Chapter 6
Integration of MP Driver with the Tools and Aids of Learning – A Case Study

6.1 Introduction

This chapter discusses in detail the Teaching Learning component of the Learning model “Ganitha Vithika” required for the optimization of the Mathematical Pathway. The various components that enhance learning like the Teaching and Learning materials and their use in teaching various concepts, Co-operative Learning and Group Learning materials used for the purpose, Lesson plans and its components, Assessment and identification of gifted children and children with difficulty, and providing them the necessary support through the Gifted Learning and Remedial Learning modules and building and using Teaching resources, are discussed.

6.2 The Teaching Learning component

Learning is an interplay of various factors and gives an intriguing character to the challenge of teaching. Developmental psychology gives us an insight into the minds of children. Child is a source of transformative energy and Learning is not standard in all children and hence the learning model should be flexible. Curriculums have to focus more on the cognitive process than behaviourism. Children have a natural drive to learn and the learning programme should encourage and strengthen this urge through active learning. Classroom learning should relate to life outside for children to feel the significance. Children should learn by exploring and discovering. Learning experiences should pave the way for construction of knowledge and fostering of creativity and become a source of joy. Assessments should be integrated into the learning process and assist to make progress. Assessments have to test problem solving capabilities and competencies.
The learning model has to be child centred. The teacher has to be a facilitator. The learning process should accommodate Children from all walks of life and different abilities.

“I hear I forget, I see I remember, I do and I understand”.

This little saying encompasses the entire principles of effective learning. The popular lecture method focuses on passing information through talk and children need to memorise the facts shared by the teacher. If a child is not a good rote learner then learning becomes a burden. With the advent of televisions, computers and interactive white board (smart boards) children are presented information in a visual format. This is an effective method for visual learners. But if it is used as the only method of teaching then children who are not visual learners will find learning difficult. The best approach to teaching and learning is the Learning by doing approach.

6.3 Teaching Learning Approaches adopted for “Ganitha Vithika”

The Learning pyramid in Fig. 6.1 clearly emphasises that Learning by doing is the most effective Learning and has high retention rates. The “Ganitha Vithika” adopts the hands on approach to learning – “Learning by doing”.

Various effective Learning methods and approaches have been integrated into the “Ganitha Vithika”. The learning model is based on

- The approach to learning with specialised learning aids (Montessori, 1967; Dienes,1960; Canny, 1984) with Teacher as facilitator (Rhodes and Bellamy 1999).
- Based on Learning styles(Knisley 2002; Bruner,1999; Kolb et al,1985) and Eight domains of Multiple Intelligences (Gardener ,1983)
- Constructivist (Piaget, 1920; Vygotsky ,1933) and Active Learning (Effandi and Iksan ,2006; Bonwell and Eison ,1991; Draper ,2005;)
- Co-operative Learning (Johnson et al,1994; Effandi et al 2006)
- Computer assisted Learning (Banerjee et al., 2005; Ravaglia et al., 1994; Mayer, 1998)
- Dynamic assessment (Holt and Willard-Holt, 2000; Bloom et al., 1956)

6.4 Constructivist Approach

Constructivism is a theory of knowledge based on generation of knowledge and meaning from an interaction between human experiences and ideas. According to this approach learning happens in three stages:

- Concrete (using and manipulating objects and situations in the environment or daily life)
- Visual representation (blackboard, flannel board, charts)
- Abstract Application (including computation and drawing)

In the “Ganitha Vithika” every math concept is introduced using Concrete-Representational-Abstract (CRA) approach. First, each concept is introduced using concrete material from the “Ganitha Kit”. Here the child learns by doing. Second, the concept is demonstrated using pictorial representations of the concrete material. Finally, the concept is taught in abstract form using mathematical notation. Students are also given practice in mental maths, word problems and application of the concepts to their daily life. This makes sure that students have a strong conceptual knowledge of each concept. The learning translates from the concrete to the abstract and hence has high retention rates.

6.5 The Teaching Learning Materials [TLM]

The Teaching Learning Materials are materials developed for teaching of mathematics concepts. Teaching Learning aids available were analysed and evaluated and the most appropriate among them were bundled into the “Ganitha Kit” [Fig. 6.2]. Some of them were improvised to make learning more effective. This “Ganitha Kit” can be used to set up Math Lab’s in
schools to give children hands on experience with Mathematics. Using the “Ganitha Kit” mathematics is made enjoyable and fun for children.

Features:

- It encourages multi-age, multi-grade, multilevel teaching.
- It promotes experiential learning.
- It brings together sound, age-old pedagogical practices and newer approaches in the teaching of basic mathematics.
- It has been conceptualised based on the Mathematics Pathway and designed using inputs from teachers, insights from experts and other sources. The aids have been time tested by teachers and found to be effective.
- It can be easily integrated into the curriculum. Components can be used to introduce a concept, reinforce it or assess the level of understanding. Lessons plans are planned around this.
- Relates Mathematical ideas to day to day living.
- Designed for both individual and group learning.
- Materials are designed to promote self learning. Children can use the materials with minimal intervention from Teacher. Teacher acts as a facilitator assisting children use the aids. Groups of children are occupied by various activities while the teacher is involved with a particular group.
- Aids are colourful, cost effective and of high standard of quality
- An aid can be used to teach several concepts when used judiciously.
- It can be used both in the Traditional and Alternate schools. It can also be used in Home Learning environments and Non Formal Education (NFE) centres.
- It is suitable for both urban and rural setups.
- Can be used effectively for remedial learning.

The “Ganitha Kit” comes with a manual which explains in detail how these aids can be used to teach various concepts of maths.
Fig. 6.1 The Learning pyramid
Fig. 6.2 Teaching Learning Materials
6.6 Using the TLM for teaching Math Concepts at elementary level

In a constructivist approach concepts are introduced using concrete materials. The TLM serves as the concrete materials. Each concept is introduced using one or more TLM’s. A brief description of how these TLM’s can be effectively used to teach concepts of mathematics at the elementary level is discussed.

Shapes & Patterns:

Objectives

1. Identification & sorting of simple 2D shapes.
2. Patterns and Tiling using 2D shapes
3. Making shapes using Tangrams

TLM

- 2D shapes
- Tangrams
- Elementary Pattern Tiles

Activities

Introduce Shapes using 2D shapes and Elementary pattern tiles. Describe the shapes based on observations. Match, sort and classify activities to reinforce the concept. Introduce patterns using the 2D shapes and Elementary pattern tiles. Reinforce through copying given patterns and completing patterns using 2D shapes and Elementary pattern Tiles. Explore shapes using Tangram to make various shapes.

Numbers 0-9:

Objectives

1. Introduction of numbers 0-9
2. Written form of 0-9
3. Comparing numbers 0-9
4. Number names 0-9
TLM

- Counters
- Number Line
- Play Money

Activities

Introduce representation of numbers using different forms fingers, claps, Counters, Number line, human number line, Play money. Teach counting in different ways. Practice identification of quantity represented by different TLM.

Introducing Numbers and Place Value from 10 – 99:

Objectives

1. Introduction of numbers up to 99
2. Written form of the numbers
3. Introduction of the concept of Place Value
4. Comparing two numbers
5. Arranging numbers in ascending and descending order.
6. Number names.

TLM

- Counters
- Number Line
- Base 10 blocks
- Place Value Cards
- Play money
- Abacus
- Slates

Activities

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Represent two digit number using Number line, human number line, Base 10 blocks, Play money. Explain the concept of place value using Base ten blocks and Play money. Explain concept of converting tens into ones and vice versa using Base ten blocks and Play money. Explain concept of a maximum of 9 in a place using Abacus to represent numbers. Represent the number using place value cards and explain expansion form using this. Using Abacus reinforce the concept of maximum of nine in a place. Explain comparison of two digit numbers using Base ten blocks, Play money and Place value cards. Use the <, >, = sign. Explain ordering using Place value cards. Introduce number names and numerals.

**Numbers beyond 100:**

**Objectives**

1. Numbers and Place value up to 999
2. Numbers and Place value greater than 9999
3. Written form of the numbers
4. Comparison of numbers
5. Ascending and Descending order
6. Number names

**TLM**

- Base 10 Blocks
- Play Money
- Place Value Cards
- Abacus
- Slates

**Activities**

Represent three digit numbers using base ten blocks and Play money. Using slates along with these explain the concept of place value. Represent using Place value cards and explain the expansion form. Using Abacus reinforce the maximum nine in a place concept. Explain the standard
form using the Place value Grid. Using slates to represent place values form different three digit numbers using Base ten blocks or Play money. Explain comparison and ordering using Place value cards.

Introduction to Lines, Planes and Angles

Objectives

1. Introduction to Plane and curved surfaces
2. Introduction to Straight & Curved Lines
3. Introduction to Angles.

TLM

- Angle Measure & Protractor
- 2D Shapes
- 3D Shapes
- Rope

Activities

Introduce flat and curved surfaces using 2D shapes and 3D shapes. Identify flat and curved surfaces in the classroom. Introduce straight and curved line using rope. Introduce the concept of plane, point, line, line segment, curve. Introduce angles using doors and windows. Explain types of angles using angle measure and protractor. Demonstrate measuring of angles using a protractor and angle measure. Discuss different angles found in 2D and 3D shapes. Using angle measure and protractor let the children measure different angles in the classroom. E.g. Between edges of the wall, Window and the wall.

Properties of 2D & 3D Shapes

Objectives

1. Identify, sort & draw freehand 2D shapes (triangle, rectangle, square & circle)
2. Identifies basic 3D shapes (cube, cuboid, cylinder, cone, sphere). Qualitative feel of roundness, edges, face, corner, vertex.

**TLM**
- Angle Measure & Protractor
- 2D shapes
- 3D Shapes
- Geo board
- Nets of 3D shapes.

**Activities**

Introduce 2D shapes and 3D shapes and relation between 2D and 3D shapes using TLM. Discuss the properties by observation. Stack 2D shapes to get its 3D equivalent. Using the Geoboard let the children represent various shapes, measure their sides and angles. Using paper let children make a square from a rectangle, rectangles from a square, triangles from rectangles and squares. Practice making 3D shapes (Solids) using nets.

**Concept of Addition & Subtraction**

**Objectives**

1. Addition and Subtraction of Number up to 20.
2. Addition and Subtractions of two digit numbers by pictorial representation of 10 s & 1s .

**TLM**
- Counters
- Base 10 blocks
- Currency

**Activities**

Introduce the concept – “Addition is joining” using Counters. Demonstrate that addition is putting together 2 or more sets of things using counters, cubes and Elementary pattern blocks. Practice making 10s, combining different single digit numbers. Using Play Money and Base 10 Blocks, show that the addition facts do not change when we add 10s, 100s etc. Now introduce
subtraction as taking away using Counters. Discuss how each addition and subtraction are linked and each addition fact has two linked subtraction facts. Using Play Money and Base 10 Blocks, show that the subtraction facts do not change when we subtract 10s, 100s etc.

Addition Procedure (with Regrouping)

Objectives

- Addition (with and without regrouping) number by writing them vertically.

TLM

- Base 10 Blocks
- Play Money
- Abacus
- Addition / Subtraction Grid
- Slates

Activities

Using Base ten blocks, Play money and slates demonstrate how two numbers can be added. Explain the need for regrouping when the total exceeds 9. To reinforce the concept, repeat the procedure in a similar fashion using the Abacus. Here the concept of a maximum of 9 things in a place will be reinforced as the Abacus rods can only take a maximum of 9 rings. Show the process of addition on addition grids. Let children practice addition with these grids till they are comfortable with addition.

Subtraction Procedure (with Regrouping)

Objectives

- Subtraction (with and without regrouping) of numbers by writing them vertically.

TLM

- Base 10 blocks
• Play Money
• Abacus
• Addition / Subtraction Grid
• Slates

**Activities**

Using Base ten blocks, Play money and slates demonstrate how one number can be subtracted from a larger. Explain the need for regrouping when a larger digit has to be subtracted from a smaller digit. To reinforce the concept, repeat the procedure in a similar fashion using the Abacus. Here the concept of a maximum of borrowing a one from the higher place is borrowing a ten is reinforced. Use the snap on rod for the borrow purpose. Show the process of subtraction on subtraction grids.

**Measurements Length, Weight & Volume**

**Objectives**

1. Need for measurements
2. Intuitive comparison of length and measurement of length using non standard units.
3. Measurement of length using standard units
4. Unit conversions for length.
5. Intuitive comparison of weight and measurement of weight using non standard units.
6. Measurement of weight using standard units
7. Intuitive measurement of Volume.
9. Operations, conversions and simple fractions for all units of measurements.

**TLM**

• Measuring tape
• Volume Measurement Containers
• Weighing Scales
• Base 10 Blocks

Activities

Address need for measurement using real life examples. Discuss situation where children have seen or used measurements.

Length

Using non standard measure let children measure different lengths and distances. Now let them verify using the measuring tape. Introduce different standard units for measuring length.

Volume

Using the volume container and waste plastic bottles introduce the concept of volume. Measure using the Volume container. Introduce standard unit of measurement of volume.

Weight

Using different objects in the class and the weighing balance let children find which objects weigh the same, which are heavier and which are lighter. Introduce standard measure using water as weights. Introduce standard units of measurement of weight.

Session 11: Money

Objectives

1. Identifies common currency & coins
2. Addition & Subtraction of money, conversion of Rs and paise
3. Operation using money, unit costs, preparation of simple bills & rate charts.

TLM

• Play Money
Activities

Using Play money introduce various denominations. Play bank and exchange money for different denominations. Play shopping game with Play money. Let children prepare bills. Discuss profit and loss based on their play transactions.

Multiplication Concept & Tables

Objectives

1. Introduction to Multiplication.
2. Multiplication tables up to 10 x10.
3. Multiples & Factors

TLM

- Number line
- Operation Board
- Base 10 Blocks
- Play Money
- Square line book

Activities

Skip count in 2’s, 5’s and 10’s. Represent groups with equal members using counters. Discuss that this forms a rectangle. Repeat this with Base ten blocks and Play money to represent multiple representation of a number. Introduce the concept of “multiplication is a rectangle”. Show that m x n is intersection of m horizontal lines with n vertical lines. The point of intersections formed is the product. Using square book explain this concept. Discuss the difference between m x n and n x m showing the orientation of the rectangle formed is different. Introduce tables using the counters. First introduce 0, 1 and 10. Discuss patterns in each of the tables. Then introduce 2, 5, 4, 8, 3, 6, 9 and 7. Ask children to practice these by drawing rectangle in their square line books.
Multiplication Procedure

Objectives

- Multiplies using standard algorithm and lattice algorithms.

TLM

- Base 10 blocks
- Play Money
- Slates
- Multiplication Grid

Activities

Using slates and base ten blocks or Play money, discuss multiplication of two numbers by representing it as a rectangle. Introduce the multiplication grid and show them 3 digit by 2 digit multiplication. Relate this to the standard procedure of multiplication.

Mensuration – Perimeter and Area

Objectives

1. Intuitively explore the area and perimeter.
2. Determines area and perimeter of simple geometric figures.

TLM

- Geo Board
- Square Ruled Note Books
- Base 10 Blocks
- Rope

Activities

Introduce area and perimeter by practical situations like fencing a plot, carpeting a floor. Using bending of rope to make a shape introduce in the concept of perimeter and using elementary blocks tile to fill a 2D shape introduce the concept of area.

Perimeter
Introduce perimeter as the distance around a shape. Practice making different shapes on a Geo Board and discuss the perimeter. Practice the same on square ruled note books. Now explain that if sides of a shape are known perimeter is sum of the sides. Practice this with children.

Area

Introduce area as the number of squares that can fit inside a shape. Since the sizes of squares vary, we use a standard size of 1cm square to measure areas. Use Geo Board and practice calculating areas of various shapes. Practice this in the square ruled note books. Show the link between multiplication and the area of the rectangle. Demonstrate that if sides of square or rectangle are given its area can be calculated.

Time

Objectives

1. Chronology of events
2. Reading Calendar to find a day / date
3. Reading Clock to the nearest hour.
4. Correlation of days in week, month and a year.
5. Reading Clocks to the minute.
6. Calculation of durations/ elapsed time

TLM

- Clock
- Calendar

Activities

Discuss concept of time through sequence of activities. Introduce the clock, and the concept that the time midnight to noon is divided into 12 hours and then from noon to midnight is again divided into 12 hours. The first one is AM and the later is called PM, there are 24 hours in day. Discuss yesterday, tomorrow, week, year. Introduce the calendar. Explain that since week days repeat every 7 days and there is a different pattern for months in a
year, the calendar helps us to calculate the number of days between two dates as well as tell on what weekday does a given date fall. Practice counting the number of days between two dates as well as figuring the day of the week on a particular date. Practice reading the clock, first up to every hour to half hour to quarter hour to five minutes and then to every minute. Teach conversions of time in days to hours as well as hours and minutes and vice versa. Work out elapsed time within a day and across days. Introduce situations that require addition / subtraction of time.

**Concept of Division**

**Objectives**

- Introduction to Division

**TLM**

- Base 10 Blocks
- Play Money
- Slates

**Activities**

Using counters discuss equal distribution of a quantity to a fixed number of people. Explain division. Now show that the equal groups form a rectangle. Establish connection between division and multiplication. Using Base ten blocks and Play money discuss dividing two digit and three digit numbers. Explain the need for regrouping when a equal distribution of a object in a specific place value is not possible. Introduce situations where there is a remainder.

**Division Procedure**

**Objectives**

- Informal & standard division algorithms

**TLM**

- Base 10 Blocks
• Play Money
• Division Grids

Activities

Using Base ten blocks and play money explain division of three digit number by single digit number. Explain how we start from the highest place and move on to the lower place value for division. Discuss regrouping and remainder. Relate this with long division. Discuss division with a two digit number. Now perform the same division using division grid. Write the procedure as you are doing the actions on the grid.

Spatial Sense

Objectives

1. Intuitive idea of map and reading simple maps.
2. Identifying shapes that tile and tiling an area using given shapes.
3. Symmetry, rotations and reflections.
4. Understand perspective in drawing 3D shapes and views of 3D shapes (Plan, Elevation & Side views)

TLM

• 2D / 3D Shapes
• Elementary Pattern Blocks.
• Tangrams
• Square ruled books

Activities

Using Elementary pattern blocks to cover an area such as a book or a slate such that there is no overlap or gaps discuss tiling. Discuss the shapes of tiles on the floor and ask if you can tile any shape to cover a floor in such a way that there are no gaps as well as no overlaps. Discuss various shapes that can tile and that which cannot tile.

Make rectangles using paper and fold it as shown below. The two parts exactly fit when folded. Explain that when something can be divided in

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such a way that both parts exactly fit each other when folded are symmetrical figures. Explain that the figures are only symmetrical when folded in a particular line, which is called the line of symmetry. Discuss using many examples including ink blots on folded paper. Discuss symmetry through reflections using a mirror. Practice completing reflections and drawing symmetrical figures in the square line book. Discuss concept of rotation using 2D shapes by tracing shapes using rotations and finding the effect.

Practice reading simple maps with children. Explain the scale, direction etc. Also discuss how to read floor plans of a house. Tessellations with different shapes taking one shape at a time.

Concept of Fractions

Objectives

1. Establish the need for fractions
2. Introduction to one fourth, half & three-fourths.
3. Understand equivalence of 2/4 & \( \frac{1}{2} \) as well as 2/2, 3/3 etc & 1
4. Understand fractions, compare fractions, equivalent fractions

TLM

- 2D Shapes
- Fraction Strips
- Volume Containers
- Number line
- Rope & Clothes Pins

Activities

Discuss division and the concept of remainder. Now explain the need to divide this remainder equally and introduce concept of fractions as dividing a smaller number by a larger number. Using fraction strips and 2D shapes discuss various fractions like \( \frac{1}{2}, \frac{1}{4} \) and so on. Introduce fractions can be used to divide any quantity into equal parts.
Introduce these concepts using: Volume containers to show fractions of volume; Rope and clothes pin to show fractions of length; 2D shapes to show fractions of areas; Number line (taking 60 beads as the starting point is convenient) to fractions of countable things.

Show that more the number of pieces smaller the size of each piece. Discuss comparison and ordering of fraction using fraction strips. Introduce addition and subtraction of like fractions using fractions strips. Discuss how numbers that are a combination of wholes and fractions can be represented in two different ways. Explain types of fractions. Discuss equivalent fractions using fraction strips. Introduce the concept that if the larger piece is divided to make same size as the smaller piece it would be possible to compare pieces of different sizes. Introduce terms such as numerator, denominator, mixed fractions, improper fractions, like and unlike fractions.

Concept of Decimals

Objectives

1. Understand 0.1, 0.2 etc.
2. Use decimals in context of units of length & money.
3. Conversion of Fractions to Decimals & vice versa.

TLM

- Base 10 Material
- Decimals Strips
- Slates

Activities

Using Base ten blocks and Decimal strips explain the concept of conversion from thousands to one. One thousand is ten hundreds and so on till one ten is ten ones. Now using decimal strips show dividing a one is slicing the cube. Explain this is 1/10. Dividing this further is making the slice into strips. This is 1/100 and dividing this further is dividing each slice into ten making it
1/1000. Introduce decimal and the purpose of the decimal point. Discuss reading and writing of a decimal number and the relation with fractions.

6.7 Cooperative Learning method

In the “Ganitha Vithika” reinforcement of concepts is done using Cooperative learning using small group of students (5-6 children in a group) with mixed levels of achievement. In these groups the students who are already familiar with the concepts, deepen their understanding by teaching others where as students who are having difficulties get support from their friends.

The advantages of Cooperative Learning is

- It helps the children think about the concept and teach others. The above average children get to teach their friends and in turn become more confident, where as below average children get personal help from their friends.

- It is easier for the teacher to manage groups rather than work with individual children.

- This has been tried in schools in India and in other countries. The results have shown that this improves the results for every member of the team no matter whether they are below average, average or above average in their math skills.

The Co-operative Learning is implemented in the following way.

The groups for cooperative learning are designed in the following way:

- The total number of children in the class is divided by 6. This gives the number of teams (minimum two teams). Any remaining children can be either assigned to existing teams or an extra team can be made (minimum of 4 children). Make sure the class has at least two teams.

- The class is divided into three groups of different levels in math: average, above average and below average. Now the children from each of this group are equally divided in all the teams. Each team will have children with mixed levels of achievement.
• Boys and girls are equally distributed in these teams. Similarly children from different social and economic background are equally distributed in these teams.

• Each team is assigned a name. In each team each team member is given identified by a alphabet. So in each team there will be a team member named A, B, C, D, E & F. An alphabet also determines the level of achievement of the child. Children at one level of learning are given one alphabet reference.

• Each team has a captain from the above average group. The leader is responsible for helping the teacher by correcting class work or homework, to ensure discipline in his team as well as making sure every child in his team is working and understanding the concepts.

• A team is assigned a place in the class where the team members will sit together.

• A chart reflecting list of all team members by letter names, team name and the designated leader is prepared and displayed in the room.

• Teams can be changed if the teacher feels a need for it.

The following method is used for working in teams:

• After the teacher has explained the concept, the children can discuss the topic among themselves and clear any doubts of the members in their group. If a team needs help, teacher can also help a team.

• The team then works together on solving the work cards / text book problems that the teacher asks them to work on.

• Once they finish, teacher calls the named members from each team (All Bs or All Ds etc.) to come and explain the problem. The students, who can do so, earn 2 points for their team. If they cannot explain the team does not get any points. If the called upon team member is absent, the team does not get any points either.

The following rules are followed while working in a team:
- Either all of the team members win or none of them do. A team wins when all members of the team have understood the concept. Any one member will be called to explain it. If the member can answer, the team gets points.

- The teams always have to sit in their own area and should not create trouble. There would be up to 4 bonus team points every Saturday for the team that behaves well.

- Every member is equal. No member can dominate the group and no member can be troubled by other team members. If any team does that, then they would lose bonus points that week.

It uses a reward system (Skinner, 1968) for encouraging children to work enthusiastically in a team. The score for each team is written on a score card. At the end of every month the team with highest points gets recognition. The scores are reset on 1st of every month.

6.8 The Group Learning Materials [GLM]

Cooperative Learning is achieved using the Group Learning Materials [GLM]. They mainly consist of the Work cards. Work cards are based on lesson plans. Each lesson plan has a set of 5 to 10 different work cards. Each workcard focuses on a competency and a skill. Each group is given a work card to solve during reinforcement time. Work cards are designed to transit a child from concrete to abstract. They are attractive activities presented graphically to develop interest in children. Numerals are used in simplest written form to avoid confusion. Real life situations from their environments are chosen so that children can relate to them. The groups exchange the cards with the other group when they have finished. This gives children ample activities to practice the concept learnt. This approach encourages group learning where a child learns with support from peers. Games, puzzles, stories, songs, dance theatre, role plays are also used wherever appropriate.
6.9 Lesson Plan

The lesson plan guides a teacher to facilitate learning based on a learning objective. It has the following components:

- **Topic** – The concept selected for learning
- **Learning objectives** – Outcomes expected after the learning of the concept has been accomplished
- **Prerequisite** – Concepts a child should know to understand this concept
- **TLM required** – The teaching Learning materials used
- **GLM required** – The group Learning materials used
- **Textbook reference** – Reference to the textbook where this topic has been dealt.
- **Introduction** - The different ways in which this topic can be introduced using the concrete materials. Once the children have the concept using concrete materials then they are made to think in the abstract by correlating the concrete experience with the formal methods and technique.
- **Reinforcement** - These are activities used to practice the concept learnt. Here the GLM and Textbooks are used for practice.

6.10 Assessment

This model adopts the continuous evaluation system. Assessment are used to track progress of a child and identify gifted and remedial learning requirements. The focus of assessment is not to award or reward a child but provide guidance to the child based on the feedback obtained during assessment. Every year a pre test is given at the beginning of the year. This helps in understanding the level of learning of the children in the class. Based on this the teacher can then set the learning goals for that year. Concrete and abstract assessments are conducted at the end of each concept learning. These provide a feedback to the teacher. Based on this the teacher can provide guidance to children who need assistance. Term test are conducted as per
education department norms. At the end of the year a post test is given to evaluate the learning curve of the child during the year. Assessments are based on competencies and skills.

6.11 Gifted Learning

Children who are exceptionally good and above average can be understimulated in a learning environment designed for average learners. This could lead to their interest waning over a period of time. To avoid this and let these children explore their potential completely challenging Learning opportunities are provided to them. Activities related to a concept focusing on higher order Mathematics skills are given to them so that they benefit from this learning. This Learning model due to its activity oriented approach gives scope for such deviations. As this system emphasizes learning by doing there is a possibility of many children being in this group. Here, Children are exposed to Vedic Math techniques to perform fast calculations (Srivathsa 1990;1998;2002;2005;2005; 2007). This will increase the speed of operations.

6.12 Remedial Learning

As this method is multidimensional and uses different types of materials and techniques for learning a need for remedial is reduced in the first place.

Children who have difficulties in understanding concepts need external support to streamline them with the class. Using this model remedial learning can be easily achieved. The TLM help a lot in working with children who have difficulty with learning. Because of it sensorial nature the materials promote understanding. The TLM are made easily accessible in the classroom or Mathematics laboratory for children to use during their free time. Children who have not understood can come early or wait after class and use them. If this reinforcement does not help then the teacher can ask the child to work with their Team leader using the TLM and GLM. If many children have difficulty
with a concept a good team leader can be assigned the job of working with this group or if needed the teacher can conduct a session for them.

6.13 Building and Using Teaching resources

Education is about fostering creativity. Teachers during their teaching tenure come across a lot of ideas, activities, approaches that can be used for effective teaching. The learning model also attempts to capture the knowledge of the teachers accumulated over a time period and create a knowledge base that can be shared with the entire teaching community. The resources in this are arranged as per the competency and skill. A teacher can use these resources to add on to the lesson plan.

6.14 Integration of the Learning model

The Learning model for the mathematical pathway – “Ganitha Vithika” is a three dimensional model. The dimensions are man, machine and materials.

In a learning process, especially at an elementary level, children need constant human interaction as their emotional needs have to be met along with their intellectual needs. An effective learning environment is the one that has a combination of person, material and technology. The person is the teacher or facilitator who understands, guides and motivates the child; the materials support activity based learning where children can learn in accordance with their learning style and technology provides backend support to do the knowledge and data management. This learning model has a balanced combination of all the three.

The process of teaching and learning is the human interface component where the teacher guides a child to learn using the materials. The automated component helps in collection of knowledge required for teaching, planning, assessment, data recording and storing, performance analysis based on the data collected and refinement of the learning process. The automated
component ensures that the computation oriented jobs are done efficiently and accurately while the human interface component ensures that the learning is personalised.

The learning model, “Ganitha Vithika” is a package which contains a **Math TLM and GLM Kit**, a **software** that has a **Concept Teaching and Learning module** which includes Concept Learning through Lesson Plans, Teaching Resources, Gifted Learning and Remedial Learning; **Progress Tracking module** which assesses the progress of a child through the Mathematical Pathway; **Performance Analysis module** which analyses the learning trends and patterns based on the progress data which can be used to refine the learning model.

In this investigation, the Math TLM and GLM kit has been developed, the content of the Concept Teaching Learning module has been created. The test content has been developed. The design of the Concept Teaching Learning module and the Progress Tracking module has been developed and the algorithms for Performance Analysis identified.

Software has to be developed using the outcomes of this investigation. A GUI based software for traversing through the pathway, administering the test has to be developed and synchronised with the algorithms. The development of software is not in the scope of this investigation.

### 6.15 Results and Conclusions

The three dimensional Learning model “Ganitha Vithika” is holistic in nature. It addresses all components of learning.

The **automated component which is the progress tracking, assessment and guiding tool is integrated with the human interface component**. This optimal learning model assists a teacher and student in utilising their valuable time in the teaching learning process and understanding
of concepts, so that the student can retain this knowledge and apply it to real life situations.

This learning model emphasises on the fact that the teaching learning process is most effective when teaching is done by a person who understands the students, their learning styles and is able to adopt learning strategies relevant to a particular student. An automated system for teaching would fail to do this and would apply one learning strategy on all children and hence the effectiveness would be reduced. Here Computer based learning is one of the components of a lesson and not the only medium of teaching as this would not give a child opportunity to learn through a sensory experience. Automated learning would have the same impact of television and would not holistically help the child in learning as brain benefits from different types of sensory experiences in comparison to only audio and visual input. This type of the learning would not leave a long lasting experience in the child.

The automated component of the learning model assists the teacher in performing tasks that are cumbersome like planning, organising content, recording student progress in charts and analysing the collected data to understand the progress of children and make any analysis based on the collected data to improve quality of teaching. The time a teacher needs to spend on non academic work is reduced and accuracy is increased by the use of the automated system. The learning model saves a lot of productive time of the teacher which can be utilised for the benefit of the children.

This learning model is well balanced as it utilises a good combination of automated and human interface system to make learning most effective. It uses advantages of speed and accuracy of information technology for providing assistance to teachers without making their role redundant. It uses the human qualities of compassion, understanding and intelligence of the teacher for learning effective. Hence this model has all the features of a balanced model for mathematical pedagogy and will be an effective tool for the teaching community.