THE MATHEMATICAL ASSOCIATION OF VICTORIA

Algorithmic thinking resources

Year 4: The Farmer's Garden

In this lesson students work to solve area problems using algorithms and their knowledge of arrays.

Level 4 – Number and Algebra | Patterns and Algebra | Define a simple class of problems and solve them using an effective algorithm that involves a short sequence of steps and decisions (VCMNA164)

MATHEMATICAL LANGUAGE

Area, dimension, multiply, multiplication, distributive, partition, product, total, metres, algorithm.

MATERIALS

Warm Up Game

- Paper clips
- Arrays Games (See link below)
- Coloured pencils

Activity

- Book – Farmer Joe's Hot Day
- Plastic square tiles (counters)
- Problem sheet (with space to work out the problems) and pencils

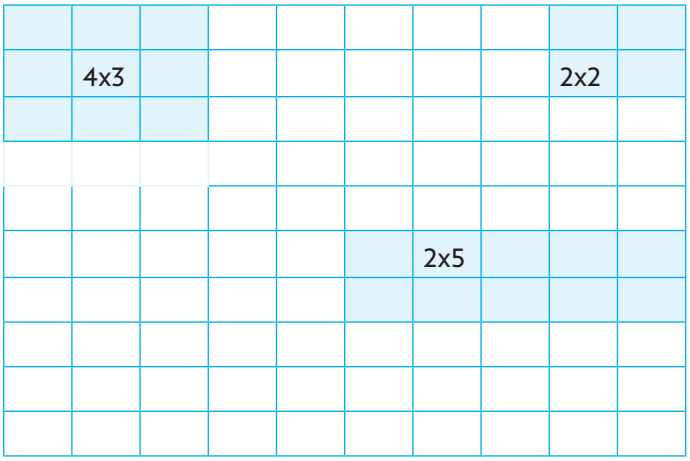
WARM UP - MULTIPLICATION TOSS

Dr Paul Swan Arrays Game 1 – 6 http://docs.wixstatic.com/ugd/c8dd86_a633534e4239408ebd8c95a228916d9d.pdf

Dr Paul Swan Arrays Game 0 – 9 http://docs.wixstatic.com/ugd/c8dd86_035d9b2601df4e03b669dc77b01c9479.pdf

- Ask students to get into pairs. Give each pair a paper clip to create a spinner, and two coloured pencils.
- Each player takes turns to spin a spinner. The result of the spin determines the region to be marked. For example, a 6 and a 4 could be recorded as 6

fours (6 rows of 4) or 4 sixes (4 rows of 6). The player draws a border around the region and the corresponding fact is recorded in the region.
- The object of the game is to cover as much of the grid as possible without overlapping.
- At any time in the game a player can decide to partition or split the region. For example, instead of 6 eights, a player may decide to enclose two separate regions such as 5 eights and 1 eight or 6 fours and 6 fours.



LAUNCH

- Begin by reading the book What The Ladybird Heard or similar text.
- Tell the students that the class will be making their own farmer's garden with four different patches. Each patch will grow something different, but each patch is a different size. They need to figure out the area of each patch.

The garden is set out as follows:

The wheat is 50 metres across and 30 metres down. The carrot patch is next to the wheat and is 7 metres across and 30 metres down. The corn is below the wheat and is 50 metres across and 6 metres down.

Next to the corn are the peas. This patch is 7 metres across and 6 metres down.

1. What method/steps would you use to work out the *area* of each patch?
2. What is *area* of the whole garden?
3. What are the *dimensions* of the whole garden?

EXPLORE

- Organise the students into pairs. Give each pair a copy of the problem The Farmer's Garden (Student Resource The Farmer's Garden).
- Ask them to record and display how they worked out each of the areas. Encourage them to use different ways to work out the dimensions and area of the whole garden.

SUMMARISE

Choose some students to share how they worked out their solutions, including some different ways in which they worked out the dimensions and area of the whole garden. Ask them the following questions:

1. What did you notice when working out the dimensions and area of the whole garden?
2. How would/could you work out the areas of gardens with the following dimensions:

- 28 x 45 m
- 63 x 57 m
- 39 x 86 m

Discuss the various methods with the students. Ask them which method they think would be the most efficient/easiest.

ENABLING PROMPTS

- Write the dimensions for each patch on the diagram.
- Use smaller numbers for each patch instead, such as: 20 x 10, 3 x 10, 20 x 4, 3 x 4. Give the students square tiles (counters) to help them model the problem.

EXTENDING PROMPTS

- The garden could have six or nine patches instead (two digit by three digit, or three digit by three digit)
- Ask the students to work out the area of the gardens mentioned above: 28 x 45 m, 63 x 57 m, 39 x 86 m, using an efficient method, such as

breaking each garden up into smaller patches to work out the total area.

QUESTIONS TO ENCOURAGE DEEPER THINKING

- Do you think you could apply these steps of working out the area of the gardens to solving any multiplication problem? Convince me.
- How does following these steps relate to the traditional algorithm for working out multiplication problems?

EXTENDED VICTORIAN CURRICULUM LINKS MATHEMATICS

Level 4 - Number and Algebra
Number and Place Value

- Apply place value to partition, rearrange and regroup numbers to at least tens of thousands to assist calculations and solve problems (VCMNA153)
- Recall multiplication facts up to 10 × 10 and related division facts (VCMNA155)
- Develop efficient mental and written strategies and use appropriate digital technologies for multiplication and for division where there is no remainder (VCMNA156)

Pattern and algebra

- Explore and describe number patterns resulting from performing multiplication (VCMNA161)
- Solve word problems by using number sentences involving multiplication or division where there is no remainder (VCMNA162)
- Define a simple class of problems and solve them using an effective algorithm that involves a short sequence of steps and decisions (VCMNA164)

Level 3-4 - Critical and Creative Thinking
Meta-cognitions

- Investigate a range of problem-solving strategies, including brainstorming, identifying, comparing and selecting options, and developing and testing hypotheses (VCCCTM020)

Digital Technologies – Levels 3 & 4
Creating digital solutions

- Define simple problems, and describe and follow a sequence of steps and decisions involving branching and user input (algorithms) needed to solve them. (VCDTCD023)

PROFICIENCIES

Problem Solving

Students develop the ability to make choices, interpret, formulate, model and investigate problem situations, and communicate solutions effectively. Students formulate and solve problems when they use mathematics to represent unfamiliar or meaningful situations, when they design investigations and plan their approaches, when they apply their existing strategies to seek solutions, and when they verify that their answers are reasonable.

Reasoning

Students develop an increasingly sophisticated capacity for logical thought and actions, such as analysing, proving, evaluating, explaining, inferring, justifying and generalising. Students are reasoning mathematically when they explain their thinking, when they deduce and justify strategies used and conclusions reached, when they adapt the known to the unknown, when they transfer learning from one context to another, when they prove that something is true or false, and when they compare and contrast related ideas and explain their choices.

ASSESSMENT OPPORTUNITIES

Teachers can assess students using a checklist or anecdotal notes through observation. Student samples and photos of students engaging in the activity can be kept as evidence.
Any of the above-mentioned curriculum links can be assessed through this activity.

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1. What method/steps would you use to work out the area of each patch?

2. What is area of the whole garden?

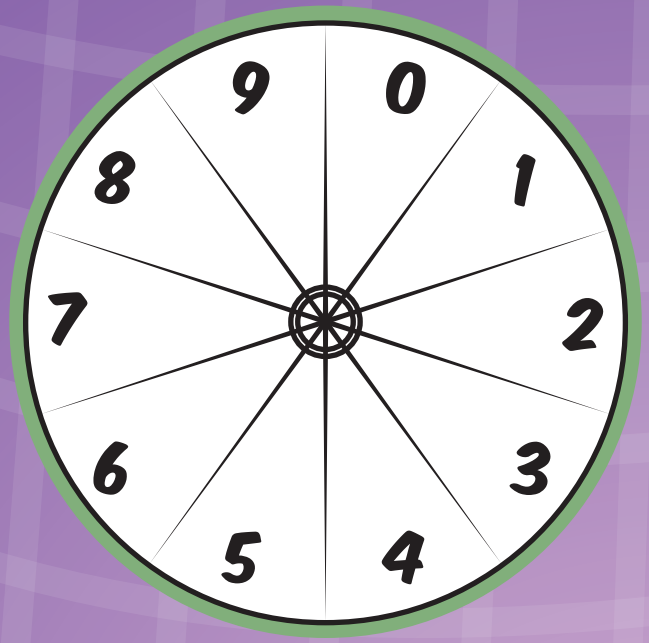
3. What are the dimensions of the whole garden?

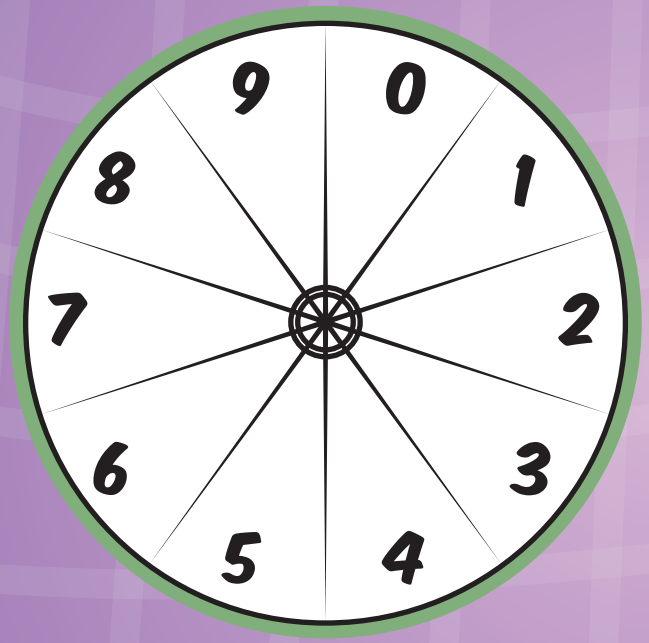
(Use your mathematics book or spare paper to record your thinking and solutions.)

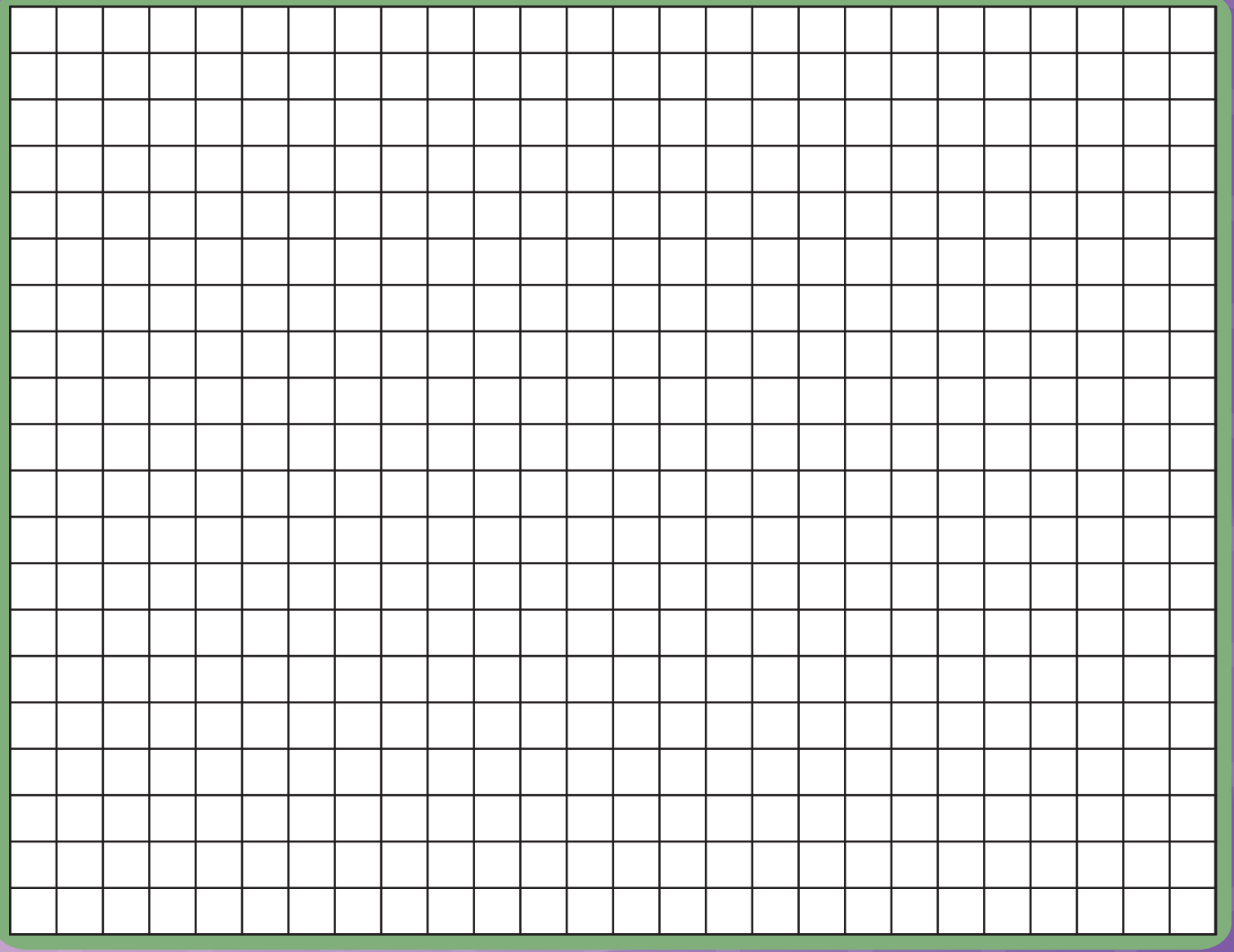
ARRAYS GAME

0 - 9

Aim: To colour (capture the most area).
Materials: Two different coloured pens or erasable markers.
A game for two players.
Rules:
Each player flicks the spinners and draws a rectangle (array) according to what is indicated on the spinners. The player should lightly shade the inside of the rectangle and write the calculation. A time limit can be set and the winner is the player who captures the most area in this time period.







The Spinner Array Game

Australian Curriculum Links

Yr 2: (ACMNA031) Recognise and represent multiplication as ... arrays.

Yr 3: (ACMNA056) Recall multiplication facts of two, three, five and ten ...

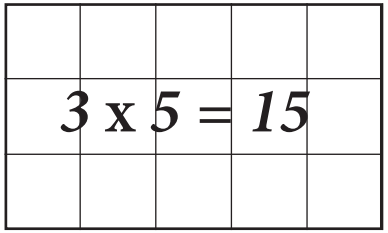
Yr 4: (ACMNA075) Recall multiplication facts up to 10 × 10 ...

Teacher Notes

There are several concepts associated with the development of multiplication. In the early years students will be exposed to the idea of multiplication as repeated addition (equal groups), grouping and arrays. This game is designed to focus students on the array model of multiplication. The array model is used to emphasise the commutative property of multiplication, that is, 3 x 5 = 5 x 3. If students understand this property it will greatly reduce the number of table facts that need to be learned.

The following array shows that there are:

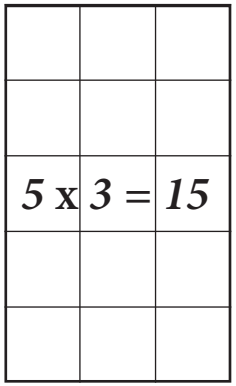
5 squares in each row
3 rows
3 *fives* are 15



The same array has been rotated 90 degrees.

Now it shows

3 squares in each row
5 rows
5 *threes* are 15



Some students, who do not know the fact, will count individual squares; others may count by threes or fives. If students are given Cuisenaire Rods then that will encourage counting in equal groups. Each time a new rod is placed it will represent another group. In the three rows of 5 example, a student might lay down one yellow rod, then another and finally a third rod. This would be quicker than laying down five light green rods.

Eventually they will learn the that 3 rows of 5 is 15. Encourage the students to write the fact on the rectangle (array).

When playing the game, students may note that some of the arrays (rectangles) are in fact squares. Point out the dimensions of the squares and link this to 'square numbers'. For example, 4 x 4 = 16 will produce a square array. If the spinners are changed or dice are substituted, then students will have to multiply by zero. This will lead to the realisation that a rectangle or array cannot be drawn.

Aim: To colour (capture the most area).

Materials: Two different coloured pens or erasable markers, optional 10 mm grid paper, rods

A game for two players.

Rules

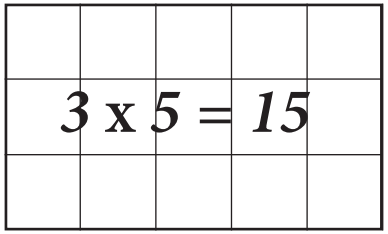
Each player flicks the spinners and draws a rectangle (array) according to the what is indicated on the spinners.

The player should lightly shade the inside of the rectangle and write the calculation.

A time limit can be set and the winner is the player who captures the most area in this time period.

Variations

In the initial stages students should draw the rectangle as the spinners indicate. Three rows of 5 would look like this.



Later a strategy version of the same game may be played where play continues until one player cannot draw an array. In this case you may wish to allow players to turn their arrays (rectangles) around to fit them in. This will highlight the commutative property of addition, that is, $a \times b = b \times a$, or 3 x 5 = 5 x 3.

Games may be made shorter by folding the sheet of grid paper in half. If playing on a laminated sheet of grid paper then certain squares may be shaded in at the start of the game and made 'off limits'.

For larger multiplication facts, 0 - 9 spinners or 0 - 9 dice may be used. When a zero turns up the student will not be able to draw an array, emphasising that anything multiplied by zero is zero (multiplication property of zero).

For facts beyond 9 x 9, different spinners or dice may be used. The larger numbers will mean that more squares are consumed more quickly, so it makes sense to use 5 mm grid paper instead of 10 mm grid paper.

ARRAYS GAME

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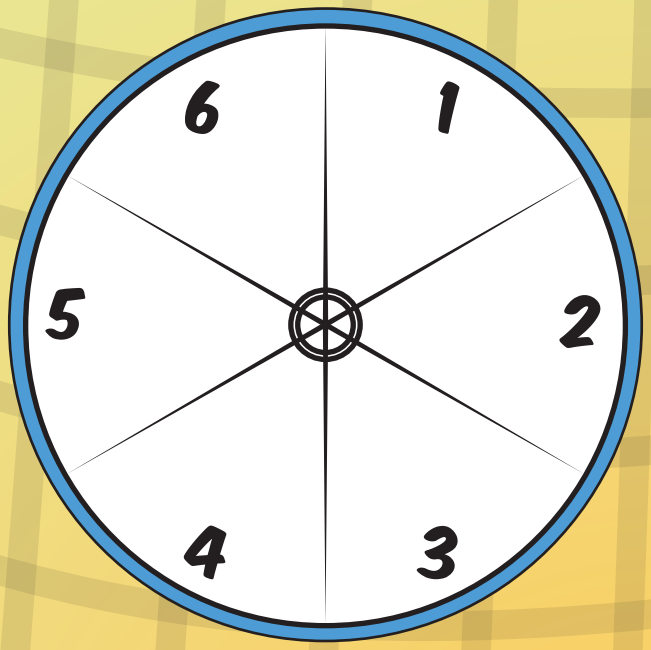

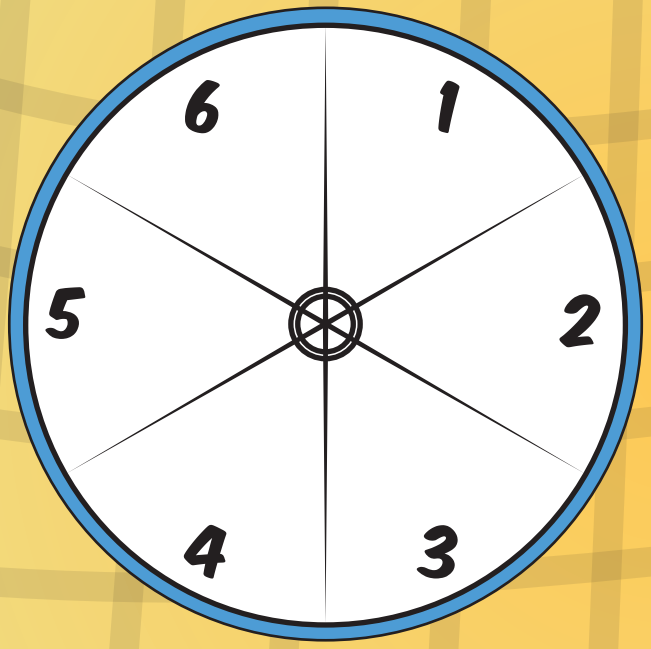

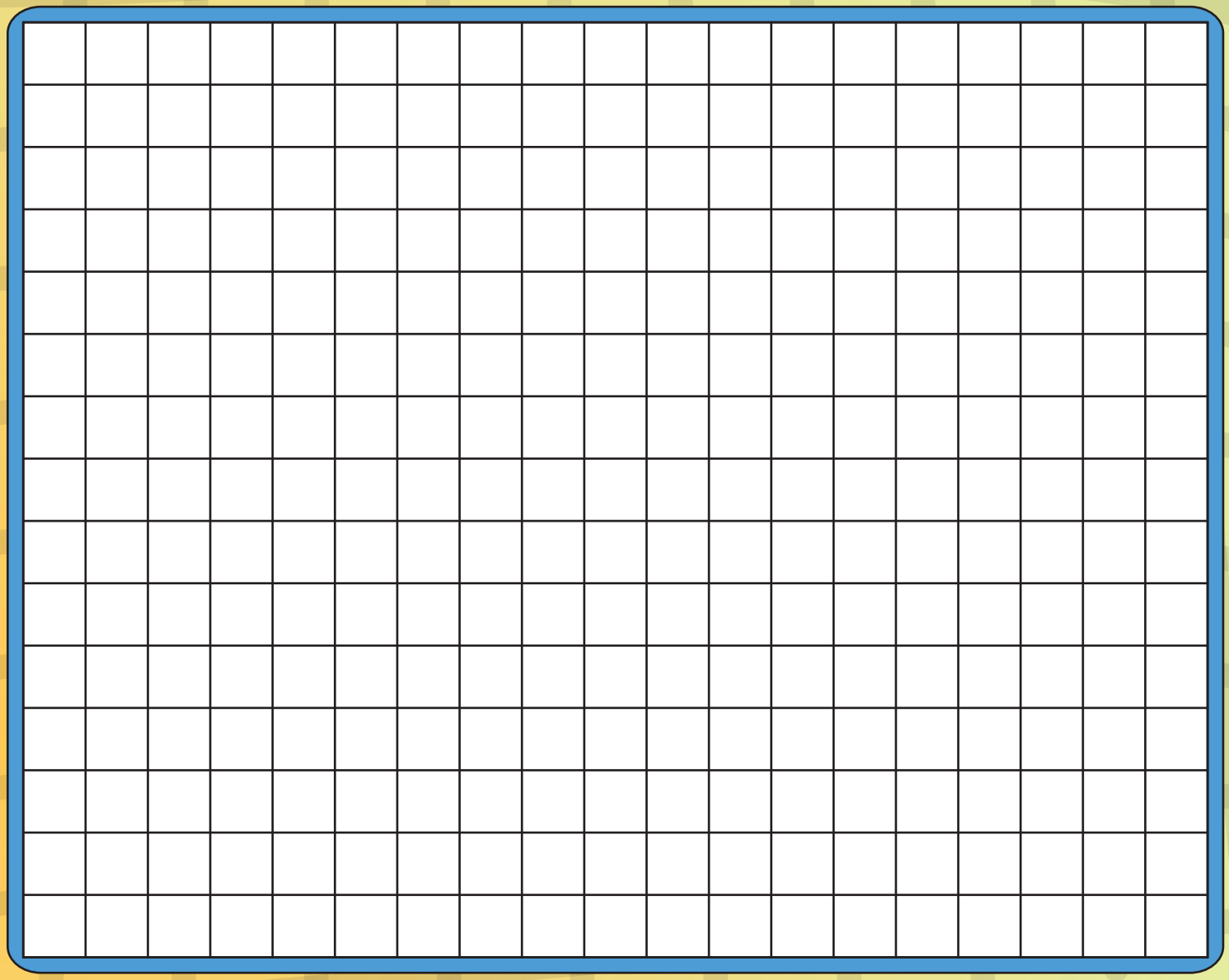

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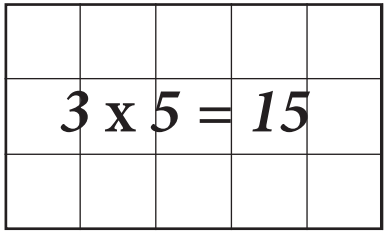

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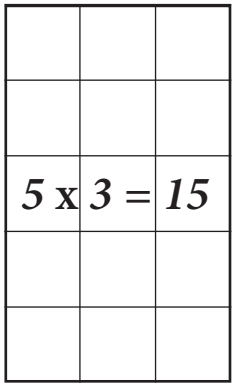

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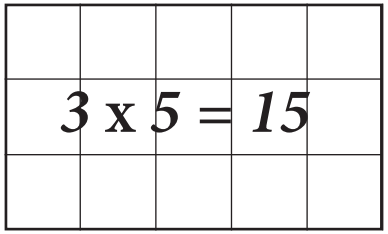

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