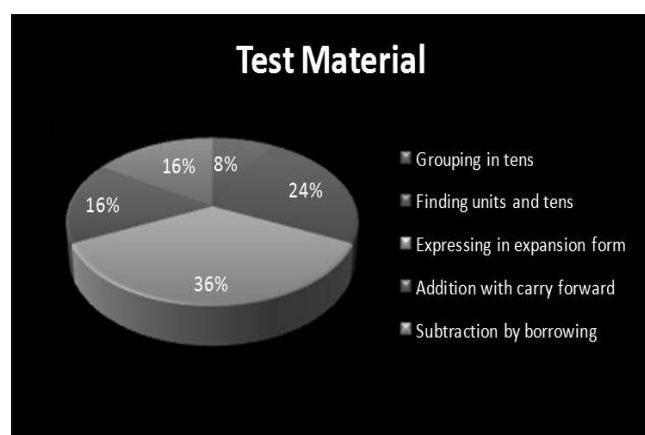


Figure 1: Percentage Composition of Pre and Post Test Materials

Sample

Children with hearing impairment from grade I and II studying in inclusive setup schools located in Mysuru were selected for the study. The study covered 20 children divided into groups of ten each. Ten children from each grade were selected. Figure 2 gives the details of selected participants in the two groups.

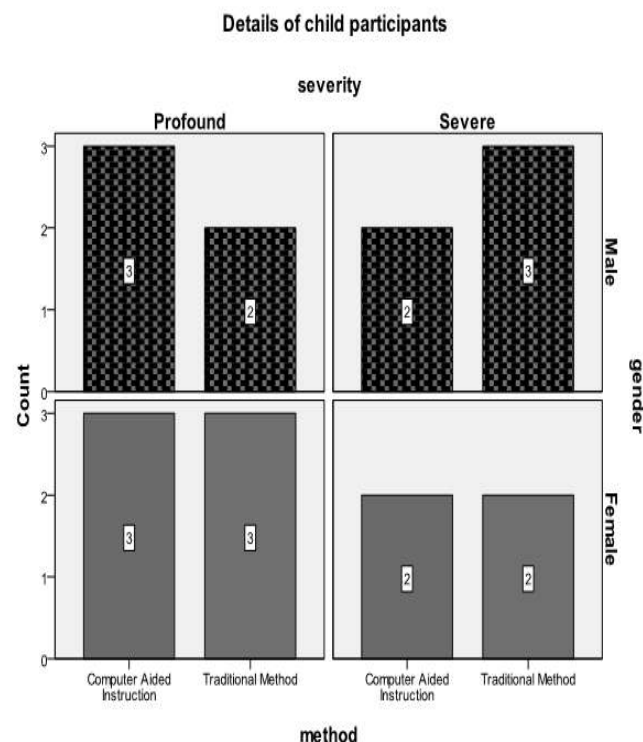


Figure 2: Details of child participants

Procedure

The study was carried out through the following stages:

Stage I: Preparation

Step 1: Preparation of tools and computer aided instruction for teaching the concept of place value

- The content of place value given in grade I and II of Karnataka State board mathematics textbook was selected.
- The content was adapted according to the need of the children with hearing impairment.
- Computer aided instruction for teaching the concept of place value was developed using Adobe Flash professional CS 5.5, Activstudio Professional Edition V3 and Power Point.
- The outline of the computer aided instruction modules were validated by 5 mathematics teachers working in 5 different inclusive schools.

Two sets of equivalent test materials were prepared for pre-and post – testing based on the CAI.

Step 2: Selection of child-participants

- Child-participants were selected as per the selection criteria and were randomly divided into two groups.

Stage II: Testing and Intervention

Step 1: Administration of pre-test

- The pre-test was administered on both the groups at the same time to all the participants.

Step 2: Carrying out of intervention

- For one group, having 10 children with hearing impairment, the intervention using computer aided instruction for teaching the concept of place value was imparted for 15 sessions of 45 minutes each on consequent week days.
- The children were not allowed to move to next module until the children gained 80% or more in the current module review exercises.
- For other group also having 10 children with hearing impairment, the concept of place value was taught by the special educator using traditional method for the same duration of 15 sessions of 45 minutes each on consequent week days.

Step 3: Administration of post-test

- The post-test was administered to all the participants of both the groups at the same time..

III. RESULT AND DISCUSSION

The study was taken up with the objective of finding out the effectiveness of computer aided instruction over traditional method for teaching the concept of place value to primary school children with hearing impairment.

The quantitative analysis using Anova and independent samples t test was further done to see the performance between the groups and within the groups in the each of the sub-concepts i.e. grouping in tens, finding units and tens,

expressing in expansion form, addition with carry forward and subtraction by borrowing. Table 1 shows the comparison of performance in post test between groups and within groups in all the five sub-categories.

		Sum of Squares	df	Mean Square	F	Sig.
Grouping in tens	Between Groups	0.450	1	0.450	3.857	0.065
	Within Groups	2.100	18	0.117		
	Total	2.550	19			
Finding units and tens	Between Groups	28.800	1	28.800	96.000	0.000
	Within Groups	5.400	18	0.300		
	Total	34.200	19			
Expressing in expansion form	Between Groups	57.800	1	57.800	61.200	0.000
	Within Groups	17.000	18	.944		
	Total	74.800	19			
Addition with carry forward	Between Groups	14.450	1	14.450	18.447	0.000
	Within Groups	14.100	18	0.783		
	Total	28.550	19			
Subtraction by borrowing	Between Groups	20.000	1	20.000	19.149	0.000
	Within Groups	18.800	18	1.044		
	Total	38.800	19			

Table 1: Comparison between and within groups

From table 1 it is evident that there is significant difference between groups at $p < 0.01$ in the performance of the children in all the sub concepts of the concept of place value except for the grouping in tens.

Also using independent samples t- test the mean and standard deviation of the two groups was calculated both in the pre and post test in all the sub concepts of the concept of place value. Table 2 gives the details of the same. Table 2: Mean and

Sub-Category		Method	Mean	Std. Deviation
Grouping in tens	Pre	Computer Aided Instruction	0.40	0.516
		Traditional Method	0.50	0.527
	Post	Computer Aided Instruction	2.00	0.000
		Traditional Method	1.70	0.483
Finding units and tens	Pre	Computer Aided Instruction	0.80	0.422
		Traditional Method	0.40	0.516
	Post	Computer Aided Instruction	5.50	0.707
		Traditional Method	3.10	0.316
Expressing in expansion form	Pre	Computer Aided Instruction	1.20	0.919
		Traditional Method	1.20	0.919
	Post	Computer Aided Instruction	8.30	0.949
		Traditional Method	4.90	0.994
Addition with carry forward	Pre	Computer Aided Instruction	0.000	0.000
		Traditional Method	0.000	0.000
	Post	Computer Aided Instruction	3.50	0.527
		Traditional Method	1.80	1.135
Subtraction by borrowing	Pre	Computer Aided Instruction	0.000	0.000
		Traditional Method	0.000	0.000
	Post	Computer Aided Instruction	3.40	0.699
		Traditional Method	1.40	1.265

Standard Deviation of both the groups in pre and post test.

Independent samples t- test was also carried out to find out equality of variance and test for equality of means. Table 3 gives the details of the same.

	Levene's Test for Equality of Variances	t-test for Equality of Means	
	F	t	Sig. (2-tailed)
Comparison of Grouping in tens	47.250	1.964	0.065
Finding units and tens	10.756	9.798	0.000
Expressing in expansion form	0.900	7.823	0.000
Addition with carry forward	0.679	4.295	0.000
Subtraction by borrowing	2.769	4.376	0.000

Table 3: Independent samples t- test scores to find out equality of variance and test for equality of means

From table 3 it is evident that there is significant difference in the t- value at $p < 0.01$ in all the sub concepts of the concept of place value except for the grouping in tens where $t = 1.964$ for $p = 0.065$ which is not very significant.

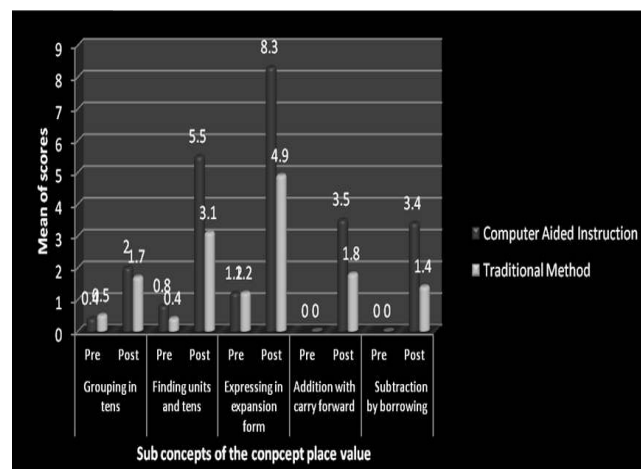


Figure 3: Mean performance on pre-test and post-test scores of both the groups in the sub-concepts in the concept of place value

The graph (figure 3) shows that there is significant difference between the performance of the children in pre-test and post-test in all the sub concepts of the concept of place value between the groups.

The post-test performance of the children with hearing impaired (CWHI) was compared statistically with the performance of pre-test, for the sub concepts of place value for both the groups. It was noticed that the CWHI performed better in the post-test after teaching the concept of place value with computer assisted instruction than using traditional method. Young students make significant learning gains using computer-assisted instruction (CAI) software (Kulik, kulik, and Bangert-Drowns 1984; Lieberman 1985; Niemiec and Walberg 1984; Ryan 1991)

The better performance of CWHI using computer aided instruction over traditional method suggests that, the performance of CWHI can be improved if better learning opportunities/ methods are provided. Children can use computer-assisted instruction (CAI) to practice arithmetic processes and to foster deeper conceptual thinking. Drill and practice software can help young children develop competence in such skills as counting and sorting (Clements & Nastasi, 1993). Indeed, the largest gains in the use of CAI have been in mathematics for primary grade children, especially in compensatory education (Ragosta et al, 1981; Lavin & Sanders, 1983; Niemiec & Walberg, 1984).

IV. CONCLUSION

Teachers should actively introduce mathematical concepts, methods, and language through a variety of appropriate experiences and research-based teaching strategies. Teachers should guide children in seeing connections of ideas within mathematics as well as with other children, developing their mathematical knowledge throughout the day and across the curriculum. They must encourage children to communicate, explaining their thinking as they interact with important mathematics in deep and sustained ways.

The computer can offer unique opportunities for learning through exploration, creative problem-solving and self-guided instruction. Realizing this potential demands a simultaneous focus on curriculum and technology innovations (Hohmann, 1994). Effectively integrating technology into the curriculum demands effort, time, commitment and sometimes even a change in one's beliefs. One teacher reflected, 'As you work into using the computer in the classroom, you start questioning everything you have done in the past and wonder how you can adapt it to the computer. Then, you start questioning the whole concept of what you originally did' (Dwyer et al, 1991). The successful teaching of mathematics in the basic level is based on the use of CAI and the effective use of technology by teachers.

V. ACKNOWLEDGEMENTS

The data for this research had been generated from the research carried out at the Department of Special Education at the All India Institute of Speech and Hearing (AIISH), Mysore on "Profile of Parameters of Intelligence in Preschool Children with Hearing Impairment." The authors thank Dr. M. Pushpavathi, Director, AIISH, Mysore for her constant support and guidance. The authors express their gratitude to Prof. S. R. Savithri, former Director, AIISH, Mysore for endorsing the original research. The authors like to offer their obeisance to their parents and spiritual masters Dr. Sri Ganapathy Sachchidananda Swamiji and Sri Datta Vijayananda Teertha Swamiji Avadhoota Datta Peetham Mysuru for their moral support in all endeavors. Authors extend their acknowledge to all the participants for their enduring participation.

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