INTRODUCTION

“Geometry begins with play.” (van Hiele, 1999)

The activities described in this section of the study guide are informed by the research of Pierre van Hiele. According to van Hiele (1986), there are four levels of geometric thought that are sequential and hierarchical. They are: the visualisation level; the analysis level; the analysis or descriptive level; the deductive level; and rigour, although it is unlikely that children in the early grades will move beyond the descriptive level. For learners to function at any given level, they must have developed confidence at the preceding level. Progression from one level to another is based more on instruction and experience than on age or physical development.

For a person at the visual level of geometric thinking, figures and shapes are identified in terms of what they ‘look like’. For example, if asked why a square is a square, the person will say that it is a square because it looks like one. However, if the square is tilted so that its sides appear to be at a 45° angle, then the person may not recognise the shape to be a square instead they may call it a diamond.

People at the descriptive level of geometric thinking, recognise properties of shapes. For example, people at this developmental level may identify a shape as a square because the shape has four sides that are the same length, or because the angles are right angles. However, at this level, the properties are not yet logically ordered or related. For example, people at this developmental level may identify a shape as an equilateral triangle because the shape has three sides that are equal in length, or because the shape has three angles are equal in size. However, they don’t recognise a relationship between the properties. For example, people at this developmental level cannot yet see a relationship between the equal angles and the equal sides of the equilateral triangle.

Recognising the relationships between different properties of shapes happens during the deductive level of geometric thinking. People at this developmental level are able to deduce some properties of a shape from other known properties of the shape.

Teachers of children in the early grades, typically work with children who are in all likelihood at the visual level of geometric thinking. The teacher’s role is to create learning situations that encourage children to develop confidence in moving from the visual to the descriptive level of geometric thinking and in some situations even to the informal deductive level. Van Hiele described five kinds of activities that promote the transition from one level to the next.

1. Free play (inquiry phase): Children are given materials that encourages them to explore and become aware of certain structures.
2. Focussed play (direct orientation): Tasks are presented in such a way that the characteristic structures of the objects gradually appear to children.
3. Explicitation: The teacher introduces the terminology.
4. More focussed play (free orientation): The teacher presents tasks that can be completed in different ways and support children to become more aware if what they have already noticed.

5. Integration (seldom included in geometric activities in the early years): Children are given opportunities to synthesize what they have learned (van Hiele, 1999)

In light of the kinds of activities described by van Hiele, developing geometric thinking in the early grades is reliant on play – playing with resources. Many resources can be made (like tangram puzzles) or collected (beads to put on string). Some resources have to be purchased.

This section of the teacher guide has been developed with the assumption that the teacher has a given range of geometric resources in her classroom. By encouraging children to use these resources in a range of carefully structured learning situations, teachers support children to become aware of geometric and other properties of shapes and objects.

To conclude, the role of the teacher in developing children’s geometric thinking is to:

- Establish the learning situations (activities) described in this guide that direct children’s’ attention to the geometric properties of shapes and objects;
- Introduce terminology; and
- Engage children in reflective discussion on the activities encouraging explanations that incorporate appropriate geometric terms.

**RESOURCES**

<table>
<thead>
<tr>
<th>Resource</th>
<th>Number required</th>
<th>Available from</th>
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<tbody>
<tr>
<td>Van Hiele Mosaic puzzle</td>
<td>1 for every pair of children</td>
<td>Brombacher &amp; Associates</td>
</tr>
<tr>
<td>Van Hiele Mosaic Activity cards</td>
<td>1 set for every four children</td>
<td>Brombacher &amp; Associates</td>
</tr>
<tr>
<td>Tangram puzzle 10 cm by 10 cm</td>
<td>1 for every pair of children</td>
<td></td>
</tr>
<tr>
<td>Tangram Activity cards</td>
<td>1 set for every four children</td>
<td>Brombacher &amp; Associates</td>
</tr>
<tr>
<td>Geoboard with minimum 7 × 7 square pin grid array</td>
<td>1 per child</td>
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</tr>
<tr>
<td>Geoboard Activity cards</td>
<td>1 set for every four children</td>
<td>Brombacher &amp; Associates</td>
</tr>
<tr>
<td>Attribute blocks</td>
<td>1 set for every four children</td>
<td>Brombacher &amp; Associates</td>
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<tr>
<td>Attribute Activity cards</td>
<td>1 set for every four children</td>
<td>Brombacher &amp; Associates</td>
</tr>
<tr>
<td>Beads and string</td>
<td>1 set for every four children</td>
<td>Brombacher &amp; Associates</td>
</tr>
<tr>
<td>Beads and string Activity cards</td>
<td>1 set for every four children</td>
<td>Brombacher &amp; Associates</td>
</tr>
<tr>
<td>GeoGenius Visualisation</td>
<td>Minimum 1 set for every 12</td>
<td>Brombacher &amp; Associates</td>
</tr>
<tr>
<td>Kit</td>
<td>children in class</td>
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<tr>
<td>GeoGenius Visualisation Kit additional card set_2</td>
<td></td>
<td>Download from <a href="http://www.GeoGenius.co.za">www.GeoGenius.co.za</a></td>
</tr>
<tr>
<td>GeoGenius Construction Kit</td>
<td>1 Superkit for every 10 children</td>
<td>Brombacher &amp; Associates</td>
</tr>
<tr>
<td>GeoGenius Construction Kit Activity cards</td>
<td>1 set for every 5 children</td>
<td>Brombacher &amp; Associates</td>
</tr>
<tr>
<td>Connecting cubes</td>
<td></td>
<td></td>
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<tr>
<td>Connecting cubes Activity cards</td>
<td></td>
<td>Brombacher &amp; Associates</td>
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TANGRAM ACTIVITIES

In these activities we expect children to develop:

- Confidence in recognising, identifying and describing 2-D shapes (the focus of the activities is on triangles and rectangles)
- An increased awareness of the properties of and relationships between the sides and angles of 2-D shapes

For these activities you will need:

- Tangram puzzle. For these activity cards the tangram puzzle should be 10 cm by 10 cm.
- Tangram Activity Cards 5 to 13

Teacher’s role:

Children are able to work on these cards independently of the teacher. Children may work in pairs and each pair of children will need a tangram puzzle and an Activity Card.

When possible teachers should take the opportunity to observe how children use the pieces and to assess informally how the children think and talk about the shapes

Notes on specific cards:

Activity card 5

In this activity children are not able to fit the pieces onto the shapes, but need to build the same shape next to the image. All the shapes use the square, the parallelogram and the two smallest triangles. Children may start to notice that some pieces will fit either side up but other pieces (the parallelogram) will only fit one way up. Children also start to focus on matching edges that are equal in length and angles that are equal in size.

Activity card 6

In this activity children are not able to fit the pieces onto the shapes, but need to build the same shape next to the image. All the shapes are made using all the triangular pieces.

When children are done, teachers could direct children’s focus to the two rectangles by asking them, what is the same and what is different about these two shapes? And how is the other four-sided shape (parallelogram) similar to the rectangles and how is it different to the rectangles?

Children should know the name rectangle and be able to recognise a rectangle.
Children may start to notice similarities and differences the rectangles and the other shapes. Children could describe the rectangles as being different to the five-sided shape (pentagon) in that there are four edges and different to the parallelogram because the corners are square (i.e. right angles).

**Activity card 7**

In this activity children are able to fit the pieces on the shapes. Children are not able to see the individual pieces, only the completed shape made by joining two pieces. Children have to identify which pieces to use. They will need to use the two smallest triangles.

Draw children’s attention to the edges and vertices of the shapes by asking, how many edges does this shape have? How many corners (vertices) does this shape have? Also ask the children what is the same and what is different about each shape?

Children should use the terminology square and triangle. They don’t have to know the name parallelogram yet and could just say “the other four-sided shape”. Children should notice that the triangle has three edges and three corners (vertices), but the other shapes have four edges and four corners (vertices).

Solutions:

![Activity Card 7 Solution](image)

**Activity card 8**

In this activity children are able to fit the pieces on the shapes. Children are not able to see the individual pieces, only the completed shape made by joining three pieces. Children have to identify which pieces to use. They will need to use the two smallest triangles and the middle-sized triangle.

Draw children’s attention to the edges and vertices of the shapes by asking, how many edges does this shape have? How many corners/vertices? Also ask the children what is the same and what is different about each shape?

Children should use the terminology square and triangle. They don’t have to know the name trapezium yet and could just say “the other four-sided shape”. Children should notice that the triangle has three edges and three corners (vertices), but the square and trapezium have four edges and four corners (vertices). The square has square corners (right angles), but the trapezium has sharp and blunt corners.

Solutions:
Activity card 9

In this activity children are able to fit the pieces on the shapes. Children have to identify which pieces to use. There are two different solutions to this card. Encourage children to fit different pieces to make each shape. They could use the two smallest triangles and the square or the two smallest triangles and the parallelogram.

Draw children’s attention to the edges and vertices of the shapes by asking, how many edges does this shape have? How many corners/vertices? Also ask the children what is the same and what is different about each shape?

Children should use the terminology rectangle. They don’t have to know the name trapezium yet and could just say “the other four-sided shape”. Children should notice that the rectangle and trapezium have four edges and four corners (vertices). The rectangle has square corners (right angles), but the trapezium has sharp and blunt corners.

Solutions:

Activity card 10

In this activity children are not able to fit the pieces on the shapes, but need to build the same shape next to the image. Children have to identify which pieces to use. There are two different solutions to this card. Encourage children to fit different pieces to make each shape. They could use the two smallest triangles and the square or the two smallest triangles and the parallelogram.
Draw children’s attention to the edges and vertices of the shapes by asking, how many edges does this shape have? How many corners/vertices? Also ask the children what is the same and what is different about each shape?

Children should use the terminology rectangle. They don’t have to know the names trapezium or parallelogram yet. Children should notice that the rectangle, trapezium and parallelogram have four edges and four corners (vertices). The rectangle has square corners (right angles), but the trapezium and parallelogram have sharp and blunt corners.

Solutions:

In this activity children are not able to fit the pieces on the shape, but need to build the same shape next to the image. Children have to identify which shapes to use. They could use the two smallest triangles, the medium-sized triangle and a large triangle.

Draw children’s attention to the edges and vertices of the shapes by asking, how many edges does this shape have? How many corners/vertices? Also ask the children what is the same and what is different about each shape?

Children should use the terminology square and triangle. They don’t have to know the name parallelogram yet. Children should notice that the triangle has three edges and three corners.
(vertices), but the square and parallelogram have four edges and four corners (vertices). The square has square corners (right angles), but the parallelogram has sharp and blunt corners.

Solutions:

Activity card 12

In this activity children are able to fit the pieces on the image. Children have to use all seven tangram pieces.

Draw children’s attention to the edges and vertices of the shapes by asking, how many edges does this shape have? How many corners/vertices? Children could also be encouraged to think about similarity. Ask the children if any of the pieces are the same as this shape?

Solution:
Activity card 13

In this activity children are not able to fit the pieces on the shape, but need to build the same shape next to the image. Children have to use all seven tangram pieces.
In these activities we expect children to develop:

- Confidence in recognising, identifying and describing 2-D shapes (the focus of the activities is on triangles, squares and rectangles)
- An increased awareness of the properties of and relationships between the sides and angles of 2-D shapes

For these activities you will need:

- Van Hiele mosaic puzzle.
- Van Hiele mosaic Activity Cards 5 to 13

Teacher’s role:

Children are able to work on these cards independently of the teacher. Children may work in pairs and each pair of children will need a Van Hiele mosaic puzzle and an Activity Card.

When possible teachers should take the opportunity to observe how children use the pieces and to assess informally how the children think and talk about the shapes

Notes on specific cards:

**Activity card 5**

In this activity children are not able to fit the pieces onto the shapes, but need to build the same shape next to the image. All the shapes use pieces 5 and 6. In some cases, the pieces have to be flipped.

Teachers could ask children, which shapes are triangles? How do you know that they are triangles? Are there any rectangles? Which shape is a rectangle? How do you know that the other four-sided shape is not a rectangle?

Children should know the names rectangle and triangle and recognise rectangles and triangles. They may be able to explain that they know that the triangles are triangles because they have three edges or three corners (vertices). The other shapes all have four edges. The rectangle is different to the other shapes with four sides because it has square corners (right-angles).
Activity card 6

In this activity children are not able to fit the pieces onto the shapes, but need to build the same shape next to the image. Children should focus on matching edges that are equal in length and angles that are equal in size.

Activity card 7

In this activity children are able to fit pieces 5 and 6 on the shapes. Children are not able to see pieces 5 & 6 individually, only the completed shape made by joining these two pieces.

Draw children’s attention to the edges and vertices of the shapes by asking, how many edges does this shape have? How many corners (vertices) does this shape have? Also ask the children what is the same and what is different about each shape?

Children should use the terminology rectangle and triangle. They don’t have to know the name parallelogram yet and could just say “the other four-sided shape”. Children should notice that the triangle has three edges and three corners (vertices), but the other shapes have four edges and four corners (vertices). The rectangle has four square corners (right-angles), but the other four-sided shapes have two sharp corners and two blunt corners.

Solutions:

Activity card 8

In this activity children are able to fit pieces 1 and 7 on the shapes. Children are not able to see pieces 1 & 7 individually, only the completed shape made by joining these two pieces.

Draw children’s attention to the edges and vertices of the shapes by asking, how many edges does this shape have? How many corners (vertices) does this shape have? Also ask the children what is the same and what is different about each shape?

Children don’t have to know the names parallelogram, quadrilateral or pentagon yet and could just say “four-sided shape” and “five-sided shape”. Children should notice that the parallelogram has four edges and four corners (vertices), but the other shapes have five edges and five corners (vertices). Children may also notice that shapes can be convex (a reflex-angle). They may describe this as dented-in.

Solutions:
Activity card 9

In this activity children are again able to fit pieces 1 and 7 on the shapes. Children are not able to see pieces 1 & 7 individually, only the completed shape made by joining these two pieces.

Draw children’s attention to the edges and vertices of the shapes by asking, how many edges does this shape have? How many corners (vertices) does this shape have? Also ask the children what is the same and what is different about each shape?

Children don’t have to know the name parallelogram or quadrilateral yet and could just say “four-sided shape”. Children should notice that the parallelogram has four edges and four corners (vertices), but the triangle has three edges and three corners (vertices). Children may also notice that the two parallelograms look different because the one has much sharper corners than the other.

Solutions:

Activity card 10

Make sure that children understand what is meant by different shapes. For example, all these shapes are the same because if we trace around the outside of one of the shape and turn or flip it, we can see that it will fit on all the other shapes.
Solutions:

1. There is only one shape that can be made by joining piece 1 and piece 2. See above.
2. There are two shapes that can be made by joining piece 1 and piece 3.
3. There are three shapes that can be made by joining piece 1 and piece 4.
4. There are three shapes that can be made by joining piece 1 and piece 5.
5. There are five shapes that can be made by joining piece 1 and piece 7.
Activity card 11

In this activity children are able to fit pieces 1, 4 and 5 on the shapes. Children are not able to see pieces 1, 4 & 5 individually, only the completed shape made by joining these three pieces.

Draw children’s attention to the edges and vertices of the shapes by asking, how many edges does this shape have? How many corners (vertices) does this shape have? Also ask the children what is the same and what is different about each shape?

Children don’t have to know the name hexagon yet and could just say “six-sided shape”. Children should notice that both shapes have six edges and six corners (vertices), even though they have a different ‘look’. Children may also notice that shapes can be convex (a reflex-angle). They may describe this as dented-in.

Solutions:

Activity card 12

In this activity children are able to fit pieces 3, 5 and 6 on the shapes. Children are not able to see pieces 3, 5 & 6 individually, only the completed shape made by joining these three pieces.

Draw children’s attention to the edges and vertices of the shapes by asking, how many edges does this shape have? How many corners (vertices) does this shape have? Also ask the children what is the same and what is different about each shape?
Children don’t have to know the names trapezium and parallelogram yet and could just say “four-sided shape”. Children should notice that both shapes have four edges and four corners (vertices), even though they have a different ‘look’. Children may describe opposite corners of the parallelogram as being blunt or sharp, but in the trapezium the corners next to each other are blunt or sharp.

Solutions:

Activity card 13

This is the first Van Hiele Activity card that children are not able to fit pieces onto the shape on the card, but need to build the same shape next to the image. Children have to use all seven tangram pieces.

Solution:
GEOGENIUS VISUALISATION KIT ACTIVITIES

In these activities we expect children to develop:

- Confidence in recognising, identifying and naming 3-D objects (the focus of the activities is on square prisms, rectangular prisms and triangular prisms)
- Confidence in recognising 3-D objects from different positions and positioning 3-D objects in relation to each other
- Confidence in describing positional relationships (alone and/or as a member of a group) between 3-D objects and him/herself and a peer

For these activities you will need:

- GeoGenius Visualisation Kit (at least one kit per 4 children)
- Beginner_1 Card Sets 1 – 6. These come with the GeoGenius Visualisation Kit
- Beginner_2 Card Sets 1 – 6. These can be printed as per instructions from www.GeoGenius.co.za.
- Novice_1 Card Sets 1 – 10. These come with the GeoGenius Visualisation Kit
- Blank view cards. These come with the GeoGenius Visualisation Kit. More can be printed from www.GeoGenius.co.za or the Instruction Guide found in the Kit.

Teacher’s role:

Arrange the children participating in this activity in groups of four. The desks should be arranged so that all four children in the group can face the middle of the table.

General GeoGenius Visualisation kit instructions (also see the instruction book that comes with the kit)

The grid is placed in the middle of the table. For the card set that is being used, each child is given the card that corresponds to their view. Working together the children in the group select the appropriate block(s) and arrange/rearrange them on the grid until the arrangement of blocks corresponds to the view on each view card. Each child should only look at their own card while the group works together to complete the task.

Initially as children get used to working with the kit, teachers may want to place the grid on top of a box in the middle of the table so that the grid is at the children’s eye level. Alternatively children could kneel down to look at the grid from eye level.
In the beginning, children struggle to accept that their cards do not show depth. Children often want to move the block(s) towards themselves so that they are up against the edge of the grid on the side that they are facing. To help them deal with this, you could ask the children how they think the card would look different if the block was further back on the grid or further forward.

Be sure to also allow opportunity for children to complete blank viewing cards. To do this, tell the group to choose any one block in the GeoGenius Visualisation Kit and place it on the Visualisation grid. Give each child a blank view card. Each child in the group should draw their View (A, B, C or D) of the block on the grid. They should label their view A, B, C or D. When they are done the children should remove their block from the grid.

Swap viewing cards between the groups so that each group gets another groups set of cards. Ask the groups to use the cards drawn by the other children to reposition the block that that group chose on the grid. The groups may pick up errors. If so, ask them to justify how they can be sure that it is an error. Return the cards back to the original groups to correct errors.

Notes on specific cards:

Beginner_1 Set 4

When each child in the group is satisfied that the arrangement corresponds to the view on their card, lead a reflective discussion that includes answering the following questions:

- Does the arrangement look the same on all four cards? No – In View A and C the block is a 2 by 3 rectangle and in View B and View D it is a 1 by 3 square.
- Is the arrangement in the same position on all four cards? No – In View A, the block is more left than in View C, but in View B and View D it is the same.
- Is it possible to place the arrangement on the grid in such a way that every view will be the same in terms of shape and position? No, because all the dimensions are different lengths.

Beginner_1 Set 5

When each child in the group is satisfied that the arrangement corresponds to the view on their card, lead a reflective discussion that includes answering the following questions:

- Does the block look the same in all four cards? No – in Views A and C we see a triangle, but in Views B and D we see a square. The triangles in Views A and C look different in that the triangle in View A slopes up whereas the triangle in View C slopes down.
- Is the block in the same position in all four cards? No – In Views A and D, the block is far right, in Views B and C the block is far left.
- Is it possible to place the block on the grid in such a way that every view will be the same in terms of shape and position? No. Explain your thinking. We could hide the “triangleness” of the block by placing it on a triangular face. If the block is restricted to the gridlines, then no – it is not possible. If the block is not restricted to the gridlines and can be placed exactly in the middle of the grid, then yes – it is possible when the block is placed on the square base.
Beginner_1 Set 6

When each child in the group is satisfied that the arrangement corresponds to the view on their card, lead a reflective discussion that includes answering the following questions:

- Does the block look the same in all four cards? No – in Views A and C we see a triangle, but in Views B and D we see a square. The triangles in Views A and C look different in that the triangle in View A slopes down whereas the triangle in View C slopes up.
- Is the block in the same position in all four cards? No – In View B, the block is far left, in View D the block is far right. In View C the block is more right than in View A.
- Is it possible to place the block on the grid in such a way that every view will be the same in terms of shape and position? Explain your thinking. We could hide the “triangularness” of the block by placing it one a triangular face. If the block is restricted to the gridlines, then no – it is not possible. If the block is not restricted to the gridlines and can be placed exactly in the middle of the grid, then yes – it is possible when the block is placed on the square base.

Beginner_2 Set 1

When each child in the group is satisfied that the arrangement corresponds to the view on their card, lead a reflective discussion that includes answering the following questions:

- Does the block look the same in all four cards? Yes – it is a 1 by 1 square
- Is the block in the same position in all four cards? No – In View B and C it is in the same position, but the block is more right than in View A than in View C.
- Is it possible to place the block on the grid in such a way that every view will be the same in terms of shape and position? Yes – if the block is placed in the middle of the grid then every view will be the same.

Beginner_2 Set 2

When each child in the group is satisfied that the arrangement corresponds to the view on their card, lead a reflective discussion that includes answering the following questions:

- Does the block look the same in all four cards? No – in Views A and C the block looks like a 2 by 2 square, but in Views B and D the block looks like a 1 by 2 rectangle
- Is the block in the same position in all four cards? No
- Is it possible to place the block on the grid in such a way that every view will be the same in terms of shape and position? Explain your thinking. If the block is restricted to the gridlines, then no – it is not possible. If the block is not restricted to the gridlines and can be placed exactly in the middle of the grid, then yes – it is possible when the block is placed on the square base.

Beginner_2 Set 3

When each child in the group is satisfied that the arrangement corresponds to the view on their card, lead a reflective discussion that includes answering the following questions:

- Does the block look the same in all four cards? Yes – the block looks like a 1 by 3 rectangle from all Views.
• Is the block in the same position in all four cards? No.
• Is it possible to place the block on the grid in such a way that every view will be the same in terms of shape and position? Explain your thinking Yes – if the block is placed upright so that it is a 1 by 3 rectangle and placed in the middle of the grid then every view will be the same.

Beginner_2 Set 4

When each child in the group is satisfied that the arrangement corresponds to the view on their card, lead a reflective discussion that includes answering the following questions:

• Does the block look the same in all four cards? No – in Views A and C the block looks like a 1 by 2 rectangle, but in Views B and D the block looks like a 3 by 2 rectangle.
• Is the block in the same position in all four cards? No – In Views A and B, the block is far left, in Views C and D the block is far right.
• Is it possible to place the block on the grid in such a way that every view will be the same in terms of shape and position? Explain your thinking. No, because all dimensions of the block are different.

Beginner_2 Set 5

When each child in the group is satisfied that the arrangement corresponds to the view on their card, lead a reflective discussion that includes answering the following questions:

• Does the block look the same in all four cards? Yes – it is a 2 by 2 square
• Is the block in the same position in all four cards? No – In View A and B it is in the same position, and in View C and D it is in the same position
• Is it possible to place the block on the grid in such a way that every view will be the same in terms of shape and position? Yes – if the block is placed in the middle of the grid then every view will be the same.
• Is there more than one way that you can place the block to satisfy the arrangement from all views? Yes – there are four different ways that children could place the block. The possible ways are:
Beginner_2 Set 6

When each child in the group is satisfied that the arrangement corresponds to the view on their card, lead a reflective discussion that includes answering the following questions:

- Does the block look the same in all four cards? No – from View A and View C the block looks like a 1 by 1 square and from View B and View D the block looks like a 2 by 1 rectangle.
- Is the block in the same position in all four cards? No – in Views A and B the block is far left and in Views C and D the block is far right.
- Is it possible to place the block on the grid in such a way that every view will be the same in terms of shape and position? Explain your thinking. If the block is restricted to the gridlines, then no – it is not possible. If the block is not restricted to the gridlines and can be placed exactly in the middle of the grid, then yes – it is possible when the block is placed on the square base.
- Is there more than one way that you can place the block to satisfy the arrangement from all views? Yes – there are four different ways that children could place the block. The possible ways are:

Novice_1 Set 1

When each child in the group is satisfied that the arrangement corresponds to the view on their card, lead a reflective discussion that includes answering the following questions:

- Do the blocks look the same in all four cards? Yes – the blue block looks like a 1 by 3 rectangle in all views and the green block looks like a 1 by 1 square in all views.
- Are the blocks in the same position in all four cards? No. The blocks are in the same position in Views A and B, but in the opposite positions in Views C and D.

Novice_1 Set 2

When each child in the group is satisfied that the arrangement corresponds to the view on their card, lead a reflective discussion that includes answering the following questions:

- Do the blocks look the same in all four cards? Yes – the blue block looks like a 1 by 3 rectangle in all views, the green block looks like a 1 by 1 square in all views and the yellow block looks like a 2 by 1 rectangle in all views.
- Are the blocks in the same position in all four cards? No – in Views A and View C, the blocks are in mirror opposite positions. Similarly in View B and View D, the blocks are in mirror opposite positions.
GEOGENIUS CONSTRUCTION KIT ACTIVITIES

In these activities we expect children to develop:

- Confidence in building given 3-D objects using concrete materials.

For these activities you will need:

- GeoGenius Construction Kit (at least one Super Kit per 5 children)
- GeoGenius Construction Kit Activity cards 1 – 10

Teacher’s role:

Children should be able to work on these cards independently of the teacher. Each child will need selected pieces from a GeoGenius Construction Kit, elastics and an activity card. Children can work in pairs or individually. The advantage of working in pairs is that children can talk about what they are doing. The disadvantage of working in pairs is that only one child can actually do the building at a time. It is not recommended that these Activity cards are done in groups of more than two.

In these activities, children recreate the polyhedra in the images on the cards using pieces from the GeoGenius Construction Kit. If children have not had the opportunity to play with this kit before, the teacher may need to help them by showing them how to use elastics to join the tabs:

Its as easy as 1 + 2 = 3!

1. Attach the tabs of two pieces together with the elastic bands supplied.
2. Repeat as required to complete the shape that you are making.
3. Eurekak! Your very own completed GeoGenius shape!

As children are working, the teacher could ask them:

- Which shape did you start with?
- Could you have started with a different shape?
- How did you decide which shapes to join together?
- Can you see any patterns in the shapes that you are joining?

Make time for constructions to be taken apart and packed away neatly so that the Kit can be
What to expect from the children:

The main focus of these activities is for children to play and gradually to start to recognise some of the properties of polyhedra.

Children are not expected to use formal mathematical vocabulary yet.

The notes on specific cards give guidance to teachers on what children may notice, but should not be taught to children.

Notes on specific cards:

Activity card 1

In this activity children make polyhedra using squares, rectangles and (equilateral) triangles. They build a cube, a rectangular-prism (or cuboid) and a triangular prism. Children do not have to know the names of these polyhedra yet, although teachers may want to encourage the name of the cube. It is sufficient for children to talk about boxes and maybe differentiate between the rectangular box and the triangular box. Teachers may use the terminology prism.

Children are encouraged to notice that the cube is made up of 6 squares. The rectangular prism is made up of 2 squares and 4 rectangles and the triangular prism is made up of 2 triangles and three rectangles.

Activity card 2

In this activity children make polyhedra using squares and (equilateral) triangles. The base of the pyramid and elongated pyramid are hidden. The intention was for these to be square-based, but children may use triangular bases or even try pentagonal bases. If this happens, the use this opportunity to discuss the limitations of 2-D print for 3-D objects and how a different view of the object may have made it more clear what shape to use at the base of these pyramids.

A square-based pyramid has one square and four triangular faces. An elongated square pyramid has five square and four triangular faces. The cuboctahedron has 6 square and 8 triangular faces.

Activity card 3

In this activity children use only (equilateral) triangles to create three of the five Platonic solids. The tetrahedron uses 4 triangles, the octahedron uses 8 triangles and the icosahedron uses 20 triangles.

Teachers could ask children if they notice anything special about the points (vertices) where the shapes meet. In all these polyhedra there are the same number of shapes (faces) meeting at
every point (vertex). 3 triangles meet at every vertex of the tetrahedron. 4 triangles meet at every vertex of the octahedron and 5 triangles meet at every vertex of the icosahedron.

**Activity card 4**

In this activity children build three types of pyramids. While they may know the vocabulary triangle and square, they are not expected to know the name pentagon yet, but could call this a five-sided shape.

Children are asked to compare these pyramids. They may describe them in terms of triangles that meet at a point. The difference is the base or the shape that the triangles are attached to.

**Activity card 5**

In this activity children build polyhedra from pentagons and (equilateral) triangles. The first polyhedron is a dodecahedron and the second is an icosidodecahedron. The dodecahedron is made from 12 pentagons and the icosidodecahedron is also made with 12 pentagons, but also 20 (equilateral) triangles.

**Activity card 6**

In this activity, children build a pyramid, a prism and an anti-prism all with a pentagonal base. The pentagonal-based pyramid is made using 5 (isosceles) triangles and one pentagon. These triangles meet at a point. The pentagonal-based pyramid is made using 5 rectangles which connect two parallel pentagons. The pentagonal-based anti-prism is made using 10 interlocking (isosceles) triangles which connect two parallel pentagons.

**Activity 7**

In this activity children use pentagons, squares and (equilateral) triangles to build a rhombicosidodecahedron.

Teachers may want to encourage children to focus on the vertices and ask them, “What shapes do we need to join to create this point?” At every vertex is a pentagon, a square, a triangle and another square.

**Activity 8**

In this activity children use hexagons, squares and octagons to build a great rhombicuboctahedron.

Teachers may want to encourage children to focus on the vertices and ask them, “What shapes do we need to join to create this point?” At every vertex is a hexagon, a square and an octagon.

**Activity 9**

In this activity children build five types of prisms and compare the similarities and differences. The triangular-based prism is made from two (equilateral) triangles and three rectangles. The square-based prism is made from two squares and four rectangles. The pentagonal-based prism is made from two pentagons and five rectangles. The hexagonal prism is made from two
hexagons and six rectangles. The octagonal-based prism is made from two octagons and eight rectangles.

All the prisms are made by joining two identical shapes with rectangles. It is the shape joined by the rectangles that are different in each prism.

Activity 10

In this activity children use pentagons and hexagons to build a truncated icosahedron.

Teachers may want to encourage children to focus on the vertices and ask them, “What shapes do we need to join to create this point?” At every vertex is are two hexagons and a pentagon.
CONNECTING CUBE ACTIVITIES

In these activities we expect children to develop:

- Confidence in building given 3-D objects using building blocks.
- Opportunities to describe one 3-D object in relation to another.

For these activities you will need:

- 40 connecting cubes per child.
- Connecting Cube Activity Cards 2 and 5 – 12

Teacher’s role:

Children are able to work on these cards independently of the teacher. Children could work individually or in pairs.

Each child will need no more than 10 connecting cubes and an activity card. In these activities, children are not expected to build the structures using the same colour connecting cubes as in the picture.

When possible teachers should take the opportunity to observe how children join the connecting cubes and to assess informally how the children think about the objects.

Notes on specific cards:

Activity card 2

Children join three connecting cubes in two different ways – a straight line and a bend. There are no different ways to join three cubes. It is important that children start to recognise that holding a shape a different position does not make it different. For example, there are only two ways of joining three blocks. The two green shapes are the same and all orange shapes are the same:
As an extension, children are asked to investigate how many shapes they can make with four and five blocks. Challenge children to find all the ways.

There are eight different shapes that can be built using four blocks:

There are 29 different shapes that we can build using five blocks:
Activity Card 5

Children join five connecting cubes in five different ways.
Activity Card 6

In this activity, it is expected that children join five connecting cubes in three different ways. The pink and green shapes are the same and the blue and yellow shapes are the same. The red shape is different to the other two.

However, there exists the possibility that there is a seventh cube hidden behind the pink shape and a seventh cube hidden behind the blue shape. The illustration below shows the pink and blue shapes from a different view where the possible seventh cube is seen.

Activity Card 7

Children to join six or more connecting cubes in four different ways. The red and blue shapes can only be made using six connecting cubes. It is possible to build the green and yellow shapes using seven cubes. The seventh cube is hidden from the image that we see. The illustration below shows the green and yellow shape from a different view where the possible seventh cube is seen.

Activity Card 8

Children join six connecting cubes in three different ways. It is also possible to build the green shape with a seventh cube that is hidden in the view given.

Activity Card 9

Children join six connecting cubes in three different ways. The shapes are the same in that they all have 5 connecting cubes joined to form an ‘L-shape’. The position of the sixth cube that is placed on top of the ‘L’ is what is different in each shape.

Activity Card 10

In this activity children join six connecting cubes.

The pink and blue shapes are the same. The green shape is the mirror image of the pink and blue shapes, but not the same.
Activity card 11

This is the first of the Connecting Cube Activity cards where children have to consider the 2-D representation of the 3-D object. In this activity they connect six cubes and match four views (A, B, C and D) to a 2-D representation.

Image 1 could be the view from D or from B. Children find it easier to accept that this is a view from D, but more difficult to accept this is also a view from B. This is because the 2-D representation does not show any depth – only the outline of what we see.

Image 2 is the view from C and image 3 is the view from A.

Ask children what they notice about the views from A and C. We would like them to start to notice that these views are the mirror reflections of each other.

Activity 12

Children could use 6 or 7 cubes to build this structure. If children use seven blocks, image 2 is not possible from any of the four views so they will need to revise their construction to use only 6 cubes.

Image 1 is the view from D. Image 2 is the view from both A and C. Image 3 is the view from B.