Sensorial Education Lesson 4

This week we shall conclude our study and understanding of Sensorial Education and the Materials used in this study area.

Sensorial Education 4

Lesson Objectives:

1. To give a detailed overview of the presentation of

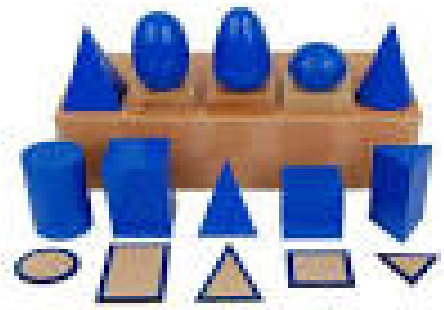
- The Geometric Solids
- The Geometric Cabinets
- The Binominal Cubes
- The Constructive triangles

Sensorial Education Notes 4

"The senses, being explorers of the world, open the way of knowledge"

Maria Montessori

Geometric solids



Materials:

Ten geometric solids:

sphere, cube, cone, cylinder, ovoid, ellipsoid, rectangular prism, triangular prism, square based pyramid, triangular based pyramid

- Bases for the solids
- A basket
- A felt mat

Objectives:

1) To provide experiences of solid shapes in the environment and to stimulate interest in discerning these shapes in the world around the child.

2) To develop language.

3) To develop an understanding of the relationships between shapes.

Presentation:

Show the child where the materials are placed on the shelf, name and bring them to the workstation showing the child how to carry the basket. Place the solids on the mat for the children to handle. The children must be able to hold the solids in their hands.

Later, after the children have handled the solids and are familiar with them, introduce the terminology associated with them with the three period lesson, dealing with two solids at a time.

Solids Bounded by Straight Lines:

Prisms:

The end face can be any regular polygon.

The sides are always rectangles. Prisms are named by their end faces. For example, the triangular prism has triangles

as end faces, and the hexagonal prism has hexagons as the end faces.

Pyramids:

These have any regular polygon for a base and isosceles triangles with a common vertex as the sides. A pyramid is named by its base (hexagonal pyramid, etc.).

Regular Curved Solids:

Sphere: all points on the surface are equidistant from the centre

Ellipsoid: a form whose plane surfaces are either ellipses or circles

Ovoid: egg shaped

When the children handle these, let them also roll them and watch the path each takes.

Curved solids with plane and curved surfaces

Cylinder: a solid bounded by two parallel planes, which are curved.

Cone: a solid with a circular base joined by straight lines to the vertex

Hemisphere: half a sphere

Exercise 1:

Ask the child to sort the solids into sets: those that can only roll, only slide and those that can do both.

Exercise 2:

Ask the child to play around with the solids by placing one or two solids together and see if they can form other solids. Then remove all solids that cannot stand on their own. Now discuss which solids can stand with others (a cone on top of a cube, cube on top of a rectangular prism and a square.)

Exercise 3

A stereognostic exercise: Choose 3-4 solids and place them in a basket cover the basket up with a scarf. Reach under the scarf and feel one of the solids underneath, say out loud what solid you believe you are holding. Take it out tor reveal the solid you have in your hand. Now allow the child to do the same, and to work on this until the child can feel and guess correctly. This allows the names of the solids to be reinforced in the child's mind.

Geometric cabinet

MATERIAL I - THE PRESENTATION TRAY:

This is a strong wooden tray containing three square of plain wood, and three wooden frames with insets of a square (sides 10 cm), a circle (diameter 10 cm), and an equilateral triangle (sides 10 cm). Each inset and the bottom of the tray are painted blue. The rest of the wood is finished with a clear, colourless varnish.

MATERIAL II - THE CABINET

The cabinet has five drawers. Some cabinets have six drawers. All the insets of the cabinet are either light gray or blue, and the bottom of each drawer is light grey or blue to match the insets. All the rest of the wood is lightly varnished. Each figure in the presentation tray and the cabinet has a small knob in the centre

to hold it by.

Drawer 1 - Six Circles

There are six circles, each inset in a square wooden frame and arranged in order of size. They have diameters of 10 cm, 9 cm, 8 cm, 7 cm, 6 cm, 5 cm, respectively. Thus, they vary in size in a regular way with 1 cm difference in diameter between any two in succession.

Drawer 2 - Six Rectangles

There are six cut-out rectangles kept in order of size, each in a square wooden frame. The rectangles are 10x10 cm., 9 x 10 cm., 8 x 10 cm.,

7 x 10 cm., 6 x 10 cm., and 5 x 10 cm., respectively. Thus, they also vary in a regular way with 1 cm. difference on one side between each in succession.

Drawer 3 - Six Triangles

- Obtuse-angled Scalene Triangle
- Right-angled Scalene Triangle
- Acute-angled Scalene Triangle
- Obtuse-angled Isosceles Triangle
- Right-angled Isosceles Triangle
- Acute-angled Isosceles Triangle

There are six different triangles inset in square frames. Three scalene triangles (no equal sides) in one row, and three isosceles triangles

(two equal sides) in the other row. Their sides and their angles classify triangles. All triangles have at least two acute angles. They are named by the third angle.

- Equilateral Triangle - All angles and sides equal (presentation tray)
- Obtuse-angled Triangle - One angle greater than 90 degrees
- Acute-angled Triangle - Three angles less than 90 degrees
- Right-angled Triangle - One angle is 90 degrees

Counting the equilateral triangle in presentation tray, there are seven triangles in all.

Drawer 4 - Six Polygons

- Pentagon
- Hexagon
- Heptagon
- Octagon
- Nonagon
- Decagon

The six polygons all inscribe within the10 cm. diameter circle.

A Pentagon (5 sides and 5 angles)

A Hexagon (6 sides and 6 angles)

A Heptagon (7 sides and 7 angles)

An Octagon (8 sides and 8 angles)

A Nonagon (9 sides and 9 angles)

A Decagon (10 sides and 10 angles)

Polygon means many angles

Drawer 5 - Four Quadrilaterals and the Ellipse and Oval

- Parallelogram
- Rhombus
- Ellipse
- Trapezoid
- Trapezium (right-angled trapezoid pictured above)
- Oval

This drawer contains the other four quadrilaterals - the parallelogram, the rhombus, the trapezoid, and the trapezium. (The square and the rectangle are in drawer 2.) It also contains two curved figures - the ellipse and ova

With this drawer all the possible regular quadrilaterals are in the cabinet.

· Square - all sides are equal and all angles are right angles.

· Rectangle - opposite sides are equal and parallel, angles are right angles.

· Parallelogram - opposite sides are equal and parallel (the square, rectangle, and rhombus are all parallelograms).

· Rhombus - all four sides are equal (equilateral parallelogram) but the angles are not right angles.

· Trapezoid - two sides parallel. (In countries other than the U.S. this is called trapezium.)

· Trapezium - no two sides are parallel

· Oval - egg shaped (from ovum meaning an egg).

· Ellipse - A symmetrical plane figure bounded by a single curved line every point of which is not equally distant from the point at the centre when viewing 1/2 of the symmetrical plane.

Thus, the cabinet contains all the regular plane figures and enables the child to classify every plane shape he sees in the environment.

PURPOSE:

1) A visual and tactile study of the full classification of the regular plane shapes as a foundation for the later study of geometry

2) To learn the words which will be needed and which will allow the child to express himself

3) To make the child aware of shapes in the environment and to get him to observe the environment with intelligence

4) Perfection of movement of the hands

5) Indirect preparation for writing as the child is feeling the curves and straight lines similar to the ones that compose the letters of the alphabet and his hand is being trained

PRESENTATION:

The Presentation Tray

The presentation tray is placed in front of the child on a table. The teacher sits beside the child. The teacher removes each inset in turn and places it on the blank square above or below the space from which is was taken out. The teacher pauses after removing the inset to let the child observe the fact that the space left by a figure is the same shape as the figure itself. The fact that the bottom of the drawer is the same colour as the figures helps make this more apparent.

The teacher takes one figure, holding it by its knob, and with the tips of the first two fingers of her dominant hand she traces exactly around the circumference of the figure. Then, she also

traces around the circumference of the space left by the figure. She then replaces the figure in its socket. The teacher repeats this with each figure in turn.

At any point in the demonstration, the child may join in using the material as demonstrated, or the child may be invited to use the material him or herself when the demonstration is over.

The exact feeling of the contours is difficult and most children need to be given exact demonstrations several times. The teacher does not interrupt the child when he or she is working but, instead, gives the child a lesson another day before he or she begins to use the

material, stressing the handling of the material at that time. The figure is held still and the fingers move around it.

Before giving a lesson the teacher must herself practice with the material until her own movements are perfect.

PRACTICE:

The child uses the material as demonstrated.

EXTENSION:

When the children have had the material to work with for some time the teacher may, after school, prepare the tray for the next day by varying the figures with three other contrasting figures from the cabinet. For example, the teacher might remove the circle, square, and equilateral triangle and put an ellipse, a rectangle, and a polygon in the tray. Over a period of time the children become familiar with all the figures in the cabinet because the teacher changes the figures in the tray from time to time. The cabinet is kept in a stock cupboard outside the classroom during the period that the figures are being introduced in the presentation tray.

LANGUAGE:

When a child knows any of the figures well, their names may be taught using the three period lessons.

PRESENTATION:

The Cabinet

Place the cabinet in the room. Once the cabinet has been brought into the classroom all the figures must be kept in their right places in the cabinet. It is no longer possible to vary the figures in the tray.

The teacher takes a drawer (e.g. of circles) from the cabinet and places it on the table in front of the child. She removes the insets, placing them in a mixed order on the table to one side of the drawer. She picks up a figure, feels around it, she feels around the sockets until she has decided where the circle fits; she then replaces it and takes another. The child joins in as soon as he or she understands the exercise; then the teacher can leave the child to work alone.

When one tray has been introduced to a child, the child may help him or herself to any tray and do the exercise in this way.

OBSERVATION:

The teacher must be aware that the child may use the cabinet in a freeway. She must watch before deciding to interrupt him or her.

Children may spin the circle around, they may discover that a square will fit into its socket in four positions, that the rectangle must be rotated through 180 degrees, etc. They are gaining valuable knowledge when they experiment in this way.

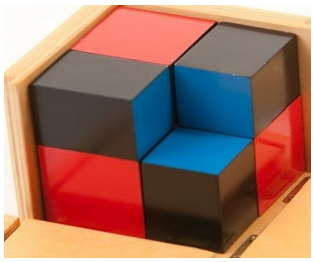
The figures may be compared and some geometrical deductions made. For example, the polygons may be inscribed in the largest circle. It can be clearly seen when doing this that the more sides a figure has the nearer it is to the area of a circle.

CONTROL OF ERROR:

Many figures will not fit into the wrong sockets. In the case of the circles or the rectangles, if a mistake is made, there will always be one figure at the end, which will not fit into the last socket.

Age: 41/2 plus

Binominal Cubes



$(a + b)^3$

Materials:

Cube 1: A cube composed of 8 wooden blocks which fit together in a binomial pattern, representing the cube of two numbers, (a + b),

or tens plus units. All the blocks fit into a natural wood box.

Each side of the cube has the same dimensions and pattern, and represents the square of (a + b). The faces of the small blocks are colour coded: a^2 is always red, b^2 is always blue, and "ab" is always black.

Cube 2: This cube contains blocks of the same dimensions as Cube 1, but it is made from plain unpainted wood.

Purpose:

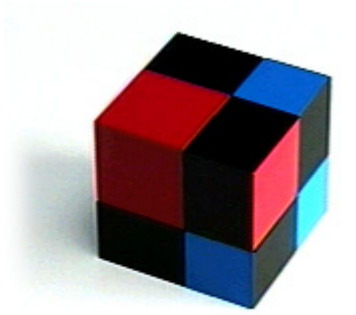
The child is at the stage of the absorbent mind. She is

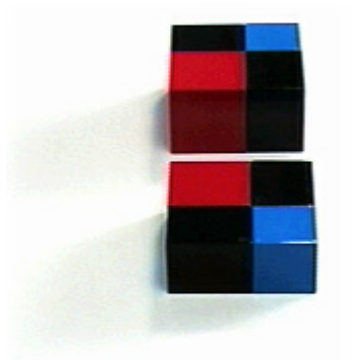
not asked to understand the formula, but is using the cube in a mathematical way. The child will build up a predisposition to enjoy and understand mathematics later.

Presentation:

The teacher takes the binomial cube to a table, sits next to the

child, and takes the cube out of the box. The teacher then invites the child to view the cube from all sides.





The teacher removes the top layer of the cube. She lets the child see that the two layers are different in height. Then, starting with the red cube ($a^{3)}$ from the tallest layer, the teacher takes the layer apart and arranges the pieces in front of the child in order (setting the pieces according to the formula).

The cube is taken apart piece by piece beginning with "a^3." The first row is set out at height "a," and the second row is set out at height "b" according to the formula.

Do not explain to the child why you are setting the cube out in this order, or talk about the mathematics of the cube. Simply show the child and work slowly.

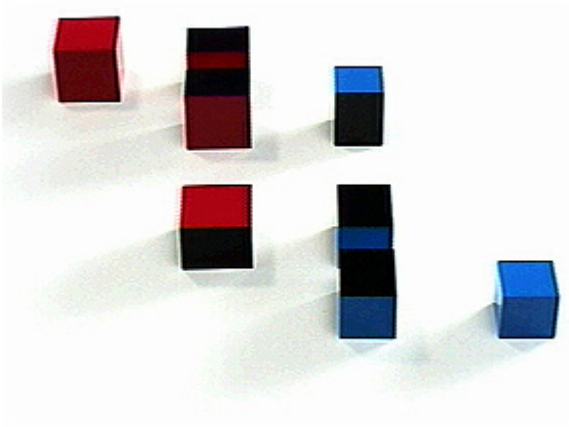
And so, the teacher takes the cube apart piece-by-piece, beginning with a^3, and lays it out very carefully.

The first row is set out at height "a", and the second row is set

out at height "b," according to the formula. Do not explain to the

child why you are setting the cube out in this order, or talk

about the mathematics of the cube. Simply show the child how to lay out the pieces.



When the formula has been set out on the table the teacher and

child view it for a minute or so.

The teacher then shows the child how

to rebuild the cube, starting with the "a^3," taking each piece in order. She lets the child see that she is matching the faces according to colour. She pauses after finishing the first layer. Then, taking "a^2b," she builds the second layer by taking the pieces in order, matching the coloured faces. When the teacher is finished, she lets the child view the cube from all sides. If necessary she may lay out the cube again and rebuild it. The child works alone when he or she is ready to do so. When the child has finished, the teacher shows the child how to replace the cube in the box.

Exercise:

Cube 1: Coloured Binomial

The child takes the cube out beginning with a^3 and lays out the pieces as shown, according to the formula. The child reconstructs the cube,

matching red faces, black faces, and blue faces, beginning with a^3.

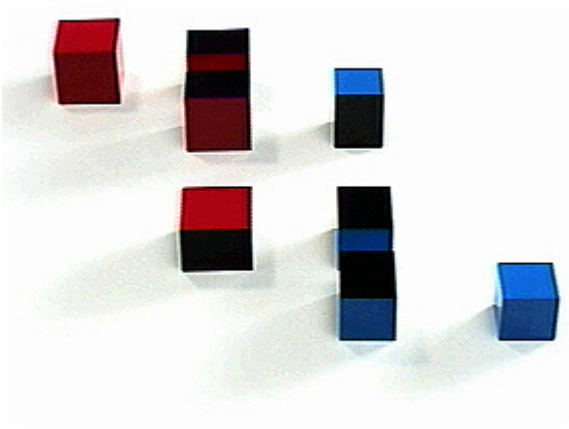
Cube 2: Unpainted Binomial

This cube is introduced later. The teacher shows the child how to handle the cube as cube 1, take it to pieces beginning with a^3 as before, and lay out the pieces according to the formula. The child then rebuilds the cube. There is no colour to help the child. The child must build the cube in the same way as before, but matching faces by size instead of colour. This, leads towards the mathematical understanding of the cube.

Formula for the cube $(a+b)^3$

a+b

x a+b
---
a^2 + ab
ab + b^2
a^2 +2ab + b^2
x a + b
a^3+2a^2b +ab^2 First layer (Multiplied by a)
_____a^2b+2ab^2+b^3 Second layer (Multiplied by b)
a^3+3a^2b+3ab^2+b^3

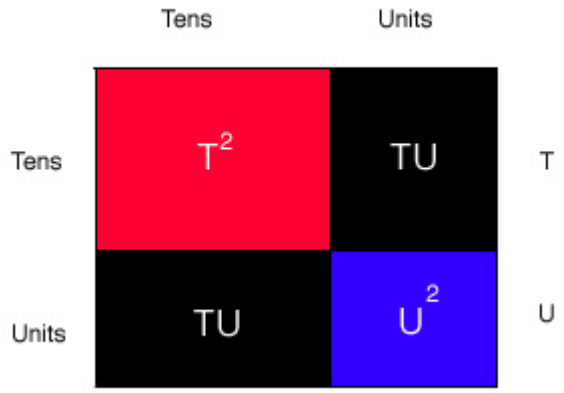


Note:

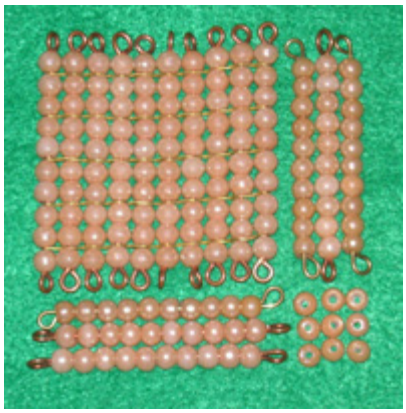
One way that humans attempt to survive is by understanding the world around them. The human brain is a pattern-seeking organism. So, by nature, children are interested in finding patterns, relationships, and order. If children have worked their way through the materials for dimension, colour, and shape, they will have found order, patterns, and relationships in those materials, and will have developed the ability to discriminate attributes to a point where they will enjoy the challenge of exploring the order inherent in the binomial and trinomial cubes. For this age, 4 to 6, the purpose of the material is not to teach math, but instead, to provide a challenge for a child's ability to find patterns and relationships. Therefore, the material is presented as a sensorial activity. It is presented like a three dimensional puzzle. Anyone who likes to do puzzles knows that in order to master a puzzle, you have to pay attention to the relationship between the pieces. People who are masters at puzzles will tell you that they take out, and organize, puzzle pieces very carefully. This is what is modelled for the child in this activity.

The math presented above and below is provided for the teacher and is not to be presented or discussed with the child of this age. The math is presented to the children when they are older and are ready for it.

As mentioned above, the binomial represents two numbers represented symbolically as (a + b). We could represent the numbers with (T + TU) for Tens plus Tens times Units. The pattern for the binomial squared is apparent on each of the faces of the binomial cube. It is represented below:



This pattern for the binomial squared can also be seen when building a square of the number with the golden beads. For example, for the number 13, which is (10 + 3), the pattern for the square of the number looks like:



$(10 + 3)^2$

$a + b$
$\times\ a + b$
$a^2 + ab$
$ab + b^2$
$a^2 + 2ab + b^2$

or

$10 + 3$
$\times\ 10 + 3$
$10^2 + (10 \times 3)$
$+\ (10 \times 3) + 3^2$
$10^2 + 2(10 \times 3) + 3^2$

AGE:

4 to 5 years.

CONTROL OF ERROR:

Teacher control.

The Constructive Triangles

MATERIAL

The constructive triangles are used to demonstrate that all plane geometric figures can be constructed from triangles. There are five boxes: 2 rectangular, 1 triangular, and 1 large and 1 small hexagonal. Each box contains triangles of different sizes, shapes, and colours. With the exception of Rectangular Box 2, black guidelines are painted in different positions on the triangles to help the child to construct other figures. This should be encouraged as an exploratory work that will provide a foundation for later concepts of equivalency, similarity, and congruency.

Rectangular Box 1

- three pairs of large right angled scalene triangles in three different colours
- a pair of red triangles that form an isosceles trapezoid bisected diagonally
- a pair of equilateral yellow triangles
- two different coloured pairs of large right angled isosceles triangles

Rectangular Box 2

- Two equilateral triangles
- Two right angled isosceles triangles
- Two right angles scalene triangles
- A trapezoid divided diagonally to form an obtuse angled scalene triangle and an acute angled scalene triangle

All of the figures are blue and there are no longer any guidelines.

Triangular Box

· One gray equilateral triangle, the shape and size of the box

· One green equilateral triangle bisected from the midpoint of the base to the apex

· One yellow equilateral triangle divided into three equal pieces by lines drawn from each angle to the centre of the triangle (along angle bisectors).

Large Hexagonal Box

- One large yellow hexagon, the same size as the box, cut by joining the vertices of every other angle to form one large equilateral triangle and three obtuse angled isosceles triangles. There are black guidelines along the perimeter of the equilateral triangle and the bases of the smaller triangles.
- A second large equilateral triangle divided along its intersecting angle bisectors to form three obtuse angled isosceles triangles. There are black guidelines along the two equal sides of each triangle.
- Two equal red obtuse angled isosceles triangles the same size as the yellow ones, but with their guidelines along the base opposite the obtuse angle.
- Two equal gray obtuse angled isosceles triangles the same size as the others with black lines along one of the equal sides.

Small Hexagonal Box

- 6 gray equilateral triangles with guidelines along two sides to form a hexagon, the same size as the box
- 3 green equilateral triangles (same size as above) which are put together to form an equilateral trapezoid. One triangle has black guidelines along two sides, the other two have a single guideline.
- A large yellow triangle which inscribes within the box, formed by joining every other vertex of the hexagon
- 2 additional red equilateral triangles (same size) each with a single black guideline
- 6 red obtuse angled isosceles triangles with guidelines along the base opposite the obtuse angle

Presentation:

Rectangular Box 1

The teacher opens the box and says to the child, "We call these the constructive triangles. Why? Because we can construct other figures with them."

She asks the child to remove them from the box and group them by similar shapes. "Now can we group each set by colour also?"

When the child has done so, beginning with the equilateral triangles, the teacher traces the black guidelines with her fingers and moves them together until they touch. "Now what do we call this?"

If the child does not know the name, the teacher should give it.

She might take the isosceles triangles next, and ask the child to do the same. There are two sets of isosceles triangles, one forms a square and the other forms a parallelogram.

"Let's try putting the scalene triangles together." The result is a rectangle, and a parallelogram."

"Now our last two red ones. Can you put those together on the guideline? What is the figure you have made? A trapezoid."

Review with the child the figures that have been made with the different kinds of triangles. With the younger children the attention is on the black line and it is a sensorial experience of shape, and vocabulary review of terms that have already been learned in the geometric cabinet.

The children can trace these new shapes and label them to put in their own geometry book.

Rectangular Box 2

Here the child can see how many shapes can be made using one shape. With this material we have no guidelines to tell us what we must do. The child takes the equilateral triangles and discovers that there is only one shape to be made, no matter how he or she joins them. The child takes the other triangles in turn and discovers how many different shapes can be made with each pair. Here the teacher can check the child's work orally to be sure that the child knows the names of the figures and that the child can write and spell them correctly, since this is a sensitive period for reading and handwriting.

Use the same procedure with each of the successive constructive triangle boxes, allowing plenty of time for experimentation, practice and mastery before the child is invited to go on to the next box

One of the main points and of Montessori is allowing the child to choose and work with materials for a long length of time without interruption. This is so that the child can internalize what he senses. The materials in this section are usually introduced to children when they are 4 ½ and above, when they are ready. The first presentation should always be a sensorial one. Just the senses, no words. As the child develops an understanding for the material you can add on to the presentations until you have completely worked through all the concepts with the child.

So a child needs repetition in order for the lessons from these materials to really sink in.

Activity Sheet.

Search YouTube.com for Presentation of as many of the Montessori Materials above and watch them. This will give you an idea of how to present the materials and help you to figure out why they are useful in educating a child and how these materials help to stimulate the senses.

(We will cover the presentations in detail during your Apparatus Training)