Poleidoblocs in Infants Schools

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Introduction

Poleidoblocs are a set of objects designed to call out certain reactions and responses in children. They are cut in shapes like those a child sees all around him and with built-in mathematical relations. The purpose of Poleidoblocs in the Infant School is to put children into something like the situation of primitive mathematicians in that through handling and observing them, through using imagination and constructive ability in working with them, children have the opportunity to discover for themselves mathematical properties both simple and more profound.

There are two sets of Poleidoblocs. Poleidoblocs F packed in a red box containing 54 blocks painted in four colours, and Poleidoblocs A in a yellow box with 140 blocks in plain wood. The cutting of the blocks of Poleidoblocs is so accurate that the pieces fit closely together, and any larger block can be composed in several different ways of smaller blocks. Poleidoblocs G and A are interrelated, and all the blocks of Poleidoblocs G can be built with blocks of Poleidoblocs A.

For use with Poleidoblocs A are a number of red metal pieces 1-inch square in size, which act as measuring tools and can also be used as tools for counting. For older children a dozen tetrahedra (six regular and six irregular) related to the 1½ inch cube are added. It is possible that with increasing experience other shapes, for example equilateral triangle, may be added to the collection.

Poleidoblocs are a different and complementary mathematical tool from those designed to assist mainly in the teaching of number notation and operations. An examination of current structural mathematical apparatus including a description of Poleidoblocs with be found in:

Educational Research, Vol. III Nos. 2 & 3, Miming Devices
Educational Research Vol. IV No. 3, Structural Systems

by J.D. Williams. These papers are a review of eight systems of mathematical teaching, including Poleidoblocs (pp. 184-186).

Concerning Poleidoblocs Mrs Williams writes "The following five points give a brief guide to other features of this system:

(i) Design of the materials. The materials are constructed so that fundamental mathematical relationships can be represented by them as simply as possible. They are meant to be of use in presenting both elementary and advanced mathematical concepts. mule it is recognised that variety of experience is needed before abstraction can take place, care has been taken not to present the child with too great a variety of material lest this should mask the underlying unifying principles.

(ii) The child's manner of learning. The material provides opportunity for the child to discover for himself by manipulation, using the tactile and kinaesthetic as well as the visual sense, the basic principles of mathematics. This discovery comes about first through spontaneous play, and then through activity guided by the teacher' s suggestions. The principles are first grasped in a concrete form, and only later symbolised.

(iii) The aesthetic pleasure of mathematics. The aesthetic pleasure enjoyed by the adult mathematicians is paralleled by the pleasure experienced by the child in building concrete structures that reflect mathematical relations. This kind of pleasure motivates interest in mathematics.

(iv) The diagnostic use of the material differences between child and child, and between child and teacher, in manner both of conceptualisation and learning, constitute a serious obstacle to class teaching. From his pupil’s free construction with the material, the teacher is able to gain a direct insight into their styles and stages of thought.

(v) Testing with the material. It is possible to use the material for devising tests of the degree. to which true understanding of mathematical concepts has been achieved.

Poleidoblocs are made of wood that is pleasant to handle, presented, in Poleidoblocs G, in colours that are attractive and also in their distribution provide clues to the interrelations of the blocks. In these characteristics they satisfy a child’s inherent tendency to savour an experience with several senses at the same time.

They give a child the opportunity sot test himself out, to compare what he makes with them with what his fellows do, and when he succeeds, to savour the satisfaction provided by achievement.

It is this satisfaction and the pleasure and excitement that achievement of a desired representation or of a good pattern gives the child who makes it, that generates zest for a closer contact and more intimate understanding of the materials he has been using. This zest can well 'be the key which unlocks the door of comprehension of mathematical law.

There are children who grow slowly and need a long period of playing with the materials of study: there are children eager to learn, who scorn: 'play' and want to work hard at acquiring new knowledge. Both can find what they need in work with Poleidoblocs.

We are yet at an early stage in our knowledge of the thinking potentialities of young. children. We do not yet know what elements of the processes of mathematical understanding can arise spontaneously within them, or what kinds of mathematical work they are able to conceive of and to carry out by themselves. We do not know much about the interaction between creative ideas, executive ability and cognitive comprehension.

Watching children work with Poleidoblocs brings new information on all these points.

It is worthwhile to compare this process with the very different discipline of the 'sum'. Here what a child does is subjected to the test of finality. The results. of his work are ’correct' or ‘incorrect' and there is no appeal.

In a young child’s interior world, on the other hand, nothing is absolute to his imagination, everything and anything is possible, and modifications are made when they are thought necessary. In the world of 'sum' no modification is possible and there is no use pretending'; unless a child can master the techniques by which the right answer is arrived. at he comes into confusion, loses contact with the class and satisfaction in himself. This can be devastating to his morale.

Poleidoblocs, therefore, are intended to give a child an entry to a world where objects have resemblances and relations which can be explored and experimented with; which can be absolutely relied upon and with which he can now, and gain produce constructions of real objects or of forms, which are a delight to contemplate and to study.

Psychologically, also, the children working with Poleidoblocs will have gained two essential experiences which will stand them in good stead for the whole of their school life. They will have found that they themselves, acting from their own initiative, can do things with ‘school objects’ that win the teachers interest. They will have found that their' own intimacy with these blocks deepens as they use them, and new aspects of them appear. They have learned to look at objects closely and to find that in so doing the object has new things to 'tell' them about itself.

Work with Poleidoblocs can also give a teacher new and precise information concerning the individual characteristics of the children they teach and the stage of mathematical understanding each child has reached. They also allow a teacher to observe the rate of growth in understanding in different children and to test in a single child or children the thoroughness of his grasp of a given principle.

It is one of the assets of Poleidoblocs that they lend themselves to the hand of the adapt-able teacher who can incorporate them into the syllabus at different points and at levels where they are thought to be appropriate. They see of patterns of relationships possible in a form which appeals to children on different ages and at different stages of development.

At the moment it is the use of Poleidoblocs in the Primary school with which we are concerned.

The Material

Poleidoblocs consist of two boxes of blocks; twelve tetrahedra and a set of red metal 1" squares.

Poleidoblocs G

This is a set of 54 blocks grouped around a 2" cube and composed as follows: -

1. A series of related cubes.
   a. Four 2" cubes coloured red.
   b. Four 1½" cubes coloured green.
   c. Eight 1" cubes coloured blue.

2. A series of related prisms (slats).
   a. Four 6" x 2" x 1½" rectangular prisms coloured yellow.
   b. Four 4" x 2" x ½" rectangular prisms coloured green.
   c. Four 2" x 2" x ½"rectangular prisms coloured blue.

3. The 2" cube divided differently into 4 quarters.
   a. By two cuts at right angles to each other passing through the centre of each edge making four cuboids (pillars) 1" x 1" x 2", coloured red.
   b. By two cuts diagonally across the cube producing four triangular prisms, coloured red.

   N.B: - 2 c. are also quarters of the 2" cube made by three cuts parallel to the edge of the cube.

4. A series of related cylinders.
   a. Four cylinders 2" in diam., ½" in height coloured red.
   b. Four cylinders 1 ½" in diam., 1” in height coloured green.
   c. Four cylinders 1 ½" in diam., 2” in height coloured blue.

5. Three cones, bases 1" in diam. 2" in height coloured yellow.

When required, a set of twelve tetrahedra can be supplied. Six regular tetrahedra and six irregular tetrahedra, related to the green cube.

It will be observed that these blocks interrelate in many ways such as:-

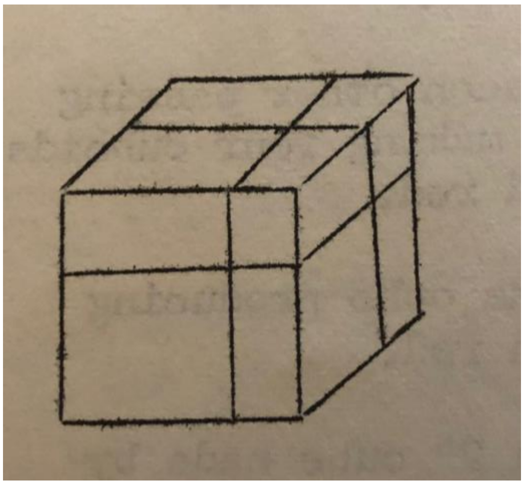
A. Series. The red, green and blue cubes.

i. Size. As cubes of 2", 1½" and 1".

The mathematical volume relations between these are complex, but with experience of handling the blocks children can see that they are same shape and form an ascending or descending series in size.

If it be desired to use the blocks to build the next item of the series viz. a cube of 3", this can be carried out as follows:-

Used for this composition:



1 red 2" cube

3 red 2" pillars
4 blue square prisms
5 blue cubes

But can be made in other ways

ii. **Area.** The surfaces of the yellow, green and blue prisms. If the green rectangular prism be placed on the yellow and the blue square prism on the green a series of areas appear once, twice or three times that of the blue square prism.

The upper surfaces of the red, green and blue cylinders when placed on top of each other also form a related series.

iii. **Height** red cylinders placed one on top of the other are equal in height to that of one green cylinder; two green cylinders placed one on top of the other are equal in height to one blue cylinder.

B. **Composition and Decomposition**

i. Four red pillars together compose one red cube.
Four red triangular prisms together compose one red cube.
Four blue Prisms together compose one red cube.

ii. Conversely the volume of 2 cubic inches = 4 red pillars, 4 red triangular prisms, 4 blue prisms.

iii. Two blue cubes together the volume of one red pillar.

iv. Four blue cubes together = the volume of two blue prisms.

v. Four blue cubes and two blue prisms or eight blue cubes= the volume of one red cube.

C. **Equivalences - Volume**

i. The Whole block of four yellow prisms are equivalent in volume to three red cubes.

ii. The Whole block of four green prisms are equivalent in volume to two red cubes.

(As already pointed out the four blue prisms are equivalent in volume to one red cube).

D. **Equivalences — Area**

i. The area of the surface of two blue prisms is equivalent to the area of the surface of one green prism.

ii. The area of the surface of one blue and one green prism are equivalent to the area of the surface of one yellow prism.

E. **Equalities**

i. The area of the base of the cone is equal to that of the top of the blue cylinder.

ii. The area of the base of the pyramid is equal to any of the faces of the blue cube or the top of the red pillar.

iii. The blue cylinders, yellow cones and pyramids, red pillars and red triangular prisms arse all equal in height.

All these are visible relations.

By logical deduction however:-

i. The volume of the red pillar = that of the red triangular prism = that of the blue prism since each ¼ of the red cube.

ii. The volume of two red triangular prisms, however disposed = that of the two blue prisms = that of two red pillars because each pair is ½ the red cube.

iii. The volume of three red triangular prisms = that of three red pillars = that of three blue prisms because each group is ¾ of the red cube.

Poleidoblocs A

A. 1. Four prisms 5" x 1" x 1"
2. Four prisms 4" x 1" x 1"
3. Four prisms 3" x 1" x 1"

4. Four prisms 2" x 1" x 1"
5. Four prisms 1" x 1" x 1" (cubes)

B. 1. Four prisms 5" x 2" x 1/2"
2. Four prisms 5" x 1" x 1/2"
3. Four prisms 4" x 1" x 1/2"
4. Four prisms 3" x 1" x 1/2"
5. Four prisms 1" x 1" x 1/2"

C. 1. Four prisms 5" x 1/2" x 1/2"
2. Four prisms 4" x 1/2" x 1/2"
3. Four prisms 3" x 1/2" x 1/2"
4. Four prisms 2" x 1/2" x 1/2"
5. Four prisms 1" x 1/2" x 1/2"

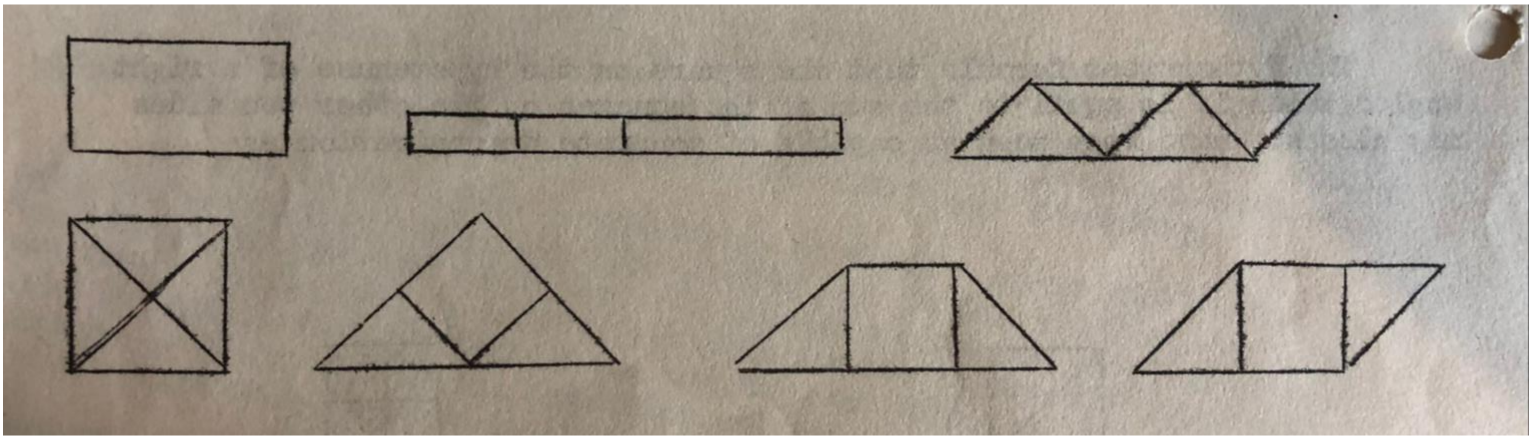
D. 24 cubes 1/2" x 1/2" x 1/2"

E. Eight right angled triangular prisms 2 1/2" on the short side
Eight right angled triangular prisms 2" on the short side
Eight right angled triangular prisms 1 1/2" on the short side
Twenty right angled triangular prisms 1" on the short side

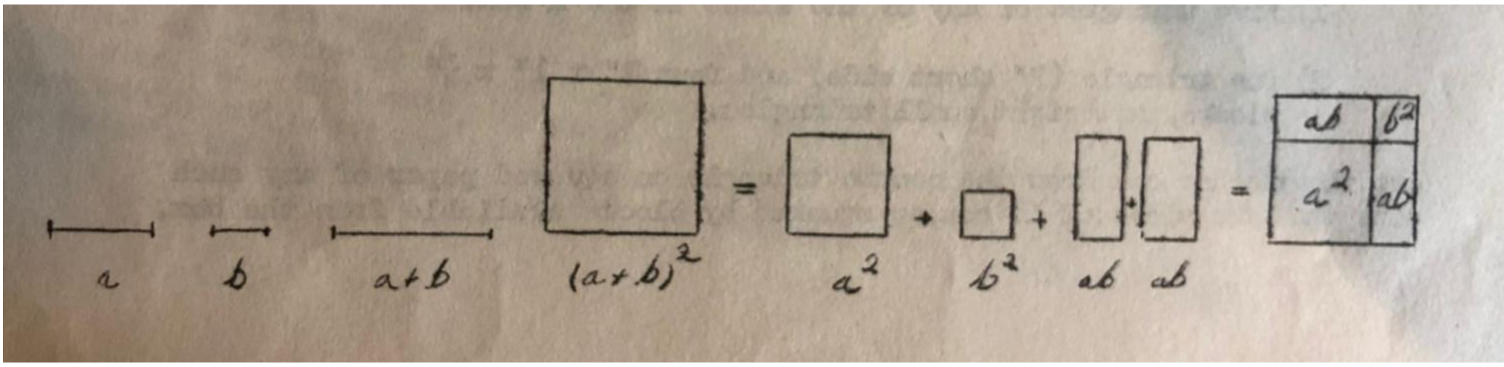
All triangles 1/2" in height

The interrelations of these blocks are too numerous and manifold to be itemised.

A characteristic of Poleidoblocs is that they bring' to light interrelations with which teachers may not themselves be familiar, for example the relation between area and shape. A teacher be- theoretically fully aware that there is no necessary connection between the 17970 and yet be surprised to ma that two square inches can appear in the following compact shapes as well as in a number of fantastic or 'open’ arrangements.



Similarly, while it will be well known that $(a + b)^2 = a^2 + 2ab + b^2$ it may not be realised that this can be stated in concrete form as



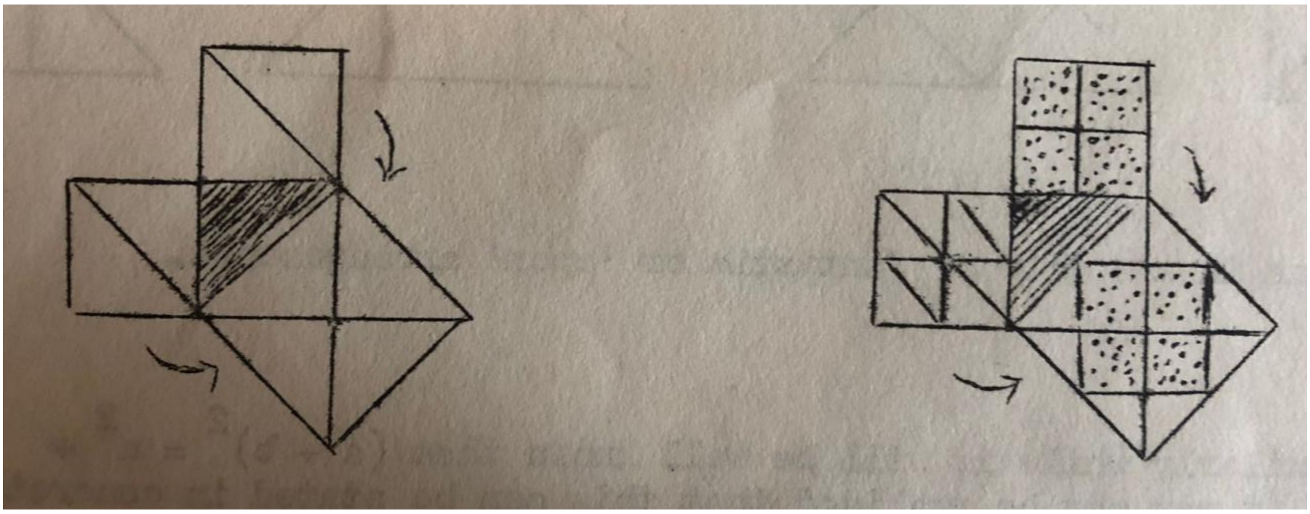
This can be presented by, for example:—

G blocks: 2 blue squares placed on top of each other,
2 red 2" x 1" x 1" pillars alongside, and
1 small blue cube.

A block: 1) One 1" x 1" x 1/2", two 1" x 1/2" x 1/2" and one 1/2" x 1/2" x 1/2" blocks.

2) Two triangles forming the 2" square, two 2" x 1" x 1/2" and one 1" x 1" x 1/2" blocks.

The Pythagorean formula that the square on the hypotenuse of a right-angled triangle is equal to the sum of the square-s on the other two sides may also not have been seen as capable of concrete demonstration as



This can be presented by, for example:—

1) Five triangles of any of the sizes in the A box.

2) One triangle (2" short side) and four 1" x 1" x 1/2" blocks, and eight small triangles.

or, the teacher can draw the centre triangle on squared paper of any such size that the sides of it can be squared by blocks available from the box.

THE USE OF POLEIDOBLOCS

The handling of Poleidoblocs falls into two sections. The first is the use of children of the blocks in a free manner within a set framework (corresponding to periods of 'free play' in' other approaches but differing from it in certain particulars). This is termed Free Construction'. The other section is that of 'Directed Activities'.

FREE CONSTRUCTION

Presentation.

The manner of presentation of the blocks to children is of central importance. At the age of 5/6 a child's attention is fluid and wandering and works simultaneously at several levels. He has only a limited ability to focus on a given task by himself, or to eliminate disturbing impulses which arise during the carrying out of any work he is attempting.

Our goal is to create circumstances in which a child will be free to make his own acquaintance with the material and through handling and using the blocks, to find out about them for himself at his own pace and in his own way. We aim also to make it possible for him to use his creativity and his manipulative ability at one and the same time, so that interest in what he is doing focuses his attention and the three together combine to make spontaneous pleasure in what he has made.

In this way he becomes free from an external judgement of 'right' or 'wrong' and develops his own ability to see whether what he has done is or is not the 'right' answer to a problem he has set himself, or which has arisen out of previous work he has done.

The work a child does in school is on the whole of a different kind from the major part of his interior personal life and experiences before he goes to school, where focus. is more diffuse, the senses more active, and personal emotions more directly involved.

It is this gap that needs to be bridged in a natural Way, so that the kind of interior mental activity which has occupied him in early childhood can become the carrier of the new developing cognitive ability and not been one cut off from it. This early childhood way of thinking is charged with immense energy and power and if properly released, can become the driving force towards the learning that school and teacher aim to contribute to him.

It is this bridge between the early and the later types of mental activity that Poleidoblocs are able to supply.

In order that they should succeed in exercising this function it is essential that both teacher and children should appreciate the real nature of the Poleidoblocs material.

A. **Introduction of Poleidoblocs**

The boxes are taken in turn, beginning with Poleidoblocs G; the lid drawn off and the box tilted so that the contents can be seen. Now Is the time to tell the children a story about the contents. Children love preciousness, something that is special, that calls their attention into focus. We have all met a child’s love for a small stone or pebble. He may be attracted by its colour, its shape or the smooth feel when touching it. The adult does not know why, but to the child it is precious, and many children guard their treasures fiercely.

It is the feeling of ‘specialness’ which should be created for the children in relation to Poleidoblocs. These are not just ordinary building bricks, they are special, they come from a long distance (the wood comes from Borneo and the blocks are cut in a small special factory in the centre of Denmark). The wood travels over the sea to Denmark and then over the sea again to us.

Having introduced the blocks they should be taken out one by one in irregular order, only one of a kind and the children allowed to handle them, while the teacher explains that they are rather like a family, as some have common qualities such as colour or shape and some not and there are interesting things to be found out about them. This ‘finding out’ is what work with Poleidoblocs is going to do.

At some point here, the teacher removes all the blocks from the box to show the diagram on the base and points out that the presence of this diagram makes it sure that all the blocks return safely to the box again.

The teacher places them all back in the box, to show they go neatly home and shows the full box so that the children see the arrangement.

B. **Using the Blocks**

From this point on the teacher can arrange the work in two ways, either letting a small group, up to 4 children at a time, work together, or arranging for each child to work individually.

a) Group Work. In this case the contents of two Poleidoblocs G boxes should be heaped on a table and the box taken away.

b) Individual Work. In this arrangement the contents of “one Poleidoblocs G box should be heaped on a table, arranged so that the Child sits with his back to the class and the box taken away.

C. **Handling of work in Free Construction**

As soon as the Child or children are settled at their table with their heap of blocks before them, the teacher join's them and uses a standard phrase of instruction 'Make what you like with these blocks and tell me when you have finished’. The child or children should then be left to get along by themselves. The teacher’s work in regard to the children using Poleidoblocs is then limited to see that other children do not interfere with those using the blocks.

The delicate and difficult aspect of the teacher's work comes when the child says he has finished. ‘That children do with Poleidoblocs shows an extraordinary variety; so also does what children say about what they do. It is not easy to discover What he has done means to the child who does it and here many snags await the inexperienced teacher. If one of the other children confidently name his or her construction, the shy child nearby may feel that a construction should have a name and may give theirs one. While in fact 'a name' is irrelevant to what the child has made. On the other hand, one child may have been creating a story and acting it out with his blocks and be shy of telling it to his teacher. Another may have failed altogether (although this is rare) to achieve anything and be feeling miserable about it. Again another, having attempted to make a construction and haying found it continually falling down, discovers that, for instance, the big red blocks, put together, make a good train and wants to play with this on the floor, which should not be accepted. Only the teacher’s practice, skill and intuition can be a guide to the handling of these situations.

What is essential is that the teacher discovers the meaning each child's construction has for him. A wise general line is for her to say, ‘Oh Tommy that leeks interesting, would you like to tell me about it!” It is important that the child should feel the teacher is interested in what he has done and has enjoyed it with him.

D. **General Characteristics**

Although children vary very much in their relation to the blocks certain types of reaction tend to appear in each group of children and need to be handled differently.

The essence of the Free Construction period is to enable children to get to know both the blocks themselves and their own reactions to them. Many children tend to think that once a single construction is made that completes all they may do or are expected to do with the blocks. If the making of the construction has taken up all their time this is a satisfactory response for that day. If on the other hand, as occurs pretty frequently in the impulsive type of child, a construction is completed very quickly, and the child seems at a standstill, this is the moment for the teacher having talked with him about it, to suggest that he may like to take it to pieces and see what else he can do. Some children make a number of small constructions, either one after another or several at the same time. The teacher then can point out where these differ and where they resemble one another, and possibly keeps this fact in mind for the next occasion to see if the same occurs.

Other children set out to do something that is really beyond their powers, try several times to accomplish that they have in mud and fail, either the construction falls apart or they cannot see how to proceed. The teacher can then, perhaps, give a hint as to how it could be made to hold together and so start the child off again.

Another type of child makes a, for him, complicated structure and then studies it for some time, finally finding a way he wants to alter it, or seeing a new idea that the existing construction can be made into.

Other children, and these are the ones who, later are going to need most time and most assistance, find it impossible to do anything at all, or make some vague forms with which they are obviously dissatisfied. Here it is the teacher's skill which will decide whether this arises from lack of initiative, or from a slow or poor imaginative power. Such children need more time than the others to get accustomed to new material and benefit from working in a group where they can watch the other children and learn from them.

An interesting class of children is formed by those who eagerly wait their turn with Poleidoblocs but when confronted with the blocks, find they cannot get started with them or ‘cannot think of anything to do'. This is a situation which commonly occurs in all creative work and should be accepted as such. Here the teacher can suggest just looking at and ‘playing" with the individual blocks and seeing what they will do.

The speed with which different children ‘find their way‘ among the blocks varies greatly and enough practice should be given to each child to enable him to reach this point.

Some children from the beginning become interested in the relations between the blocks. For example, in the entry class one teacher notes:-

> “David observed that tab red cubes made one green slat and Michael then without hesitation placed three red cubes on to the yellow slat.”

When a group of children work together each child build individually, or some children will rival each other in the same type of construction, as for example

> “Rodney started making tower and they all followed and had a wonderful time seeing who could make the highest.”

Sometimes the children will combine together to make a corporate effort. For example:

> ‘After several attempts the finished became a combined group effort. It was a yard containing sheds, a house, a well, flower beds and walled gardens.'

At another time the teacher’s intervention can be determinative, as in one instance a teacher report:-

> ‘None of the children in the group were keen; the three boys because it was “play” and they wanted to “work” and the two girls because they are never interested in building with bricks anyway. I sat down with them and we compared sizes and the boys and Lorraine were most interested and excited and discovered many things’.

In some schools an impulse to tell stories about their construction arises among the children and these can be very illuminating as giving an insight into how the blocks appear to the children.

The range of type of construction made by any school class of children varies greatly. In some, children will constantly repeat the same type of structure such as houses, churches, castles, a factory, rockets, a fort, a bridge. In other classes considerable variety will occur as a house and a lorry and a church; 3 wells fixed together: a seesaw: Blackpool Tower: a shop, a Christmas house, a brick lorry, a ship, a lift with things on: a house and roundabout, and so on.

Now and then children’s constructions are emotionally determined as ‘a boat on fire, is sinking’: ‘a chimney smoking on top of a town’: ‘going to a wedding’: ‘an old building bombed down’: ‘a pig sty with a gun on the side’, ‘a hiding place’.

An important aspect of children’s Free Construction work concerns the ideas of ‘up’ and ‘down’ or ‘within’ in their work. For instance, in an Infants entry class a girl makes a house and another girl a ‘tunnel’, a boy ‘Daddy’s tool box’ and another boy a ‘tower’. Another boy of 5 1/2 made a ‘station, beside it an underground railway with a tent underneath, 3 small rockets and another tent.’ The model was spread the length of the table and all the bricks used’.

The teacher must decide according to the age and the initiative of the children when they are ready to undertake - at the end of the Free Construction period - the replacing of the blocks in the box and whether this should be done individually or in a group. Children look upon permission to do this as a privilege and enjoy keenly the fitting of the individual blocks on to their proper place in the base diagram.

It is important to keep the Free Construction periods and the introduction to mathematics periods separate. Otherwise play of the wrong kind tends to get mixed up with concentration on noticing and thinking and the Work becomes confused. Children should be quite clear that they are either 'making things‘ or ‘thinking about the blocks' and how they have used then to make their constrictions.

E. Record Charts

For the teacher's assistance Record Chart-s have been devised for recording the constructions of the children. These are not intended as research material on the children's responses, but as aids to the teacher, both as to what to look for in the children’s work and as enabling the teacher to observe development in the work of the individual children.

When completed these forms will later assist the teacher to recall what individual children did, how they approached. and completed their work and how their actual constructions varied or repeated themselves: whether their constructions were more original when working on their own or with a group, whether they influenced the work of their group or copied the others.

By the time all the children in a class have had two opportunities for Free Construction with the Poleidoblocs, the teacher will have noticed great variation in approach to the task, in execution and in the child’s relation to his construction and to the final result.

Direct observation and notes of what the children do say will give every teacher an invaluable objective record of What kind of individuals makes up this particular class. They will find the eager, the hesitant, the indifferent, the concentrated approach; the ones who do not know what to do and don't try and those who have something definite in mind and work hard to achieve it, the imaginative hands, the simple and those who get easily bored.

RELATION OF CHILDREN WORKING WITH POLEIDOBLOCS TO THE CLASS

It is in the discretion of the teacher to decide how and when the chicken in her class get their turn with Poleidoblocs. The time children need to complete their construction varies considerably but experience has shown that, except for instances where a child is engaged in a particularly complicated construction, 20 minutes should be the limit of time allowed. If any child has finished earlier, he should be allowed to leave and go back to his class.

Children look forward to working with Poleidoblocs and as soon as confidence has been gained by the Whole class that everyone will have his turn, it works out well.

As it is intended that Poleidoblocs should be available to each child throughout his time at school and when, in other classes he will be learning different branches of mathematics, it is advisable from the start to make their use part of accepted classroom activities.

When all the children in a class have worked with the blocks the arrangement should be changed, so as to give each child opportunity to have worked alone and as a member of a group and also as a member of different groups.

Working in groups can be valuable to some children and dangerous to others; valuable to those who doubt their own ability to do anything and who gain encouragement from watching others; dangerous for the group if one of the members is full of original ideas and rather dominant in temperament, as he can then drain the vitality of the others and produce a ’type' reaction copied emptily by the others.

As a general rule it has been found better to combine girls and boys in a group and sometimes to stimulate discussions among them.

When a child has found freedom in ‘constructing' with Poleidoblocs and when his constructions show development, he is ready to begin on the elements of mathematical thinking.

INTROUDCTION TO MATHEMATICS

Mathematical thinking arises out of ’noticing'. 'Noticing’ is done by the fingers as well as the eyes and the mind and noticing with the fingers sometimes precedes noticing by eye. Achievement in noticing is followed by a sense of adventure, allied with curiosity. 'What do things look like?’, 'What do they feel like?', ‘What will they do?', "What can I make with them. What a child wishes to make and what pictures his imagination presents to depends upon the nature of his personal relation to the world around, whether his attention is caught by what people around him are doing or saying, by the things he sees and handles, or by what is going on in his interior thoughts and feelings.

It must be remembered that there are two kinds of imagination. The first is the one we have seen at work in Free Construction; the forming of static or moving pictures the mind, an attempt to translate them into external shape.

The other kind of imagination is the kind that finds its fulfilment later in mathematics and in science. It is blended with curiosity and is related directly to the outside World. In small children it appears as the enquiry “What will happen if I… stand this thing up - put that together - fit this inside that and so on".

There is a third kind of intellectual query and this can arise quite early. It relates not to the action and conversation between the Single Child and the object, but to conversations mostly between two or more children at a time and about two or more objects. ‘How do these compare?', ‘What exactly are these?’, (how many, what size and what do they do together).

Poleidoblocs are devised to enable the individual children in a class to develop at their own speed and with their individual emphasis. Colour photographs taken of the constructions made by an entry class of Infants, regarded from a mathematical point of view, show a surprising range of variation in spontaneous appreciation of or/and interest in the mathematical qualities of the blocks.

One of the key qualities of Poleidoblocs is the fresh insight children’s work with them gives us into children’s spontaneous ability to discover mathematical qualities and relations between the blocks. Some children are aware of symmetry from the beginning, while others seem unable to succeed in successfully completing any model such, for instances as the walls of a room, where perception of symmetry from the beginning, while others seem unable to succeed in successfully completing any model such, for instances as the walls of a room, where perception of symmetry is involved.

The children whose work is quoted in this Manual, are all ordinary children in village schools, but it is those which extend our understanding of what children can do which have been selected for quotation. The terms used by the teachers in their reports are those used by the children.

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The following are some instances:-

‘Before Anne (5 ½) started to build she sorted out each different shape and colour and out them into separate piles’.

Composition

Of children working in a group an infant’s teacher notes: -
(6-7 years)

‘This group worked hard and built up small blocks to match bigger blocks, when they were short- calculated – e.g. 8 of the smallest squares needed to make a square (2) inch block, tried to make 5-inch block from smallest squares, found that hadn’t enough, remarked “we want hundreds and hundreds of these little ones if we are able to do this”. Then they began to experiment with all the sizes and build with them’.

Length

‘Anne and Lesley noticed how many very small units make rods ‘ Like our number apparatus for tens and units’.

Height

Geoffrey said, “I’m going to build a tower, I’m using all the square blocks up except the flat ones”: 4 of those (triangular prisms) make one whole square’.

Arguing about height leads to measurement.

‘Tony and Peter (First Infants) built towers, peter said his was the highest. He measured his by standing up. Tony also stood up. He said he was as high as Tony and his tower higher than Tony’s. Tony then tried to build his up higher, but ‘Christopher and Fay (5/6- 6/1) built towers and Christopher said they were both the same. They discussed this, and yellow slats were used to prove who was right’.

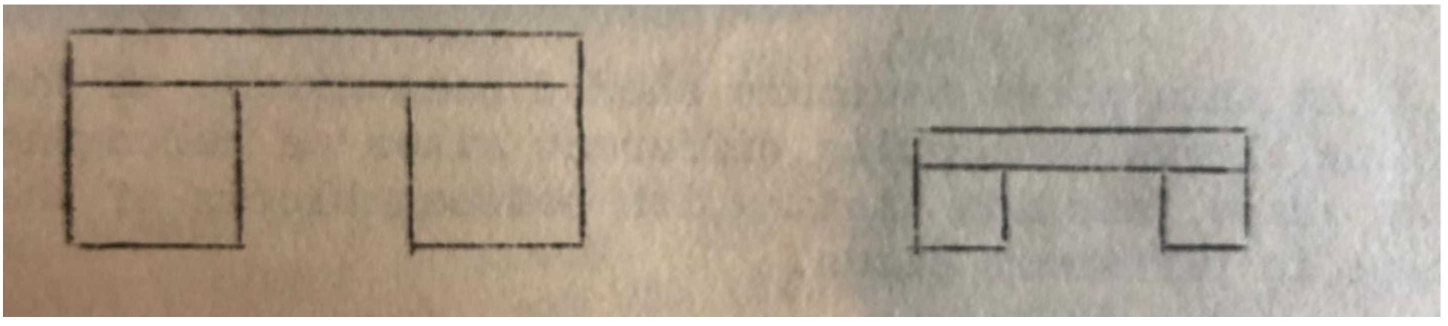
Counting

‘Johnathan counted how many blocks he had used. The rest of the children also counted theirs.’

‘Three children made towers. We counted the number of bricks in each tower and found the highest tower did not have to have the most blocks’.

Shape and Size

‘Richard constructed two bridges and said, ‘the car goes through the big bridge and then the little one to get into the garage’.



The teacher, therefore, in settling out to introduce the children of her class to mathematical thinking needs to have in her mind both a clear idea of the kinds of knowledge and experience she wants the children to gain, and the stages in development of mathematical understanding the individual children have reached.

DIRECTED ACTIVITIES

A. Shapes.

When a teacher decides that a child's familiarity with the blocks of Poleidoblocs G has reached a stage when the time has come to move towards thinking about mathematical properties, interest can be stimulated after a construction with Poleidoblocs has been made.

It can be suggested to the child to look carefully at his construction and see how it was put together: to take it to pieces and to sort out the different blocks they have used. The teacher can then ask, 'could you make it again or teach Peter how to do so?' The degree of difficulty will depend upon the elaborateness of the original construction. When the child has carried out the suggestions, note should be taken of whether the blocks have been grouped by shape or by colour or by both: whether the blocks have been grouped by shape or by colour or by both: whether one of other factor is ignored, or whether the existence of the two qualities in the same block confused the issue for the child or not.

When a child is able to analyse his construction and make it over again we know that the process, as the psychologists say, is reversible.

At some point teachers should concentrate on the shapes of the blocks, accepting different sizes as belonging to the same shape, and not distinguish between blocks of the same shape in different sizes.

Teaching

When a child or a group of children can securely sort the blocks into their different shapes, describing them by their ordinary names, slats, pillars and so on: the teacher should introduce them to the mathematical name for each shape. Children enjoy learning special names for special things, provided not too many are given at once. Sufficient opportunity should be given of sorting and naming the blocks for familiarity with them to be gained.

Game.

The contents of 2 G boxes are piled on a table with 4 to 6 children sitting round it. Each child picks up a block in his hand and gives it to his right-hand neighbour and continues for three rounds.

Each child as he receives his new block, is instructed to put the block together with those of the same shape he has already acquired. When all the blocks are distributed the teacher suggests that each child study his collection, seeing that it is sorted into heaps of the same kind. The teacher discusses with each child the groupings he has made.

B. Size of Similar Shapes

The same procedure is carried out as for A, except that the teacher now explains that what is to be looked for, this time, is different size of the same shape. It is sometimes wise to begin with children working individually. When groupings have been made, the teacher discusses with each child the blocks he has put together and checks whether the idea of different sizes of the same shape has really been grasped, or if more opportunity is needed, either by one of the children or by all of them for this to be realised.

When the blocks used by the child in his construction have been arranged, the teacher points to the rest of the blocks that remain unused in the heap on the table and says, ‘Can you fit those, one by one, into the small heaps you have made’.

The blocks of Poleidoblocs G provide a delightful opportunity to discover 3 steps of sizes. The idea of a series should not as yet be introduced, as such, but the children encouraged to go as far as they can in recognising that the attractive appearance of many parts of their construction arise from the use of three blocks of the same shape but different in size. It is wise to allow children much opportunity to play around this characteristic of the G blocks, arranging the sets of 3 in different ways, until they have become fully familiar with the idea.

C. **Size, Shape and Colour.**

The above procedure is repeated with the addition of the factor of colour. The blocks of Poleidoblocs G give the best field for these exercises as the qualities are evenly distributed between length, breadth, height etc. with no one predominating.

Game.

When A-C have really been grasped, a cribbage type of game can be played in which the blocks of 2 G boxes (much later on combined with those of part of Poleidoblocs A) are heaped in the centre of the table and covered with a duster. Each child puts his hand under the duster in turn and pulls out a block. This he places in the appropriate group in the collection he is making in front of himself and when all have been withdrawn each child’s groups are checked by the teacher.

D. **Length and Height**

The time has now come to explore the idea of series. For these the 1” to 4” in blocks of 1 square inch cross section of the A box should be used. There are 4 of each length and these should be put together in a heap on the table and two children, working in a pair, are asked to sort them in whatever way they can.

Children will vary considerably in the speed with which they grasp the fact of a series of 4 rising from 1” cube to the 4” block of 1 square inch cross section.

When the brighter children have discovered the existence in the heap of the four different lengths they can be encouraged to try out arrangements of them lying side by side or standing upright, so they form a stair.

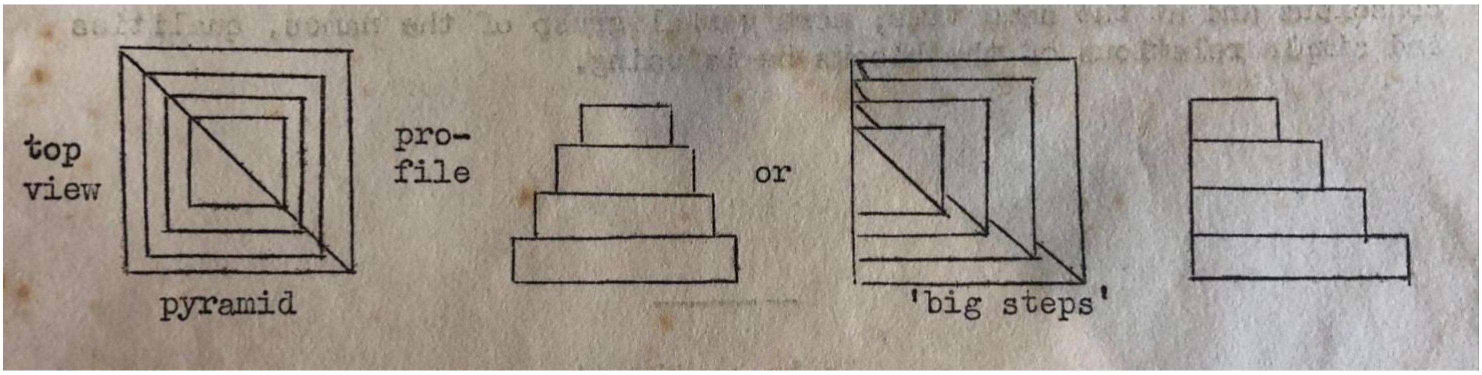
If that proves too difficult it can be made easier by using only 2 or 3 of each type of block in the heap, but a valuable moment is reached when a child discovers that by putting the 'one' cube on top of the other blocks it reaches to the same height as its neighbour.

When the series of 4 has been really grasped, the fifth member of the series should be added and the whole experimented with until the idea of a series in these blocks has been firmly grasped.

E. Other Forms of Series

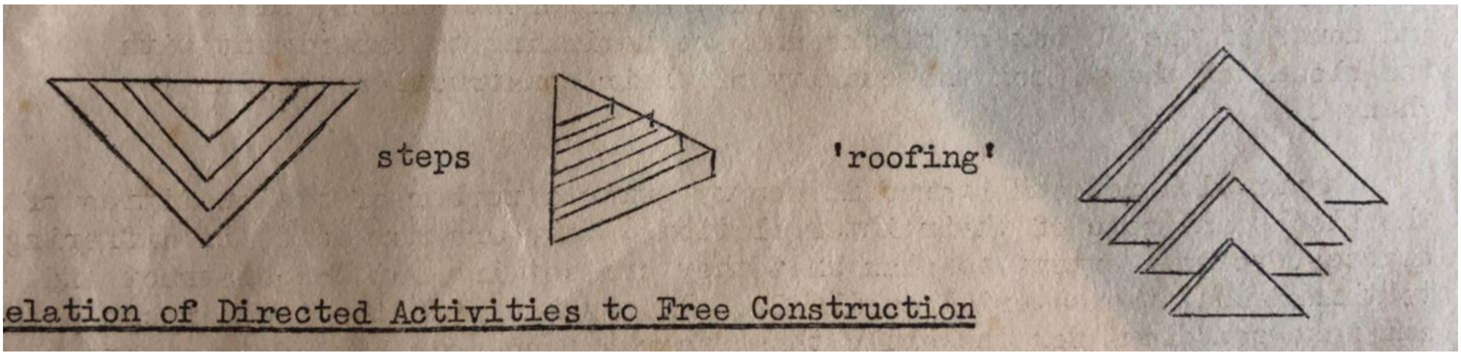
As pointed out on P.5 there are available a number of different forms of series in the blocks of Poleidoblocs G. Some of these certain children will spontaneously discover for themselves, for other children a hint from the teacher may be needed to set them going.

The triangular of Poleidoblocs come in usefully here. If two similar triangles be out with their long sides together they form a square. Four of these squares, one on top of the other form a fresh series as illustrated below:



It is an excitement for any child to discover that the second largest of these squares exactly fits on top of the red G cube, the next smallest on top of the green cube, and the smallest of them all on top of the small blue cube.

Taken singly this series of triangles makes an interesting set of ‘steps’ put one on top of the other, or if stood on the long side of each triangle, children see them as differing sizes of ‘roofing’ blocks.



Relation of Directed Activities to Free Construction

It should be realised that in work in Poleidoblocs, either in Infants or Junior schools, there should be interaction between Directed Activities and Free Construction, each fertilising the other.

When children have passed through this first set of Directed Activities and have thoroughly grasped the different shapes: Sizes and names of the G box of bricks and are beginning to experiment with the blocks of the A box the quality of their constructions begins to change.

Having learned and stored in memory quite a number of the qualities of the blocks and some of their interrelations, they are now able, in differing degrees, to some extent to plan what they are setting out to construct and to think about the material available. Discussion with the teacher can point and make conscious for the child this progress and spur him on to a more conscious and at the same the more verbal grasp of the names, qualities and simple relations of the blocks he is using.