Unit Overview: Chicken Boxes

Summary of learning goals

As part of the Special Topic **Bringing the Real World into Algebra** this unit looks at number patterns and their rules, exploring pre-algebra ideas in a real-world setting. The four lessons present increasingly complex aspects of one real situation: making enough "flat pack' boxes to house the chickens at an agricultural show. The underlying ideas are that the number of components of any one type (e.g. the number of side panels) required for a show is a function of the number of chickens to be housed; that the function rule can be found by analysing number patterns; and that there are often multiple correct ways to describe a function.

Students see how the geometric construction of the chicken boxes (with toothpicks and chickpeas) is reflected in the number patterns, and how having a careful description of the number pattern enables predictions to be made about the numbers of components needed for displays of any number of chickens. Students learn to interpret the mathematical rules in terms of the features of the arrays of chicken boxes, so that the symbols in the rule make sense. Students therefore work towards the idea of function in a concrete way.

Students will probably start by seeing only 'local' features of the pattern – e.g. "I always need three more side panels to make another box". The aim of the unit is to provide many opportunities to expand this view of pattern to the more algebraic idea of a general rule that works for any number e.g. "to make 100 boxes, I would need 1 + 3 x 100 side panels". Some students may go onto to express the general rule with an algebraic letter e.g. "to make *b* boxes, I would need 1 + 3 x *b* side panels", and therefore experience a first introduction to the world of symbolic algebra

Australian Curriculum: Mathematics (Years 5 and 6)

ACMNA107: Describe, continue and create patterns with, fractions, decimals and whole numbers. Resulting from addition and subtraction. (Year 5)

ACMNA133: Continue and create sequences involving whole numbers, fractions and decimals. Describe the rule used to create the sequence. (Year 6)

Summary of lessons

Who is this unit for?

This pre-algebra unit is designed to develop some of the basic elements of algebraic thinking, before students encounter formal algebra. The unit requires very little background knowledge, and only simple whole number calculation. Some upper primary students may use this unit as a scaffolded introduction to the use of letters to stand for varying quantities.

Lesson 1: A Single Row of Bird Boxes

Using a toothpick model, students develop and describe rules for the number of 'flat pack' panels needed to build a row of temporary bird boxes for a poultry show. Following typical student thinking reported in the research, students are guided to move from recursive thinking to the relational thinking of functions. Through class discussion, students see that there is more than one correct rule for describing a particular pattern.

Lesson 2: Box Designs with Other Shapes

This lesson follows on from Lesson 1 where students mathematically modelled the function that describes the relationship between the total number of cubic bird boxes in a row and the number of panels required to make them. In this lesson, students find similar relations for rows of triangular and hexagonal prism based bird boxes.

We value your feedback after these lessons via https://www.surveymonkey.com/r/RKRDYBW

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Lesson 3: Modelling an Array of Chicken Boxes

Students move from considering patterns arising from the number of components in one row of chicken boxes to considering patterns in an array of boxes. Students first look at patterns in the subsequent rows, and then combine these rules with the rules for the first row to calculate quantities of components for the entire array. Students are then challenged to find other patterns in the whole array.

Lesson 4: Modelling Chicken Boxes in 3D

Students are set the challenging task of finding the number of toothpicks to make a three dimensional model of an array of chicken boxes of any size. They build a 4 x 4 array to test their ideas. A worksheet is provided for students who require a structured approach. The lesson concludes with a class reflection on all the learning intentions of the unit.

Reflection on this sequence

Rationale

All units in the Special Topic: Bringing the Real World in to Algebra are guided by the principles of Realistic Mathematics Education (RME). As a consequence, this unit:

- Sees mathematics as something best learned by doing.
- Uses realistic situations to develop mathematics.
- Places emphasis on sense making.
- Uses "guided reinvention" where possible.

The four lessons present increasingly complex aspects of one real situation. Students see how the geometric construction of the chicken boxes is reflected in the number patterns, and how a careful description of the number pattern enables predictions to be made about the numbers of components needed for displays of any number of chickens. Students learn to interpret the mathematical rules in terms of the features of the arrays of chicken boxes, so that the symbols in the rule make sense. Students work towards the idea of function in a concrete way. The underlying ideas of all lessons are that the number of components of any one type (e.g. the number of side panels) required for a show is a function of the number of chickens to be housed; that the function rule can be found by analysing number patterns; and that there are often multiple correct ways to describe a function.

reSolve Mathematics is Purposeful

The context of making 'flat pack' chicken boxes for a show is crucial to this mathematical inquiry. It is slightly quirky and broadly intriguing. It also provides a purposeful anchor point for the sequence of increasingly complex tasks. Students' understanding of the usefulness of function rules over simper descriptions of pattern (and perhaps some very early algebra) is made possible by the carefully sequences and scaffolded nature of the inquiry.

reSolve Tasks are Challenging Yet Accessible

Several teachers who trialled this unit commented that prior to teaching the material they thought that it would be too difficult for their students. However, after teaching the unit they found that all students had success. They attribute this success to the fact that the sequence is structured to support students throughout. The gradually increasing complexity of the tasks provides many opportunities for consolidation of earlier ideas, alongside various opportunities for extension.

reSolve Classrooms Have a Knowledge Building Culture

The teacher is central to supporting and scaffolding the connections students make between the context of the Chicken Boxes, the toothpick models and the more abstract mathematical understanding of function and rules for patterns, it is the collaborative group work that students engage in when constructing their boxes and analysing the numerical patterns within them, that is also of great importance. The discussion that students have with each other supports the knowledge building culture of the classroom.

Further Reading

More about RME:

Van den Heuvel-Panhuizen, M. (2000). *Mathematics education in the Netherlands: A guided tour*. Freudenthal Institute CD-rom for ICME9. Utrecht: Utrecht University
http://www.fisme.science.uu.nl/staff/marjah/download/vdHeuvel-2000_rme-guided-tour.pdf

More about pattern spotting and mathematics:

Hewitt, D. (1992) Train Spotters' Paradise. *Mathematics Teaching*, 140, p 6 – 8. https://nrich.maths.org/9071