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## Pedagogy of Teaching Maths – Part 1

### TEACHING AIDS

#### CUISENAIRE RODS

Cuisenaire Rods are a versatile collection of rectangular rods of 10 colors with each color corresponding to a different length. The shortest rod, the white, is 1 centimeter long; the longest, the orange, is 10 centimeters long. One set of rods contains 74 rods: 4 each of the orange (o), blue (e), brown (n), black (k), dark green (d), and yellow (y); 6 purple (p); 10 light green (g); 12 red (r); and 22 white (w). One special aspect of the rods is that, when they are arranged in order of length in a pattern commonly called a “staircase,” each rod differs from the next by 1 centimeter, which is the length of the shortest white rod.

Unlike Color Tiles, which provide a discrete model of numbers, Cuisenaire Rods, because of their different yet related lengths, provide a continuous model. This means they allow you to assign a value to 1 rod and then assign values to the other rods by using the relationships among the rods.

Cuisenaire Rods can be used to develop a wide variety of mathematical ideas at many different levels of complexity. Initially, however, students use the rods to explore spatial relationships by making flat designs that lie on a table or by making three-dimensional designs by stacking the rods. The intent of students’ designs, whether to cover a certain amount of a tabletop or to fill a box, will lead students to discover how some combinations of rods are equal in length to other, single rods. Students’ designs can also provide a context for investigating symmetry.

Older students who have no previous experience with Cuisenaire Rods may explore by comparing and ordering the lengths of the rods and then recording the results on grid paper to visualize the inherent “structure” of the design. In all their early work with the rods, students have a context in which to develop their communication skills through the use of grade-appropriate arithmetic and geometric vocabulary.

Jumbo Cuisenaire Rods are easier to build with for very young students. As they explore they naturally learn about relationships between the rods. Allowing time for all students to gain familiarity with Cuisenaire Rods is essential at this stage. You can do this by providing daily play time with the rods for up to a week or even longer. Play time is especially important after the students have begun to use the rods to learn math, so that the natural engagement of hands-on manipulatives continues.

Rods can be used to build understanding of addends. Students look for various ways to make trains equal in length to a specific rod (for example, the light green rod)

## **GEOBOARD**

A Geoboard is a very useful device for introducing children to important topics in school geometry. It consists of an array of nails or pegs which are placed at equal distances on a square acrylic board making up a grid. The baseboard is made from wood or acrylic. Drill holes at equal distances forming a square grid.

It is convenient to place the pegs at gaps of 1cm. Nails can also be used, but the heads must be small. Acrylic boards with holes drilled in them are good for use on an overhead projector. Graph paper can also be placed below an acrylic board which is useful in estimating areas. The pegs or nails can be glued onto the acrylic board.

Geoboards were invented by Caleb Gattegno in the 1950s. Geoboards come in different sizes and configurations, but basically they all consist of a series of spaced pins. The spacing and the arrangement of pins may vary.

For example, pins might be spaced at 10 mm or 20 mm intervals and are laid out in a square pattern. Other pins are laid out in an isometric grid, while still others are in a circular pattern. The most common Geoboard is set out in a square arrangement. Often a different arrangement will be featured on the back of the Geoboard. Plastic or elastic bands are placed around the pins on the Geoboard to form lines and shapes, making the Geoboard the ideal manipulative for developing geometry concepts.

While using a geoboard a great deal of geometric language may be developed. For example, mathematical vocabulary such as intersect, perpendicular, right, acute, obtuse, as these naturally occur in the contexts of tasks and activities

## **ABACUS**

An abacus is a manual aid to calculating that consists of beads or disks that can be moved up and down on a series of sticks or strings within a usually wooden frame. The abacus itself doesn't calculate; it's simply a device for helping a human being to calculate by remembering what has been counted. The modern Chinese abacus, which is still widely used in China and other countries, dates from about 1200 A.D.

The Place Value Abacus assists with the development of Place Value. Nine washers may fit on any prong, but ten cannot. Once ten washers are placed on any prong they must be exchanged (traded) for one washer on the prong to the left.

In essence, 10 ones are traded for 1 ten and 10 tens are traded for 1 one-hundred. As washers move one place to the left they acquire a value tens times as much. This is the basis of our base ten place value system.

When a washer is moved one place to the right it is only worth one-tenth as much.

Two or more Place Value Abacuses may be joined to emphasise the Hundred Tens Ones (HTO) system of naming numbers. A pattern is formed in the way that we name numbers. There are Hundreds, Tens and Ones of millions, Hundreds, Tens and Ones of thousands and Hundreds, Tens and Ones of ones.

## ALGEBRA TILES

Algebra tiles are mathematical manipulatives that allow students to better understand ways of algebraic thinking and the concepts of algebra. These tiles have proven to provide concrete models for elementary school, middle school, high school, and college-level introductory algebra students.

They have also been used to prepare prison inmates for their General Educational Development (GED) tests.<sup>[1]</sup> Algebra tiles allow both an algebraic and geometric approach to algebraic concepts. They give students another way to solve algebraic problems other than just abstract manipulation.<sup>[1]</sup> The National Council of Teachers of Mathematics (NCTM) recommends a decreased emphasis on the memorization of the rules of algebra and the symbol manipulation of algebra in their *Curriculum and Evaluation Standards for Mathematics*.

There are 4 modes: Solve, Substitute, Expand, or Factor.

- In Solve and Substitute, vertical lines indicate "is equal to" (=).
- In Expand and Factor, the large area is the product of the top and left areas, as in a standard multiplication table.

Use tiles to represent variables and constants, learn how to represent and solve algebra problem. Solve equations, substitute in variable expressions, and expand and factor. Flip tiles, remove zero pairs, copy and arrange, and make your way toward a better understanding of algebra

## BASE TEN BLOCKS

Base Ten Blocks provide a spatial model of our base ten number system. The smallest blocks – cubes that measure 1 cm on a side – are called units. The long, narrow blocks that measure 1 cm by 1 cm by 10 cm are called rods. The flat, square blocks that measure 1 cm by 10 cm by 10 cm are called flats. The largest blocks available that measure 10 cm on a side, are called cubes.

When working with base ten place value experiences, we commonly use the unit to represent ones, the rod to represent tens, the flat to represent hundreds, and the cube to represent thousands. Providing names based on the shape rather than on the value allows for the pieces to be renamed when necessary. For example, when studying decimals, a class can use the flat to represent a unit and establish the value of the other pieces from there.

The size relationships among the blocks make them ideal for the investigation of number concepts. Initially students should explore independently with Base Ten Blocks before engaging in structured activities.

As they move the blocks around to create designs and build structures, they may be able to discover on their own that it takes 10 of a smaller block to make one of the next larger blocks. Students' designs and structures also lead them to employ spatial visualization and to work intuitively with the geometric concepts of shape, perimeter, area, and volume.

Base Ten Blocks are especially useful in providing students with ways to physically represent the concepts of place value and addition, subtraction, multiplication, and division of whole numbers. By building number combinations with Base Ten Blocks, students ease into the concept of regrouping, or trading, and can see the logical development of each operation.

The blocks provide a visual foundation and understanding of the algorithms students use when doing paper-and-pencil computation. Older students can transfer their understanding of whole numbers and whole-number operations to an understanding of decimals and decimal operations.

## COLOR TILES

Color Tiles are a versatile collection of 1-inch square tiles that come in four colors – red, green, yellow, and blue. They are pleasant to handle and easy to manipulate. Students can use the tiles to act out story problems involving all sorts of everyday objects. Learning to use small colored squares to represent such objects is a significant step in the process of learning to abstract.

Although Color Tiles are simple in concept, they can be used to develop a wide variety of mathematical ideas at many different levels of complexity. Young children who start using Color Tiles to make patterns may likely talk about numbers of different colored tiles.

Some children may even spontaneously begin to count and compare numbers. The fact that the tiles are squares means that they fit naturally into a grid pattern, and when Color Tiles are used on top of a printed grid – for example, a number chart – the tiles can be used to discover many number patterns. As they record their patterns, students are also using their spatial skills and strategies to locate positions of particular tiles.

When making patterns, students often provide the best inspiration for one another. Given sufficient time, some student will come up with an idea that excites the imagination of other students. It is preferable that new ideas arise in this way, because then students develop confidence in their own abilities to be creative. Though students need to explore patterns freely, some students may also appreciate challenges, such as being asked to make patterns with certain types of symmetry or patterns with certain characteristics, such as specific colors that represent different fractional parts.

Logical thinking is always involved when students investigate Color Tile patterns, because, in order to recognize and continue a visual pattern, students must form conjectures, verify them, and then apply them.

### **ATTRIBUTE BLOCKS**

Attribute blocks sets include red, yellow and blue circles, hexagons, rectangles, squares and triangles. Each set include different sizes and thicknesses of the blocks so students may differentiate by thick or thin and large or small.

A standard set contains 30 to 60 blocks, but students may also use pattern block templates for drawing two different sizes of each shape for homework and classwork assignments. Hard plastic sets provide more durable sets, but foam sets offer quieter use for whole-class activities.

Attribute Blocks strengthens fundamental mathematical skills and develops problem-solving techniques through logic. Blocks come in bright colors and varying shapes and sizes. Pieces come in 5 shapes, in 3 colors, that come in 2 sizes and thicknesses. Pieces range from  $3/4$ " to  $1-1/2$ ".

Attribute Blocks are the ideal piece of equipment for developing high order mathematical thinking logic and reason. For example, Venn Diagrams

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