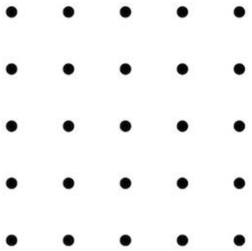
AFRICAN INSTITUTE FOR MATHEMATICAL SCIENCES
SCHOOLS ENRICHMENT CENTRE (AIMSSEC)
AIMING HIGH

SQUARES GAME

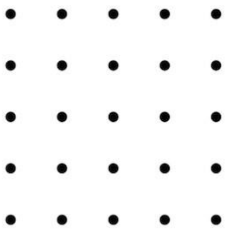
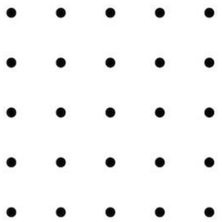
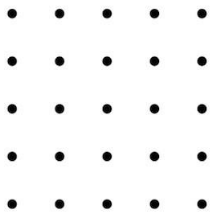
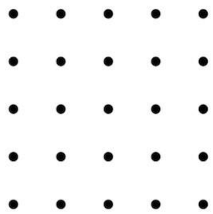


TEAM GAME: Draw a dotty grid on a board or a piece of scrap card where everyone can see it. This game can be played by two teams. Take it in turn for a player from each team to mark a point with the team colour. The winning team is the first to have 4 points in their colour at the vertices of a square. The teams must try to stop their opponents from making squares.

GAME FOR 2 PLAYERS Play exactly as in the team game. Score a point for each win. Try to find winning strategies that will help you to win.

HELP

Start by drawing squares on these dotty grids to use later during the games. Look for tilted squares. Compare the squares that you have drawn with other people. Are your quadrilaterals all squares? Have they found squares that you did not see?

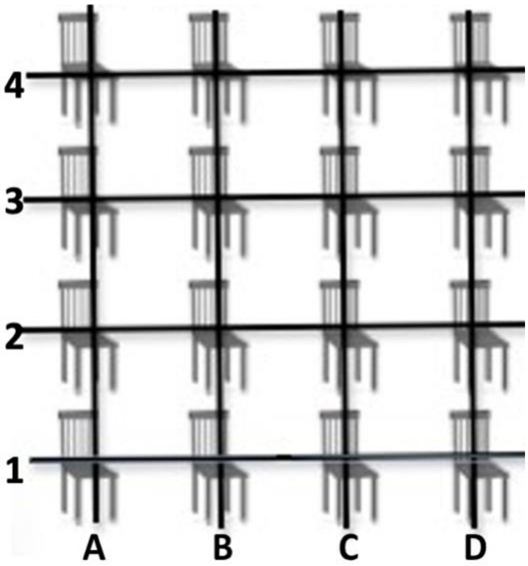
NEXT

If you can play against a computer at http://nrich.maths.org/2526 then try to learn how to win by thinking about the strategies used by the computer. For games like Chess and Go people become world champions by studying past games. If you can't play against a computer you can still go back over the game and see what difference an alternative move could have made. Study your moves and your opponent's and try to decide what are winning moves and what are losing moves.

The computer follows an algorithm (which may or may not be random) to place its pieces. By studying the moves over a series of games can you work out the computer's strategy?

Do you think that it is random or deterministic (i.e. the computer will always play in a certain position given a certain configuration of pieces)?

SQUARES TEAM GAME



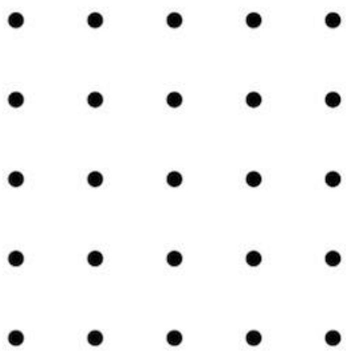
This game can be played by two teams and can be played by a whole class. Take it in turn for a player from each team to sit on one of the chairs. The winning team is the first to have 4 team members sitting at the vertices of a square. The teams must try to stop their opponents from making squares.

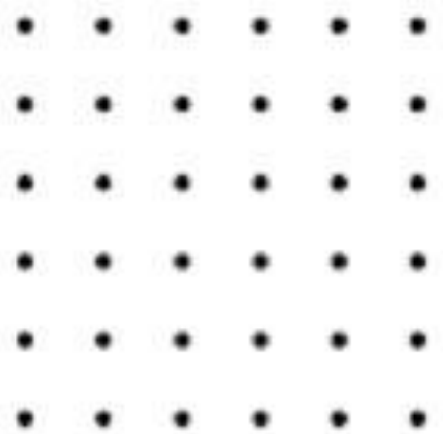
This works well if the learners stand together in 2 groups so that they can consult each other and if they are given time to decide where their next player should sit.

If there is doubt use the rope to check whether the 4 points form a square.

UPGRADE TO A 5×5 GRID OR 6×6 GRID

This is a game for 2 players. The game is more challenging with a 5×5 or 6×6 grid. Take it in turn to mark an intersection point with your mark. The winner is the first to mark 4 points that are vertices of a square.





PLAY THE GAME AGAINST A COMPUTER
http://nrich.maths.org/2526

SQUARES COORDINATE GAME

This is a game for 2 players. Take it in turn to give the coordinates of your chosen points. Both players must write down the coordinates and mark them on their charts. The winner is the first to capture 4 points that are vertices of a square.

				y	5				
					4				
					3				
					2				
					1				
-5	-4	-3	-2	-1	0	1	2	3	4
					-1				
					-2				
					-3				
					-4				

Player 1 coordinates:	**Player 2 coordinates:**

SQUARES GAME NOTES FOR TEACHERS

Why play this game?

This game is a good starting point for learning school maths from Year 5 to year 10. It This offers an excellent opportunity to practise visualising squares, angles and gradients on grids and also it encourages students to look at strategies using systematic approaches. Describing strategies to others is always a good way to focus and clarify mathematical thought.

Working with tilted squares provides an opportunity to examine the properties of gradients and to think about the gradients of parallel and perpendicular lines.

This can lead on to further work on coordinates (see Square Coordinates on the NRICH website) and to proving Pythagoras Theorem (see Make Squares Jigsaw and Pythagoras Jigsaw on the AIMING HIGH website).

Learning objectives

Lessons can be planned to use this game to work towards one or more of the following:

- to develop problem solving and visualisation skills and experience of working systematically;
- to develop concepts of area;
- to introduce the ideas of distance, gradient and perpendicularity in analytic geometry;
- to lead up to work on Pythagoras Theorem.

Generic competences

By playing this game students will have an opportunity to:

- **think mathematically,** reason logically and give explanations;
- **think flexibly**, be creative and innovative and apply knowledge and skills;
- **develop visualization** and the skill to interpret or create images to represent concepts and situations;
- interpret and **solve problems**;
- **work in a team to** collaborate and work with a partner or group.

Suggestions for Teaching

The game can be used in different forms for short periods in many lessons. Depending on the age of your learners, the topic for your lesson and the learning objective, start with the whole class playing one of the versions of this game in two teams. Learners are often surprised when the winning square isn't aligned with the grid. This leads to discussions about what makes a square a square.

After a demonstration of the game, learners could be left to play for a while in pairs, either on a paper grid or on a computer. Give learners the option of reducing the size of the board if they seem overwhelmed or increasing from a 4 by 4 (16-dot) grid to 5 by 5 (25-dot or even to 36-dot) if they would benefit from a greater challenge.

Bring the class together for a discussion of their thoughts on the game. Did anyone consistently win or lose? Can anyone think of any good strategies which might help them win? Once ideas have been shared the group can return to playing in pairs, or they can play a game together against the computer, trying, as a class to decide on the best move at each stage. Ask each learner to explain the reasoning behind the moves they choose.

One aspect of developing a winning strategy that the class could discuss is the number of distinctly different starting points (6 on a 5 by 5 board) and the number of different squares that can be drawn that include each of those points. That is, "Is there a good place to start and why?". This is a great investigation, with the capacity to expand by changing the sizes of the starting grid, and which leads back into the game itself.

Working on the properties of a square offers an opportunity to look at gradients to establish whether a square is a square. With classes who never arrive together or on time, this and other interactive games can be used to engage the early arrivers and set up a relaxed mathematical atmosphere.

The problem can be built up gradually from a 16 dot board to a 25 dot board then to a 36 dot board. Learners could experiment making different squares using the interactivity in Square Coordinates

The group could be asked to draw examples of the different squares on their specific board size, and to compare notes to check for wrong or omitted solutions.

Some learners might find 'believing' in the tilted squares difficult. On paper they could use the corner of a piece of paper (or a set-square) to convince themselves that the angles in a shape are 90^{o}. They could be encouraged to cut the shapes out and move them around to see if the cut-out really looks square.

Key questions

- Is your move a good one? Why did you make it?
- Why do you think the computer made that move? Was it a good one?
- How do you know that is a square?

Follow up

How Many Squares? https://aiminghigh.aimssec.ac.za/how-many-squares/
Square Coordinates http://nrich.maths.org/2667
Pythagoras Theorem; https://aiminghigh.aimssec.ac.za/make-squares-jigsaw/
and https://aiminghigh.aimssec.ac.za/pythagoras-jigsaw/