Dr Margaret Lowenfeld Trust

Child Education Article

We have recently been involved in a research project, investigating the mathematics that children can learn through their experiences with Poleidoblocs.

For those not familiar with the product, Poleidoblocs is a set of 54 coloured blocks, cut into six basic shapes: cubes, cuboids, cylinders, triangular prisms, cones and pyramids. All of the blocks relate to each other in a large number of ways, including area, volume, number, and progression.

The blocks were originally introduced by Dr Margaret Lowenfeld over 50 years ago, who believed that, 'through imaginative handling, tactile and visual experimentation these blocks create for children a basis for mathematical thinking, and provide at all stages, opportunity for children to devise concrete expressions of symbolic statements.

Our research project, has been evaluating the relevance of such statements, alongside the mathematical effectiveness of Poleidoblocs, in today's schools for today's children. We have been particularly interested in identifying their effectiveness in teaching aspects of the National Curriculum and considering outcomes of activities with the under fives in relation to the Desirable Outcomes for Nursery Education.

We are now keen to share some of our findings, in the hope that they can help provide teachers with stimulating, practical activities to use Poleidoblocs effectively and to their full potential.

In an introductory teachers guide, Lowenfeld describes the many properties which Poleidoblocs can offer teachers, both in free play and more structured learning activities. Her experiences, along with those of many researchers since, have shown that through the manipulation of solid shapes, such as Poleidoblocs, children are

involved in many operations which are common to all kinds of mathematical activity, including matching, sorting, ordering, symmetry, combining, partitioning and fundamental types of movement.

As Lowenfeld recommended children have a period of free play with the blocks, providing tactile experiences and opportunities for exploration, in recognition of the fundamental ways in which children learn, this is where our research project began.

At the start of the project we observed children of different ages and abilities playing with the Poleidoblocs, without any formal instruction. These children ranged from 2-7 years old.

During this general observation period we became aware of how much mathematical knowledge can be gained, quite spontaneously, and identified a number of patterns in the ways in which children interact with the bricks.

The youngest child we observed was 21 months old, who carried out random stacking of the blocks in single tower constructions. At this level children appear to build one brick on top of another, continuing until the structure collapses. They do not line up the edges and comers of the blocks, which would provide better stability, and repeatedly explore balancing on top of the cone, triangular prism and pyramid shapes showing little understanding of the need for a level base.

At the next level there are significant refinements in the ways in which children use the bricks. They begin to deliberately select bricks which are the same. The child will select a brick and will then match and collect all of those the same. At this next stage the child will also have more success in the height of their towers as they begin to line up the edges and corners, so each brick is balanced more carefully.

It became clear during these early interactions with Poleidoblocs that the children are constantly learning about and experiencing the geometric properties of each shape. They appear to be constantly reflecting upon the activities they are

carrying out and refining their approaches.

The older children built far more complex structures, as would be expected, and while considerable variation was evident in the final structures of children within the same age ranges, there were still general patterns evident in the way they constructed.

Such patterns included the deliberate selection of certain shapes, using the larger, more stable shapes for the base of their structures; using the pointed cones and pyramids for decoration at the end; matching for sameness, incorporating parallel and identical portions; exploring ideas of symmetry; building outwards as well as upwards; representation and becoming more adept at sorting by colour and shape.

These older children appear to have a bank of understanding - some appreciation of what is likely to happen in given situations, an appreciation of geometrical features and a confidence to explore these further.

Of the many observations made, four areas were chosen in which significant and measurable development appeared to take place:

1. Sorting and classification
2. Symmetry
3. Measures and equivalence
4. Mathematical vocabulary

A series of assessment tasks were devised which we then used with different sample groups from Reception and Year 1 children - the results of which will be published later this year.

These assessment tasks along with the free play sessions have enabled us to observe the mathematical understanding that children display in aspects such as sorting and matching, symmetry, balance and sequencing, in addition to their understanding of the features of 3-D shapes, including pointed, curved and sloping

faces.

Through analysing the children's spontaneous responses it is possible to see a progression in the skills and understanding demonstrated through individual constructions, and to devise a whole range of mathematical activities through which these can be developed and enhanced.

When used as a teaching tool, Poleidoblocs make it possible to adjust the rate of work to the comprehension of the individual child, and to assess the extent to which real understanding of a concept or procedure has been achieved.

Teaching Through the Play

Appreciating that young children exercise their senses continually and have a natural curiosity for the world around them, their desire to explore, touch and manipulate should be met.

Teachers can observe the ways in which the children interact with the bricks and the type of structures the children produce in their free play sessions with them. As they manipulate the bricks, children will demonstrate their awareness of size, shape, balance and symmetry.

When they have finished their work the children may like to tell you about the structures they have made, providing opportunities for discussion, through which appropriate language and concepts can be developed.

Free play sessions can be used more formally as a means of assessment and planning. If you can be conscious of the typical stages that any child moves through as they learn about 3-D shapes, then you can become sensitive to the stage that a child has reached. Using this information it is possible to plan what you will teach next.

“Observe the children during free play sessions, during which you can assess each child’s level of understanding and development.”

This information can then be used to plan and support the child’s learning, at a level best matched to their individual needs.

Finally, you can extend and consolidate the child’s knowledge and understanding. Use aspects of their structures, in which they have displayed instinctive knowledge of a mathematical concept, as a bridge to helping them extend their learning further.

Free play sessions are also a natural way to begin introducing new mathematical vocabulary. Teachers are more successful in the area of mathematical vocabulary, when linking it to current knowledge, in order to move the child forward. Words such as sloping, curved and symmetrical will have greater meaning within the contexts of the children’s constructions.

Direct play

After the initial period of free play, the children can be asked to use the blocks in a more structured way, following a set of suggestions or guidelines. These can be used to encourage children to think more carefully about the pieces they are using and to critically view their structures against the criteria set. For example:

Suggest a model you would like the children to build, such as a castle, house, playground or robot. Each child‘s structure is likely to be different, offering ideal opportunities to discuss how each has been made and how they differ. These ideas can be easily linked to current classroom topics.

Build a tower with a selection of Poleidoblocs which the children can copy. Begin with simple structures and make them more elaborate as the children’s confidence grows. Children may like to build models of their own and have a partner copy it. Encourage the children to look carefully at each block and how it is

positioned. so they can make an identical copy. Are there any patterns of shape or colour?

Present each child or group of children with an object such as a toy, table or large box. Ask them to build a tower as tall, or as wide, as the object they have been given. If they achieve this, you could then ask them to repeat the exercise using the least/most number of blocks.

Build a tower for the children. Provide them with a preselected set of blocks with which to build a tower matching the height of yours. This will involve them matching heights of different blocks - «anatomy: : blue cylinder/red cuboid/blue cubes, etc.

Include a triangular prism, on its square base. Then two out of that must be turned up on its end, in order to be put upon, and to match the height? We found that using the triangular prism in any orientation other than as a shape caused great entertainment for reception and year 1 children.

Sorting and Classification

The blocks offer ideal opportunities for children to develop their powers of observation. Encourage them to sort and classify them into groups for various children such as:

- 4 different coloured shapes
- Different sized shapes
- Shapes with square/round/triangular faces/shapes with 2/3/4/5/6 faces
- Shapes with straight/armed edges

Such groups can be used to introduce mathematical vocabulary such as shape names and features. Why are these the same? How are they different? Can they be sorted in another way? Learning to characterise 3-D shapes such as cylinders, outboards, etc. In true way, an important part of the National Curriculum.

Once sets have been sorted, the children can begin to represent them fictionally.

Venn and Carroll Diagrams

The Poleidoblocs lend themselves to being sorted onto diagrams such Venn and Carroll diagrams.

When introducing Carroll diagrams to the children, it can help understanding if they first transfer shapes from a Venn diagram directly across to a Carroll diagram, where they are the same, The main difference of this sorting exercise is that children are sorting for both the positive and negative aspects of the sort.

Try out these sorts:

- 1 blue shapes/not blue shapes
- 1 green shapes/not green shapes and round face/not round face
- 6 faces/not 6 faces and blue shapes/not blue shapes

Measures and Equivariance

Fee/flags

Children love the magic surrounding a feely bag game...they cannot resist! Activities can be developed for the children in many ways:

Place several shapes in the bag. Hold up a shape and ask the child to find the matching shape hidden in the bag.

Extend the activity. Instead of giving a visual clue, ask the child to find a shape that you describe to them. e.g. a cube/a curved shape/the smallest shape/a

pointed shape.

Place a selection of blocks on the table in front of the child. Put one in the bag. Ask the child to feel the shape in the bag and point to its matching shape on the table.

Ask the children to match 2 shapes to 1. i.e. 2 blue cubes to match the red cuboid/2 blue cuboids to match 1 green cuboid.

Let the children test each other with the feely bag and see what ideas they come up with themselves.

These activities also provide a fun way to introduce particular vocabulary for describing and naming the shapes.

Equivariance

In their free play sessions, children often instinctively compare shapes in their structures.

For example, if they have used all the red cuboids they will often substitute them with two blue cubes or a blue cylinder. These provide the same height and width as the red cuboid.

Poleidoblocs provide children with invaluable experiences in understanding equivalence, which will stand them in good stead when they are later introduced to place value, fractions, coins and percentages.

You can provide simple games and activities involving fair swaps to develop their understanding:

Starting with the large red cube, work with the children to investigate other ways of making a cube the same size. You can use 8 x blue cubes, 4 x blue cuboids, 4 x triangular prisms, 4 x red cuboids, and any combinations of these.

Draw a square on card, the same size as one square face of the large red cube. Ask the children to use their 3-D shapes to cover the shape in as many different ways as possible. is. 1 x blue cuboid, 4 x blue cubes, 4 x triangular prisms, 4 x red cuboid, etc.

Area and Volume

Area can be introduced by providing the children with experiences in covering space. They can begin by covering 2-d spaces with the Poleidoblocs.

Begin with simple areas for the children to cover, representing different 2-D faces of the Poleidoblocs set, circles, triangles, squares, etc. Make this more fun by composing pictures of clown faces, robots, animal forms, etc., using the 2-D shapes, for the children to cover.

Draw around selected shapes on squared paper. Count the squares. Use this to compare the area inside each shape. Can the children predict which will have the larger/smaller area?

Symmetry and Balance

Building with Poleidoblocs allows pupils to explore 3-D symmetry. Many of their structures during free play will show signs of symmetry, which is likely to occur spontaneously. Recognise when children are displaying symmetry in their models and use it as an opportunity to introduce planes of symmetry.

Build half a structure. Ask the child to construct the other half to match it. Use scales to find out which shapes balance each other. e.g. 2 blue cubes balance 1 red cuboid, or 1 triangular prism, or 2 blue cuboids.

Mathematical Vocabulary

Poleidoblocs offer ideal opportunities for developing the mathematical vocabulary surrounding shapes and their properties. The best way to begin this development is to work with a small group of children and give them all a shape to describe. You may be surprised at the number of ways they describe the shape, often using familiar objects with which they associate it.

Although much of the language they use will not be mathematically correct, you can gradually introduce new words, linking them to current knowledge and representation in order to move the children forward.

Give each child in the group a blue cylinder and a triangular prism. Ask them to tell you everything about the shapes.

Put a pile of selected shapes in front of the children. Ask questions such as, Which shape looks like a witch's hat? Why? (the cone. Its round and pointed.) Which shape looks like a wheel?

Hide a shape behind your back, or in a bag, and ask the child to question you about its properties, such as "How many faces has it got?" When they are confident at playing the game, encourage the children to play in pairs, or small groups, without an adult.

Fun Games

Provide a narrow, winding over cut from shiny blue paper. Place it on a flat surface and ask a child or group of children to construct a bridge to go over the river. You can make the river narrower or wider to accommodate the different ability levels of the children.

Give each child 1 yellow cuboid and 1 green cuboid. Put flat on the ground and tell the child that this is their train. Provide a selection of different shaped blocks, which is going to be the luggage for the train. Ask the children to put as much luggage on the train as they can - no bags must overhang the width of the train and none can be any higher than the height of the red cube (or they'll be knocked off when the train goes under the tunnel!)

Which child can fit the most bags on their train? Why?

Encourage the children to look at the best ways to stack the bags, in a limited space.

In pairs, ask the children to sit back-to-back. Each child is given a set of 8 different bricks. Both have an identical set. One child builds a simple structure using their 8 bricks. They then give instructions about the bricks they have used and where they have put them, for the second child to follow. This develops communication skills, mathematical vocabulary, etc.

As children become more adept at this game, increase the number of bricks from which they must choose, and include bricks which are similar.

Throughout this work with Poleidoblocs the children will be working towards the following National Curriculum guidelines:

Desirable Outcomes - Mathematics

Children use mathematical language such as, circle, In front of bigger than and me, to describe shape, position, size and quantity. They recognise and create patterns may begin to use their developing mathematical understanding to solve

practical problems.

They compare, sort, match, order, sequence and count:

The National Curriculum

Key Stage 1 Programme of study: Shape, Space and Measures

- Describing and discussing shapes and patterns that can be visualised
- Making common 3-D shapes and models; beginning to classify shapes according to mathematical criteria
- Recognising and using some geometrical features of shapes. Including verticals, edges and surfaces
- Comparing objects using appropriate language, by direct comparison using non-standard measures

Key message:

- Programmes of Study: Using and Applying Mathematics
- Using and applying mathematics in practical tasks, In real life problems and within mathematics itself

In explaining their thing to support the development of their reasoning in selecting and using mathematical equipment and materials in understanding the language of shapes and comparatives.

In discussing their work. responding to and asking mathematical questions and recognising simple patterns and relationships.

No need for sufficient trading volume on a day-by-day basis.