CHICKEN BOXES

Lesson 2: Box Designs with Other Shapes

Australian Curriculum: Mathematics (Year 6)

ACMNA133: Continue and create sequences involving whole numbers, fractions and decimals. Describe the rule used to create the sequence.

Lesson abstract

Students apply and test their understandings from the previous lesson by finding similar relationships for rows of triangular and hexagonal prism based bird boxes.

Mathematical purpose (for students)

Models and data help us see how patterns grow. We can describe how patterns grow using words and numbers.

Mathematical purpose (for teachers)

Modelling a pattern shows how a pattern physically grows.

Collecting and organising data shows how a pattern grows numerically.

The way a pattern grows numerically can be described using recursive (step-by-step) rules and using relational rules. Relational rules generalise a pattern so you can efficiently calculate the number of objects at any given step in the pattern.

Suggested presentation Two lessons of approximately one hour each

Vocabulary encountered

- edge
- pattern
- prism
- rule
- sequence

Lesson materials

- reSolve PowerPoint *2a Other Shapes*
- Regular triangle and hexagons for students to trace around (e.g. pattern blocks) (optional)
- Spreadsheet *2b Other Shapes Comparison* (optional)

We value your feedback after these lessons via our website.

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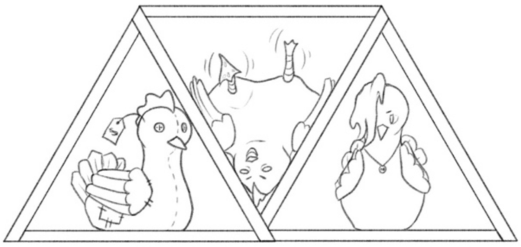
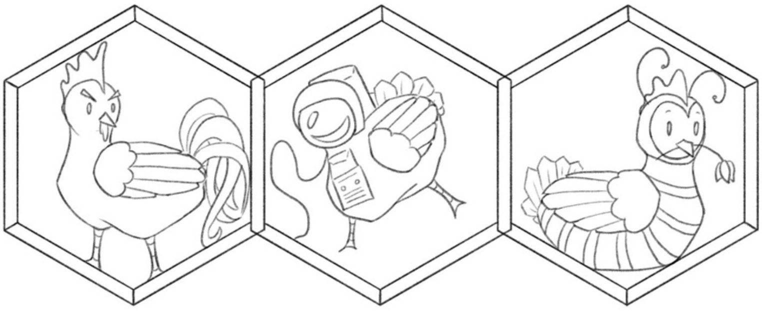
Alternative chicken box designs

Review the findings of the previous task, focusing on the number of panels needed for chicken boxes based on the total number of chicken boxes.

Talk about the fact that you have only considered boxes with square fronts. Today we will see what patterns we can find for other shaped fronts. We will look at triangular fronts (each bird box will be a triangular prism) and hexagonal fronts (each bird box will be a hexagonal prism). Confirm with students what these boxes will look like.

Show students slide 2 of *2a Other Shapes* and have students experiment with how they might orient/organise the triangles to form a row of boxes. The most efficient arrangement with fewest panels is shown below and on slide 3. Repeat with the hexagons on slides 4-5.





As in Lesson 1, have students model a row of triangular boxes and a row of hexagonal boxes and look for patterns and rules for the number of panels/sticks. Encourage students to collect and organise their data in ways that make it easy to identify patterns.

Teacher notes

- Students may like to model their new designs using the same concrete materials as in the previous lesson. While this is possible, it will prolong the lesson, and hexagons made this way are not very stable.
- A more efficient method of modelling is by tracing around pattern blocks or other templates, or by using geometry software.

Ask students to describe their patterns in everyday language to reinforce the meaning. The statements could be something like: *If we multiply the number of triangular prism bird boxes by two and then add one, we will always be able to find the number of sticks/sides.*

Encourage students to express their thinking using letters if you explored this in the previous lesson. The following equations should result (b represents the number of boxes, s represents the number of sticks; your class might use different letters):

- Triangular Boxes: $b \times 2 + 1 = s$ or $s = b \times 2 + 1$
- Hexagonal Boxes: $b \times 5 + 1 = s$ or $s = b \times 5 + 1$

There are different correct rules that students might find. Encourage students to investigate and justify these. Look at the similarities and differences in the rules.

Conclusion

Ask students: *now we have rules for triangular, square and hexagonal boxes. Can you see any relationship between the properties of a box and the rule for how many sticks/sides it needs?* Guide students to notice that to calculate the number of sticks required:

- for three-sided triangular boxes, you multiply the number of boxes by two and add one;
- for four-sided square boxes, you multiply the number of boxes by three and add one;
- for six-sided boxes, you multiply the number of boxes by five and add one.

Issue the challenge: *How could we make a rule for how many sticks we would need to make any number of boxes with any number of sides?* Guide students to make the generalisation that for boxes with any number of sides, the number of sticks required is always equal to *(number of sides of box – 1) x (number of boxes) + 1*. Discuss why this is.

Teacher note

- This result relies on the way our rows have been constructed: each box shares one side with the box that came before it. If each box shared more than one side with the box before it, the answer would be different. Students might like to try constructing boxes and rows like this—it requires some out of the box thinking!

Conclude the lesson by discussing the practicality of the new designs.

- *What are the pros and cons of the various designs?*
- *How comfortable do the new designs look for the chickens?*
- *How easy would it be to set up and to store the panels?*
    - Each shape has sides of equal length so the side panels will all be the same making it easier to assemble and to stack the panels. The back panels are different though!

Students will hopefully establish here that the original design is probably the most practical (comfortable and simple to build) for housing chickens.

Further activities

Graphing number patterns

Students can graph the patterns that have been found. They can then discuss the linear nature of the graphs and which pattern 'climbs' most steeply and why.

Some students may be able to use a spreadsheet to graph the patterns. Either enter numbers directly from your findings or enter the formulas into the spreadsheet and fill down to make the numerical data automatically.

The spreadsheet *2b Other Shapes Comparison* shows what the completed graphs might look like. Part of the spreadsheet is shown below. Students might make their own spreadsheet, or they can be given a copy of *2b Other Shapes Comparison* with the formulas removed.

Prompt student reasoning by asking:

- *Why do the lines all start very close together, but become further apart as they move to the right?*
- *Which line increases the fastest? The slowest? Why?*
- *Could there be a line between the lines representing squares and hexagons? What might that line look like?*
    - If we made a row of pentagon-shaped box and graphed the resulting pattern, it would fall between the lines representing squares and hexagons.

	Number of toothpicks		
Number of boxes	for squares	for triangles	for hexagons
1	4	3	6
2	7	5	11
3	10	7	16
4	13	9	21
5	16	11	26
6	19	13	31
7	22	15	36
8	25	17	41
9	28	19	46
10	31	21	51
11	34	23	56
12	37	25	61
13	40	27	66
14	43	29	71
15	46	31	76
16	49	33	81
17	52	35	86
18	55	37	91
19	58	39	96
20	61	41	101
21	64	43	106
22	67	45	111
23	70	47	116