UNIT 6

Little Boxes

What is the most suitable way to package four small boxes?

WHAT HAPPENS?

In the context of a request from a health foods manufacturer, students are challenged to develop the 'best' design for packaging four small snack boxes.

Students will:

- Explore nets of rectangular prisms. (Discover)
- Brainstorm packaging arrangements for four boxes. (Devise)
- Select an appropriate (feasible) arrangement. (Devise)
- Design multiple nets for the arrangement. (Develop)
- Evaluate and select a net according to criteria established by the students. (Develop)
- Communicate and justify decisions and the process. (Defend)

TEACHER NOTES:

Food packaging boxes provide an exceptionally good stimulus as they relate to an extensive range of mathematical concepts, including arrays, measurement (length, mass), 2D and 3D shapes, percentages, numbers associated with addresses, font sizes and symmetry in the graphics, categorical data such as bar codes and product codes, and the mathematical terminology that goes with these concepts. Opportunities to review terms such as vertices, edges, faces and so forth are also valuable.

Materials

- Empty small food boxes (mini cereal packets, sultana, biscuit boxes)
- Sheets of A3 paper
- Masking tape, scissors, rulers, pencils
- Copies of box nets, if required

Curriculum Links

- HPE – Diet
- Media – Marketing and advertising
- Technology – Design considerations in packaging

Mathematical Focus

- Measurement and Geometry – Nets and properties of rectangular prisms, geometrical language, working with centimetres and millimetres
- Number and Algebra – Decimals

Resource Sheets

- Resource sheet 1: Letter of Request
- Resource sheet 2: Snack Box Net

Support Website

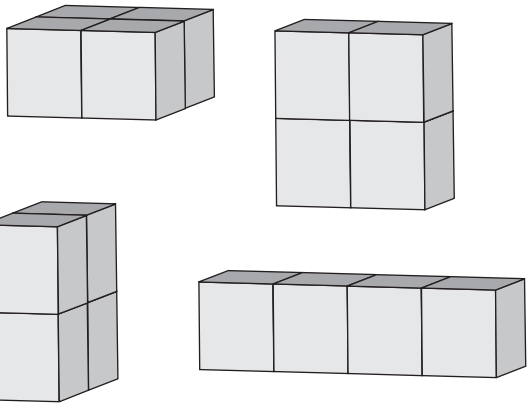
www.curriculumpress.edu.au/maths

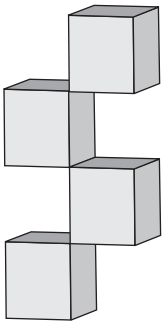
All of the resource sheets are available to download as PDF files. Those that you might customise are also available in Word document format.

INACTION! LITTLE BOXES

STUDENT APPROACHES

This activity originated as a part of a larger integrated study into health and media. Students created a healthy snack food recipe, designed packaging for their product and developed a marketing campaign to increase the appeal of their snack to children. They were then challenged to find a way of combining four packets for distribution through supermarkets. The students were really enthusiastic and a few even discussed the expenses and practicalities of shelving placement with staff at their local grocery stores, as well as taking measurements of shelf heights and so on. There is a multitude of ways that four boxes can be packaged together and the students had to explore those options before they chose the arrangement that they wished to work with. A few designs are illustrated below:





TEACHER NOTE:

A group of students actually pleaded to work with this rather unusual and highly impractical design. They knew it was not a realistic option but wanted to see if they could design a net for it. Despite many attempts and considerable frustration, they eventually succeeded and were highly pleased with themselves, not to mention developing a great understanding of nets!

The real success of this activity is that students can approach the task in individual ways. Some students will measure one box and multiply the dimensions while others will draw 2- or 3-dimensional sketches before commencing, and still others will take a box, trace around it, place it in the next position, trace again and so on. Students using the first approach often do so erroneously and tend to multiply every dimension by four regardless of the arrangement. Some students even measure surface area and perimeter before realising there is no real purpose. Few achieve an appropriate method early and it is a great process for developing persistence and resilience in mathematical tasks.

Only rarely do students demonstrate frustration and a very simple prompting toward the next step enables them to return with renewed enthusiasm. This is a great unit for developing confidence in mathematically less able students as the heavy reliance on spatial awareness and manipulation often suits these students well.

INVESTIGATING BOXES (RECTANGULAR PRISMS) AND THEIR NETS

- Have students explore boxes and consider the mathematics required to manufacture and produce the product.

- Request that students individually or in pairs create nets for boxes by dismantling existing packages. Note the placement of the graphics and text for advertising purposes if links are going to be made to advertising.
- Challenge the students to determine whether there are alternative nets that could be folded to create the same rectangular prism. Students draw several possible nets, and check by assembling the nets into boxes.
- Have students share findings. Ensure that they can see there are several possible nets for a rectangular prism.

The exploration and identification of the mathematics involved in designing and manufacturing a product gives students the opportunity to identify mathematics in an everyday context.

Key Vocabulary

At all times look for opportunities to introduce, use and encourage students to use appropriate spatial terminology:

- edge
- vertex
- parallel
- face
- perpendicular
- base
- right angle

Assessment Ideas

Focused observation:

Observe students' level of:

- engagement in classroom discussion
- logical expression of ideas
- use of mathematical and everyday language
- recognition that several nets are possible for a single prism.

INTRODUCE THE TASK

- Read students the letter (Resource sheet 1 or an adapted version) to establish the context for the inquiry. The letter is written in adult language to make the context appear authentic. The meaning and requirements may need to be explained to children.
- Facilitate a whole class discussion, or use think-pair-share techniques to enable the students to determine a possible approach. Students should determine that there is a need to generate multiple ways of arranging the boxes.

REFINE THE TASK

- Lead a class discussion of the considerations when packaging snack boxes. What might manufacturers need to consider? Possible answers include:
  - How boxes could be stacked on shelves.
  - How they could be boxed into larger containers for shipping.
  - Display front size/shape for advertising.
  - Height of supermarket shelves.
  - Storage in cupboards/pantries etc.
- Allow the class to determine how they will use the considerations they feel are important to determine which possible arrangements are worth further investigation.

Using these considerations, each group of students selects a possible arrangement of four boxes to explore.

Students may identify placements that are unrealistic, however it is important that they be allowed and encouraged to persevere with their designs. They will learn that even complicated 3D shapes have nets and will be able to see the impracticality by themselves or through teacher questioning.

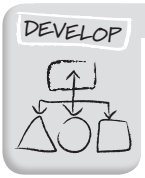
Students may try a variety of approaches including sketching a 3D design, trial and error, measurement, etc. It is rare that any of these work initially and is of benefit to let students try, fail, reflect and approach the task from different directions. It is also beneficial to have students share their methods and the advantages and disadvantages with the whole class.

Assessment Ideas

Task analysis:

Did students:

- Consider their own approaches and identify alternative approaches/methods when initial methods were unsuccessful?
- Demonstrate team work and willingness to listen to others' ideas and express their own appropriately?



CONSTRUCTING NETS AND PRISMS

- Develop a net for one snack box from the dimensions given in the letter (Resource sheet 1). If students can do this themselves it will enable them to have a better understanding of the construction process, however it does take a significant amount of time. Alternatively, provide students with one copy of the net in Resource sheet 2.
- Have the students construct a snack box from their net.
- Working with this constructed snack box, A3 paper, rulers and so forth, students generate one or more net designs for their group's chosen arrangement of four snack boxes. Do not allow students to use more than one snack box as this forces them to find methods of visualising, measuring and representing lengths rather than simply tracing around outlines.
- Evaluate their net to ensure it meets the requirements of the task and is the best net they can create.

PRESENTING DESIGNS

Lead students to identify any further considerations for assessment of the net that have become apparent. For example, students may consider that minimising the amount of paper/cardboard/plastic used is necessary both economically and for the environment. Limiting the number of joins and folds would also be beneficial.

Have students prepare a group presentation of their design to the class. The presentation should persuade the class of the advantages of their design and how it meets the manufacturer's requirements. The presentation should include:

- Justification of the arrangement chosen for the boxes and about why the net was chosen.
- Evidence of the accuracy of the net they have created.
- Details of how they went about the task, and the difficulties and successes they faced (including challenges of working in a team).

SELECTING AND COMMUNICATING THE FINAL PRODUCT

Have the class collectively select the final design for submission. This is done to diminish ownership and focus on a class outcome.

Students, as a class, reply to the snack food manufacturer with an accurate design and a covering letter arguing the advantages of the design they have developed.

Assessment Ideas

Task analysis:

Assess whether students were able to:

- Develop a net.
- Determine the effectiveness and accuracy of the net.
- Reflect upon their decisions and the process.
- Provide evidence to support their justifications.

Use reflection strips or a similar reflection tool to assist with meaningful reflections.

TO EXTEND

- Using a greater number of boxes increases the difficulty of the activity by increasing the number and complexity of designs. Choose a number that can be packaged in multiple ways, such as eight or twelve.
- Explore tessellations/patterns with potential final designs to determine how efficiently the nets can be placed to create a template for bulk cutting.

TO SIMPLIFY

- Reduce the number of boxes to two, to minimise the number of possibilities.
- Provide multiple boxes for improved visualisation and manipulation.

ALTERNATIVE INQUIRIES

- Students individually determine a packaging design for 12 matchboxes and present and justify their design orally. A written report could be submitted in defence of their design. The design could be extended to the packaging of a product developed by the students, taking graphic design and advertising into consideration.

Assessment Idea

These ideas would provide alternative individual assessments if further assessment is desirable.

Letter of Request

Snacktime Pty Ltd
183 Machinery Street
Felvale Industrial Park
FELVALE NSW 2780

ABC Primary School
123 School Road
Education City QLD 4030

June 12, 2011

Dear Teacher,

At Snacktime, we take pride in our involvement in developing healthy Australian children. We do this by developing delicious snacks which are nutritious, low in salt, sugar and fat, and which appeal to our younger market. Some of our most popular lines include Choc Rocks, Honey Hits, Pecan Puffs and Banana Bites.

We have decided to launch a new 'pick a pack' product by packaging together one of each of these snacks in a pack of four. We would like to be able to advertise that students were involved in the design of the packaging to help promote the product.

As your school is located in an area where our product is currently unavailable, we have decided that it would be a great opportunity to ask your students to determine the packaging design. We could then release the products in your area and have a media campaign advertising the local involvement at the same time.

If you are willing to take on this project, we would be very grateful. What we would require from you is a diagram showing how the boxes are to be packaged, a net that we could use to cut the packaging from, and an explanation as to why you think this is the best design. The finished dimensions of each snack box are 9.0 cm × 5.5 cm × 2.5 cm.

Thank you for your assistance, and we look forward to hearing from you.

Yours sincerely,

C Packer

C. Packer
Production Manager
Snacktime Pty Ltd

Snack Box Net