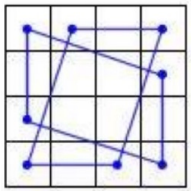
DURER'S MAGIC SQUARE

16	3	2	13
5	10	11	8
9	6	7	12
4	15	14	1

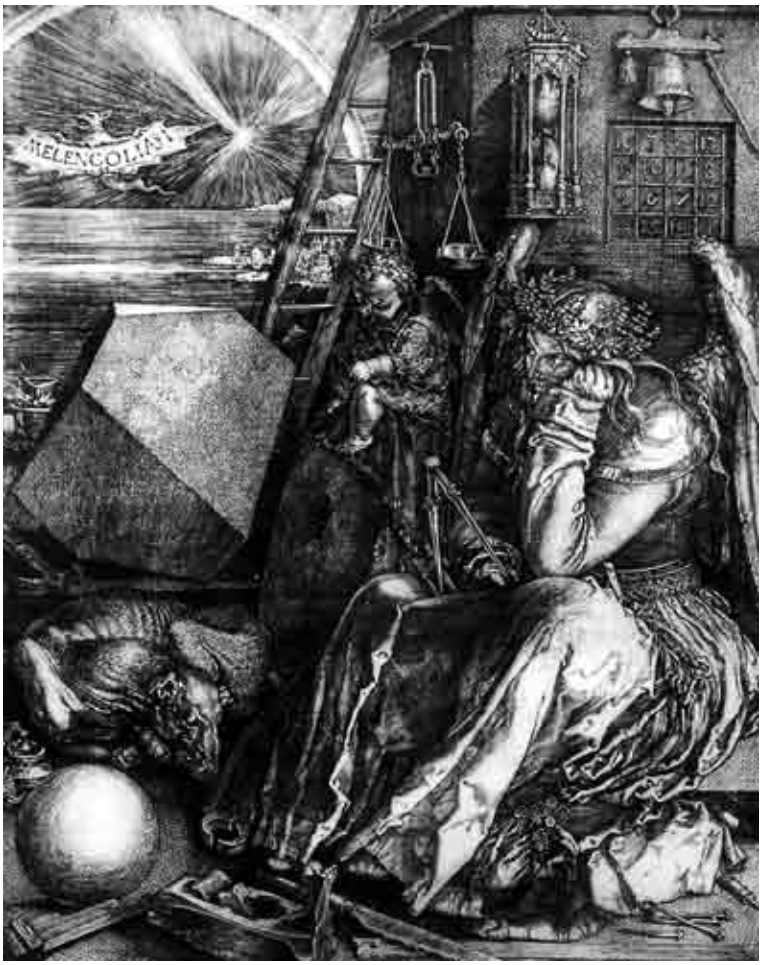


Add the columns one by one, add the rows, then add the diagonals. What do you notice?

Add the numbers in the squares at the corners of each parallelogram shown. What do you notice?

Yes, so far all these totals have been 34. In addition the diagram with the two parallelograms has 4-fold rotational symmetry so there is a lot of mathematics in this supermagic square.

Now investigate the totals of different sets of 4 numbers chosen from this magic square. Draw diagrams like the one given above.

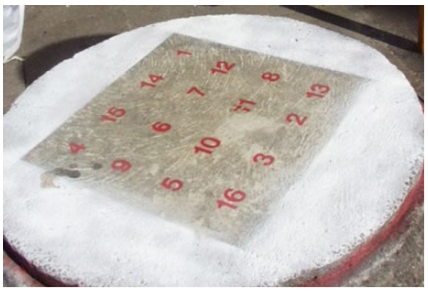


Can you find 10 diagrams and, for each one, describe the quadrilaterals you draw and describe the symmetries in the diagram.

This is Albrecht Durer's supermagic square from his famous engraving Melencolia dated 1514. Can you see it at the top right hand corner of the engraving under the bell? It has many more special properties.

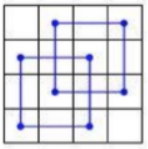
A friend was visiting a school in Denmark and photographed this seat in the playground.

What is the same and what is different about the magic square on the seat from Durer's magic square?



HELP

Check this diagram by adding the numbers at the corners of each blue square.
Find other quadrilaterals with the '34 property'.

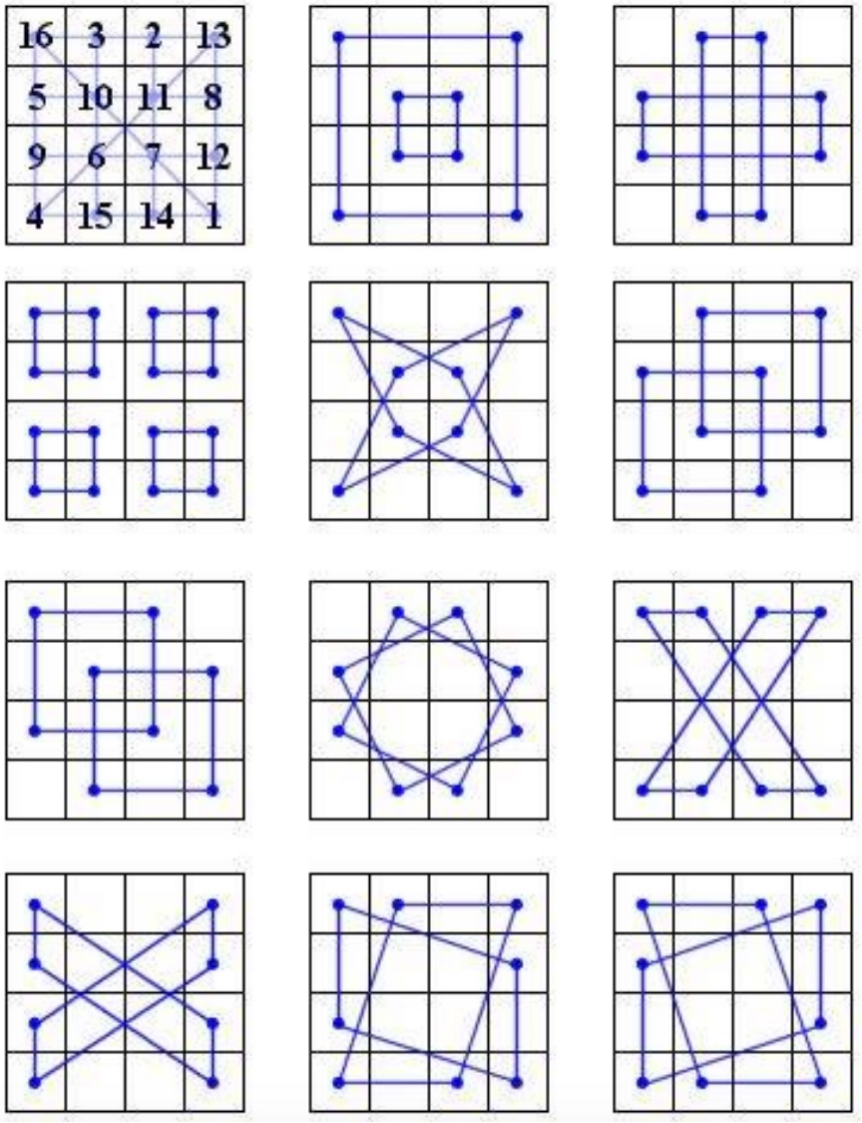


NEXT

Do some research on the internet about Durer and/or about magic squares.

NOTES FOR TEACHERS

SOLUTION



For each of these diagrams the numbers at the 4 vertices of the quadrilaterals add up to 34.

Imagining the diagrams numbered 1 to 12 in the obvious way, you will see rectangles in diagram 3, squares in diagrams 2, 4, 6, 7 and 8, rhombuses in diagram 5 and parallelograms in diagrams 9, 10, 11 and 12.

<u>Rotational symmetry order 4</u>
Diagrams 2, 3, 4, 5, 8, 11 & 12.

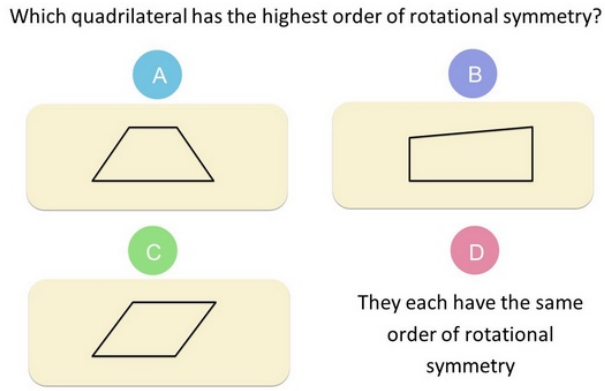
<u>Rotational symmetry order 2</u>
Diagrams 6, 7, 9 & 10

<u>Reflection symmetry in vertical and horizontal axes</u>
Diagrams 2, 3, 4, 5, 8, 9, 10

<u>Reflection symmetry in diagonal axes</u>
Diagrams 2, 3, 4, 5, 6, 7, 8

Diagnostic Assessment This should take about 5–10 minutes.

1. Write the question on the board, say to the class:
   "Put up 1 finger if you think the answer is A, 2 fingers for B, 3 fingers for C and 4 fingers for D".
2. Notice how the learners responded. Ask a learner who gave answer A to explain why he or she gave that answer and DO NOT say whether it is right or wrong but simply thank the learner for giving the answer.
3. Then do the same for answers B, C and D. Try to make sure that learners listen to these reasons and try to decide if their own answer was right or wrong.



4. **Ask the class again to vote for the right answer by putting up 1, 2, 3 or 4 fingers. Notice if there is a change and who gave right and wrong answers.** It is important for learners to explain the reason for their answer otherwise many learners will just make a guess.
5. If the concept is needed for the lesson to follow, explain the right answer or give a remedial task.

The correct us C
A and B. have no rotational symmetry.
C. has rotational symmetry of order 2.

https://diagnosticquestions.com

Why do this activity?

This is a very rich activity and perfect for differentiation in a mixed attainment level class. But it is also equally suitable for younger learners where the emphasis can be on practising simple addition as well as for older learners where the investigation gives them an opportunity to review properties of quadrilaterals and symmetry.

Intended learning outcomes

Years 6 and 7 Practice in addition and properties of quadrilaterals.
Years 8 and 9 Practice in addition. Properties of quadrilaterals, reflective and rotational symmetry.

Generic competences

In doing this activity students will have an opportunity to:

- **think flexibly**, be creative and innovative and apply knowledge and skills;
- **visualize** and interpret and create visual images to represent concepts and situations;
- **research** and search for, evaluate, select, organise, analyse, and interpret information.
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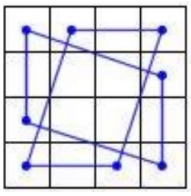
Suggestions for teaching

Draw the magic square on the board. Ask the learners to add the columns one by one. Ask them "What do you notice?" Then ask them to add the rows, then add the diagonals. You might like to show them an image of Melencolia and ask them what they see in it. This may be all you choose to do with very young learners.



Then talk about the parallelograms in this diagram. Ask the class to add up the numbers at the vertices. What do they notice? Ask the learners about the properties of these quadrilaterals.
Tell the learners that the task is to investigate other quadrilaterals in the same way and to add the numbers at the vertices. If the total is 34 then draw the quadrilateral.

You could give them the sheet of 4 by 4 grids from page 6, ask them to draw on the grids the pairs of quadrilaterals that they discover and to describe the pattern formed by the 2 quadrilaterals. Ask them if they can find 4 congruent quadrilaterals with the '34 property' that they can draw in one diagram.

Key questions

- Can you find 4 numbers at the corners of a quadrilateral that add up to 34?
- What is the name of that quadrilateral?
- What properties does that quadrilateral have?
- Can you find another quadrilateral, congruent to that one, where the 4 numbers at the corners add up to 34?
- Can you describe the symmetries in that diagram?

Follow up

5 by 5 magic square: https://aiminghigh.aimssec.ac.za/years-7-to-9-picture-puzzler/

Note: The Grades or School Years specified on the AIMING HIGH Website correspond to Grades 4 to 12 in South Africa and the USA and to Years 4 to 12 in the UK.				
	Lower Primary or Foundation Phase	Upper Primary	Lower Secondary	Upper Secondary
South Africa	Grades R and 1 to 3	Grades 4 to 6	Grades 7 to 9	Grades 10 to 12
USA	Kindergarten and G1 to 3	Grades 4 to 6	Grades 7 to 9	Grades 10 to 12
UK	Reception and Years 1 to	Years 4 to 6	Years 7 to 9	Years 10 to 13
East Africa	Nursery and Primary 1 to	Primary 4 to 6	Secondary 1 to 3	Secondary 4 to 6