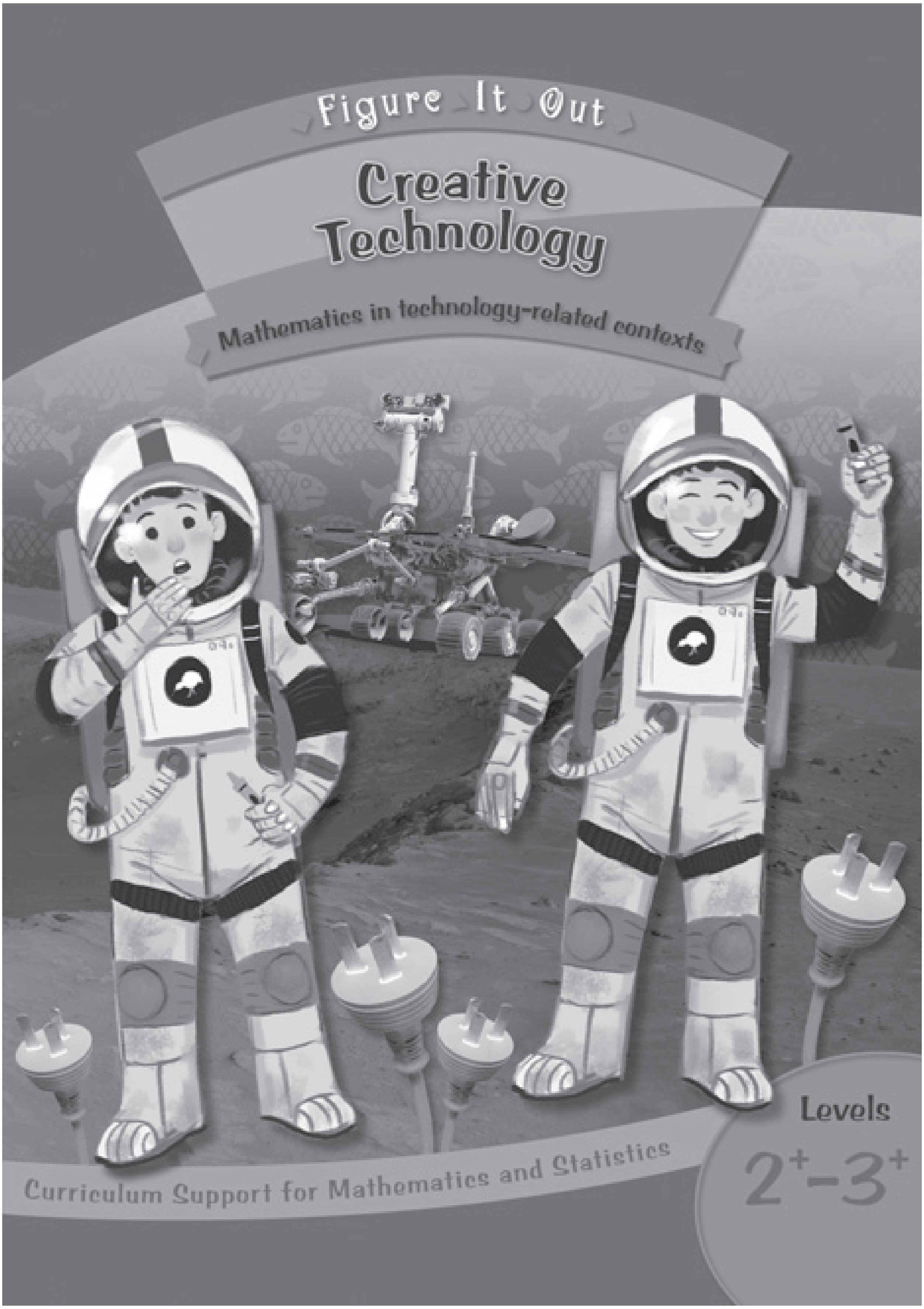
MINISTRY OF EDUCATION
Te Tāhuhu o te Mātauranga

Teacher Support Material
(including Answers)



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This resource has been developed to support
The New Zealand Curriculum

Teacher Support Material
(including Answers)

MINISTRY OF EDUCATION
Te Tāhuhu o te Mātauranga

Contents

Introduction

The books in the Figure It Out series are issued by the Ministry of Education to provide support material for use in New Zealand classrooms. The achievement objectives for mathematics and statistics and the key competencies referred to in this *Teacher Support Material (including Answers)* are from *The New Zealand Curriculum.*

Student books

The activities in the Figure It Out student books are written for New Zealand students and are set in meaningful contexts, including real-life and imaginary scenarios. The contexts in the level 2^+–3^+ *Creative Technology* book reflect the ethnic and cultural diversity and the life experiences that are meaningful to students in years 4–6. However, you should use your judgment as to whether to use the student book with older or younger students who are also working at these levels.

Figure It Out activities can be used as the focus for teacher-led lessons, for students working in groups, or for independent activities. You can also use the activities to fill knowledge gaps (hot spots), to reinforce knowledge that has just been taught, to help students develop mental strategies, or to provide further opportunities for students moving between strategy stages of the Number Framework.

Teacher Support Material (including Answers)

In this new format, the answers are placed with the support material that they relate to. The answers are directed to the students and include full solutions and explanatory notes. Students can use these for self-marking, or you can use them for teacher-directed marking. The teacher support material for each activity, game, or investigation includes comments on mathematics and the technology-related context, as well as suggestions on teaching approaches. The *Teacher Support Material (including Answers)* for *Creative Technology* can also be downloaded from the nzmaths website at www.nzmaths.co.nz/node/1992

Using Figure It Out in the classroom

Where applicable, each page of the student book starts with a list of equipment that the students will need in order to do the activities. Encourage the students to be responsible for collecting the equipment they need and returning it at the end of the session.

Many of the activities suggest different ways of recording the solution to the problem. Encourage your students to write down as much as they can about how they did investigations or found solutions, including drawing diagrams. Discussion and oral presentation of answers is encouraged in many activities, and you may wish to ask the students to do this even where the suggested instruction is to write down the answer.

Students will have various ways of solving problems or presenting the process they have used and the solution. You should acknowledge successful ways of solving questions or problems, and where more effective or efficient processes can be used, encourage the students to consider other ways of solving a particular problem.

Figure It Out

Creative Technology

Teacher Support Material (including Answers)

Overview of Creative Technology, Levels 2+–3+			
Title	**Focus**	**Page in students' book**	**Page in support material**
Back to Basics	Describing position and orientation	1	6
Cotton Wool Catapults	Making statistical comparisons	2–3	9
Quirky Cards	Exploring costs and value for money	4–5	13
Problem Pikelets	Scaling amounts of ingredients	6–7	15
Patent Problems	Exploring probability	8–9	17
Drop Zone	Using statistics to evaluate models	10–11	20
Land Rush!	Using the language of direction to describe paths	12–13	22
Tailspin	Exploring the distribution of a single variable	14–15	24
Bird Scarers	Basing decisions on observational data	16–17	27
Inventive Thinkers	Using timelines and interpreting time-based information	18–19	30
Call Chaos	Using a range of additive strategies	20–21	32
I Spy Symmetry!	Exploring symmetry and transformations	22–24	33

Introduction to the Technology-related Contexts

The contexts surrounding these mathematical activities are based on technology – its practice, body of knowledge, and relevance to society. As they engage with the activities, students may be inspired to further investigate a particular technological principle or issue.

While further investigation is encouraged, it should be remembered that the technology learning area has its own set of objectives. So before using any of these activities as part of your technology programme, refer to the technology learning area of *The New Zealand Curriculum*. In your technology programme, you need to give your students opportunities to engage in effective technological practice and to enhance their technological literacy.

For information on how to construct effective and exciting units of work, Techlink (www.techlink.org.nz) is an excellent resource. It provides in-depth analysis of what technology education is all about, along with case studies, examples of student work, and teachers' inspiration.

Support for English Language Learners

Many students, including English language learners, need support in meeting the language demands of the curriculum. You can help them by identifying the language demands of particular activities before you begin teaching and by scaffolding tasks so that all students can participate fully.

As you and your students work with the activities, you can support them by providing:

- opportunities to notice language in context
- explanations, illustrations, and examples of language
- opportunities to encounter the same information many times and in many different forms (to hear it, see it, touch it, read it, say it, write it, draw it)
- opportunities to encounter language (through listening and reading) as well as to use it (in writing and speaking) in the context of the activities
- language-focused activities that are meaningful and contextualised.

After focusing on language in the given context, you will want to keep revisiting the same language in other contexts.

You may need to provide English language learners with any culturally specific prior knowledge needed for the activities. You will also want to find out about and make links to their prior knowledge, including cultural and linguistic knowledge.

All of the activities make multiple language demands. This support material includes strategies for supporting learners with selected English language demands for some mathematics activities. You can adapt and apply these strategies to support students with other language needs that you identify.

In this support material, the activities with support for English language learners are:

- Page 1: Back to Basics: Supporting students with describing and understanding descriptions of geometric designs
- Pages 2–3: Cotton Wool Catapults: Supporting students with making comparisons
- Pages 8–9: Patent Problems: Supporting students with understanding and expressing degrees of probability

Some other useful resources are:

The English Language Learning Progressions (This was sent to all schools in 2008. PDFs of the four booklets are available online at http://esolonline.tki.org.nz/ESOL-Online/Student-needs/The-English-Language-Learning-Progressions)

Supporting English Language Learning in Primary Schools: A Guide for Teachers of Years 5 and 6 (SELLIPS). For information about ordering a PDF of this booklet, go to http://esolonline.tki.org.nz/ESOL-Online/Teacher-needs/Reviewed-resources/Supporting-English-Language-Learning-in-Primary-School-SELLIPS

Making Language and Learning Work 3: Integrating Language and Learning in Years 5 to 8 (DVD). For more information, see ESOL Online at http://esolonline.tki.org.nz/ESOL-Online/Teacher-needs/Reviewed-resources/Making-language-and-learning-work-DVDs

The Focus on English resource is designed to help teachers provide language support for mathematics, science, and social studies in years 7–10. It is available online at http://esolonline.tki.org.nz/ESOL-Online/Teacher-needs/Reviewed-resources/Cross-curricular/Focus-on-English

Principles of effective teaching and learning for English language learners, available online at http://esolonline.tki.org.nz/ESOL-Online/Teacher-needs/Pedagogy/Principles-of-effective-teaching-and-learning-for-English-language-learners

ESOL Online at www.esolonline.tki.org.nz

Teacher Support Material (including Answers)

Page 1: Back to Basics

Achievement Objectives

- Position and orientation: Describe … position relative to a person or object (Geometry and Measurement, level 1)
- Shape: Represent objects with drawings and models (Geometry and Measurement, level 3)

Developing students' mathematical understanding

Mathematics is a language – one that enables concise, structured, and unambiguous communication. Language is not limited to words; pictorial representations such as diagrams and pictures also communicate meaning. In this activity, students use language and sketches to communicate spatial relationships in arrangements of 2-D shapes.

Exploring the technology-related context

There have been rapid advances in communication in the last 200 years. Electronic devices have removed the constraints of distance and increased the speed and ease with which we can communicate. It is no longer necessary to be within earshot or in sight of another person.

Vocabulary alert

hands-free, portable, chat over the Internet, transmit

Answers

Challenge

1. a.–c. Practical activity. Designs and descriptions will vary.

2. Results and discussion will vary.

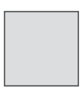
Mathematics and Statistics Notes

In this introductory activity, students create and describe geometric designs for other students to recreate. Making connections between shape, structure, and location develops spatial thinking. The activity emphasises the importance of students learning to describe even simple mathematical transactions in concise and unambiguous language – their instructions need to convey the design by themselves.

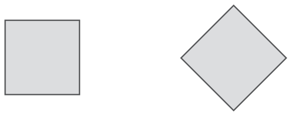
The geometric shapes suitable for this activity include attribute blocks, geoshapes, tangram pieces, or tessellating tiles. International pattern blocks also fit together well.

Before the activity, revise geometric terms. The students need to be familiar with the names of the shapes, geometric terms such as side and vertex, and prepositions that can be used to describe relationships.

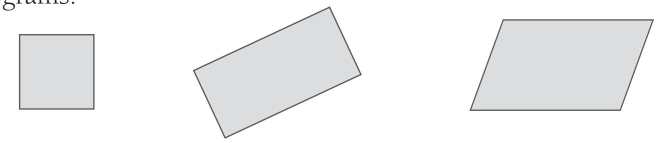
There are two main approaches to teaching students about shapes. The first involves showing the students examples of "typical" shapes. For example:

square  rectangle  parallelogram 

Be aware that some students will see shapes as different if their orientation or size is changed. For example, a student may see these as two different shapes:



A second approach involves teaching students about the attributes of families of shapes. For example, a parallelogram is a 4-sided shape with 2 pairs of parallel sides. All of these shapes are examples of parallelograms:



Discuss families of shapes with the students, exploring the attributes they have in common.

This activity provides an opportunity for students to develop the key competency *using language, symbols, and texts* by using geometric terms to devise and follow a set of instructions.

Some students may find it difficult to describe their design in words. If necessary, scaffold the activity by starting with 2 or 3 shapes, building up to 5.

You could extend the activity by asking the students to incorporate compass directions into their instructions.

Support for English Language Learners

Supporting students with describing and understanding descriptions of geometric designs

Language focus: Describing shapes and location

To support your students, especially English language learners, you could model and record the vocabulary, use a speaking frame to show some ways they can describe shape and location, and provide opportunities to practise before they work independently.

Vocabulary

- Hold up the shapes you will be using, asking students to call out words for the shapes. Write these on the board beside each shape (either using a picture or by sticking them on).
- Ask the students to brainstorm in pairs any other words to describe the shapes, such as “side” and “vertex”.
- Have the pairs share their ideas with the whole group and record these words too.

Prepositional phrases for location and speaking frame

- Tell the students to give you directions to put the shapes into a design. As you accept and follow their directions, record the prepositional phrases they use.
- Model a sentence (or several) that describes shape and location, for example, *The blue octagon is above the yellow rectangle.* Then write your sentence on the whiteboard.
- Erase the optional parts of the sentence, move your shapes, and co-construct a new sentence by filling in the gaps.
- Erase the optional parts of the sentence again and tell the students to refer to the frame as they are describing the patterns.

Pairwork describing shape and location

- Have the students work in pairs. Label the pairs A or B. Give the pairs either design A or design B (which you have prepared earlier). Tell them to talk in pairs about how to describe their design to another pair.

- Give each pair a set of shapes. Have pairs A and B sit back to back and take turns describing their designs and listening and recreating the designs. (To provide differentiated instruction, you could prepare designs of varying complexity to suit the levels of your students. To make the activity more challenging, you could also have the students give their descriptions in a chain of four – so student 1 has the picture, describes it to student 2 who recreates it and then describes it to student 3, and so on.)
- Then give each student a set of shapes and complete **Activities One** and **Two** on page 1.

The Focus on English resource on ESOL Online provides suggestions and resources to support learners with the language for describing shapes. See ESOL Online at http://esolonline.tki.org.nz/ESOL-Online/Teacher-needs/Reviewed-resources/Cross-curricular/Focus-on-English/Shapes

For information about language for describing and ideas on how to support students, see *Supporting English Language Learning in Primary Schools: A Guide for Teachers of Years 5 and 6*, Describing, pages 10–17.

Technology-related student activities

- Discuss with the students ways in which this task could have been completed using modern technology (for example, creating a design on the computer or taking a photo on a cellphone and sending it to a classmate for them to use to check their re-creation).
- Discuss how communication has progressed from local to global.
- Explore the effects of technology on human interaction.
- Discuss the effect of being unable to access certain types of communication. For example, what might happen in a crisis situation if people were unable to use their cellphones?
- Research ways to address privacy issues, for example, using codes, encryption, secure sites, and passwords.
- Research changes and modifications to communication devices. See www.arctos.com/dial
- Research alternative ways of communicating information, such as semaphore, Morse code, ASCII, the telegraph, and Braille.

Pages 2–3: Cotton Wool Catapults

Achievement Objectives

- Measurement: Use linear scales and whole numbers of metric units for length … (Geometry and Measurement, level 3)
- Statistical investigation: Conduct investigations using the statistical enquiry cycle:
  - gathering … whole number data … to answer questions
  - identifying patterns and trends in context, within and between data sets
  - communicating findings … (Statistics, level 3)

Mathematics Standards

The approaches and thinking that students demonstrate as they engage with these tasks and problems can provide evidence in relation to the mathematics standards. For example:

- Statistics: investigate … comparison questions by using the statistical enquiry cycle:
  - gather, display, and identify patterns in category and whole-number data
  - interpret results in context (Statistics, year 5)

Developing students' mathematical understanding

Making comparisons is an important part of most statistical investigations. In this activity, students compare the effectiveness of different catapults. To do this, they need to systematically gather measurement data, and then find ways of processing and analysing it in order to reach conclusions.

Exploring the technology-related context

Technology has helped people for millions of years. It has also provided the means to cause harm. Often, in times of war, technological progress has accelerated. Sometimes, military innovations can be put to peaceful purposes, for example, radar and GPS.

Vocabulary alert

catapult, popsicle stick, existing, modify, cotton wool, accuracy, firing range

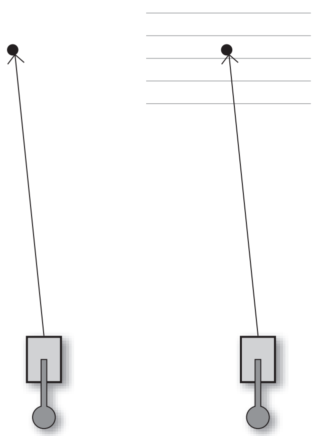
Answers

Activity

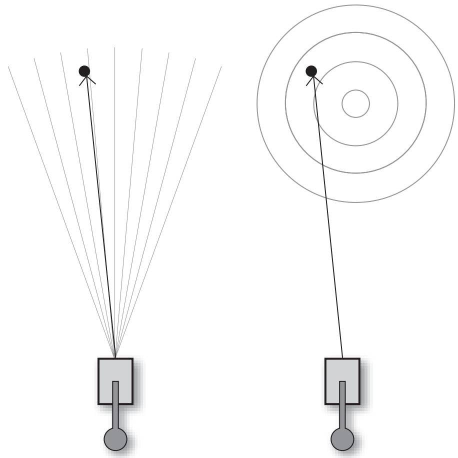
1.–2. Practical activity and discussion.

3. Methods will vary. Here are four ideas:

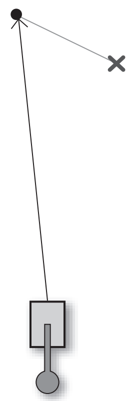
For power, use a measuring tape to find the direct distance from the base of the catapult to the point at which the ball hits the ground. Alternatively, mark a set of parallel lines directly in front of the catapult. Score points for each line you get the ball over.



For accuracy, mark a set of lines that radiate at equal angles from the catapult. The closer you get to the centre line, the greater your score. Alternatively, set up a series of concentric circles on the floor. Score maximum points for hitting the bull's eye and fewer points for the outer circles.



4. Firing range set-up will vary, as will measuring and recording systems. Power (distance) can be recorded as raw data (cm) or points. Accuracy would usually be measured as points, but it could also be measured in cm (distance from target). The target could be a cross marked on the floor:



For power, you want maximum distance from the catapult. For accuracy, you want minimum distance from the target. Design your scoring system with this in mind.

Once you have completed the firing and scoring process, you will need to process your data so that you can come up with a result. You may find that simply adding the points in each category will give you the information you need. But you should be able to explain why your system is fair!

5. Discussion will vary.
6. Practical activity.

Mathematics and Statistics Notes

In this activity, students build catapults out of simple materials, use them to fire cotton wool balls, and then evaluate their performance. The activity requires teacher guidance and is suited to a whole-class lesson. It could be linked to a wider unit on machines or to a technology project. Before beginning, get your students to explore the history of catapults.

Depending on your students, and on how much time you plan to allocate to the activity, you could give them no guidance, get them to research the Internet for ideas, or show them either a working model that you have built yourself or a You Tube video.

Students will construct, test, and refine their catapults in an iterative cycle, so ensure that protocols for working are discussed and agreed before the materials are made available. Assign a dedicated place for trialling.

Once the students have working catapults, they will need to decide how to measure the two variables, power and accuracy. The answers provide some suggestions. Expect your students to sort the best proposal from competing proposals via a process of mathematical argumentation.

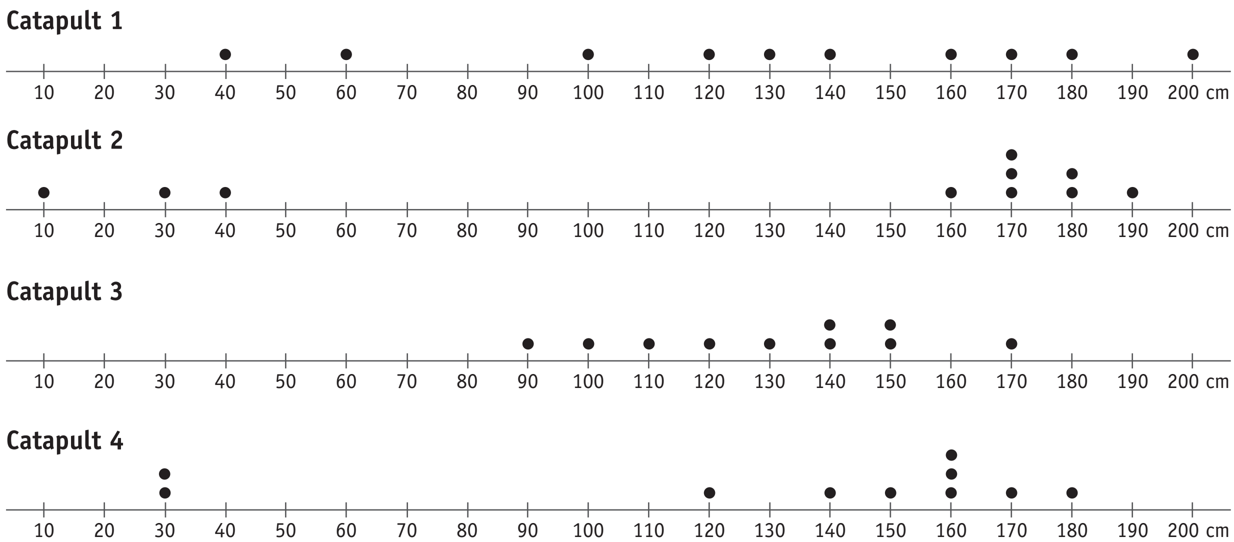
Note: The Focus on English resource on ESOL Online provides suggestions and resources to support learners with the language of measurement. See ESOL Online at http://esolonline.tki.org.nz/ESOL-Online/Teacher-needs/Reviewed-resources/Cross-curricular/Focus-on-English/Measurement

The DVD *Making Language and Learning Work 3: Integrating Language and Learning in Years 5 to 8* (Curriculum Focus, Year 7 Technology) includes an example of a class working within the context of making lanterns and shows how the teacher incorporates support for language within a mainstream classroom lesson.

Once data has been collected, it needs to be analysed to determine which of the catapults is best. Ask your students to suggest how they might do this. The simplest way is simply to add up the points or measured distances and see which group gets the greatest or least total, depending on whether power or accuracy is being measured and how points are assigned.

Alternatively, students could compare dot plots. Although more challenging, this method will be more statistically valuable, introducing as it does the ideas of spread and central tendency (the tendency of values to cluster around a particular point).

Below are four notional sets of data. Note that distances have been rounded down to the nearest 10 cm (in other words, distances have been grouped in 10 cm intervals). This avoids overlapping dots and makes the overall pattern easier to see.



If your students analyse the four dot plots, they will see that each catapult fired 10 shots and scored an identical total distance, 1 300, so simply adding distances to find a winner will not work. But although total distance is the same for each catapult, spread is very different. Get your students to discuss in groups which of the catapults most consistently fires a good distance and to compare their thinking with that of other groups.

Once catapults have been ranked for fire power (1st, 2nd, 3rd …), they can be similarly ranked for accuracy. One way of finding an overall winner is to combine the two rankings (for example, 1 + 2 = 3) and see which catapult gets the best (lowest) combined ranking.

This activity requires students to work together and be considerate of others, which gives them opportunities to develop the key competencies *participating and contributing* and *managing self*.

Extension

Investigate angles by exploring the optimal angle for firing. The following link provides a fun way for students to develop their awareness of angle size: www.xpmath.com/forums/arcade.php?do=play&gameid=74

Support for English Language Learners

Supporting students with making comparisons

Vocabulary focus: Making comparisons using adjectives

Some students may benefit from support with understanding and using language for making comparisons.

Before beginning question **1** on page 2, establish that distance and accuracy are the criteria on which you will be judging the effectiveness of the catapults. Tell the students that the most powerful and most accurate catapults are the most effective (and write this on the whiteboard).

After the students have fired their catapults and recorded the results, choose three (good) results to discuss. Put the adjectives on two clines from powerful/accurate to more powerful/more accurate and to the most powerful/the most accurate.

Explain that "more" and "the most" are how we make comparisons with some adjectives (those with three syllables and many with two syllables). Co-construct sentences comparing the three catapults and write them on the whiteboard, for example, *Mina's catapult is powerful, but Tom's catapult is more powerful. Anna's is the most powerful catapult.*

Add another couple of examples and introduce sentences with "as powerful as" and "not as powerful as", recording these sentences on the whiteboard, too. Ensure you give examples and illustrations to make the meanings clear.

Have the students discuss the results in pairs and use the constructions above. If necessary, provide speaking frames like the ones below for some students to refer to.

__________ catapult is _________________ but __________ catapult is more ______________________ .

__________ catapult is the most ________________ .

__________ catapult is not as __________________ as ___________________ catapult.

__________ catapult is as ______________________ as ___________________ catapult.

As you begin question **5**, preview some of the language the students will need to make comparisons between the different features, for example, sentences using "long", "longer", "longest". Begin a comparison chart for adjectives, putting them into categories according to the rules they follow. For example:

–er and –est	double consonant + –er and –est	more and the most	more and the most
long, longer, longest	big, bigger, biggest	powerful more powerful the most powerful	good, better, best

Language areas like comparisons are large and complex. You will need to select small chunks to focus on at one time and keep adding more each time your students encounter the language.

Technology-related student activities

- Discuss how the use of GPS technologies have changed the way we live.
- Choose a particular technology (for example, the motor car, the LCD screen) and discuss its good and bad impacts.
- Explore the history of a particular technology (for example, the motor car or aeroplane) and research the major innovations that have taken it from its early days to today.
- Select the life and work of an inventor or designer, such as Leonardo da Vinci, Barnes Wallis, Colin Murdoch, Thomas Edison, or John Britten. Try and find out what it was that drove them and how they dealt with the difficulties they encountered along the way.

Pages 4–5: Quirky Cards

Achievement Objective

Number strategies: Use a range of additive and simple multiplicative strategies with whole numbers … [and] decimals … (Number and Algebra, level 3)

Mathematics Standards

The approaches and thinking that students demonstrate as they engage with these tasks and problems can provide evidence in relation to the mathematics standards. For example:

- Apply additive and simple multiplication strategies … to:
  - combine … whole numbers (Number and Algebra, year 5).

Developing students' mathematical understanding

Numeracy involves developing mathematical skills and knowledge to meet the demands of everyday life. In this activity, students compare the cost of electronic circuit components. Using comparisons to inform decision making and knowing how to evaluate the benefit of "specials" are important everyday skills.

Exploring the technology-related context

Technological practice is responding to a need or opportunity. Teachers could encourage students to choose an appropriate event or recipient for the cards and to suggest suitable attributes.

Vocabulary alert

electrical circuit, power source, wiring, output, switch, electrical current, leaf switch, light-emitting diode (LED), button cell battery, twinpack, spool

Answers

Activity

1. $6.70, for 4 LEDs + 2 batteries + 30 cm of wire. ($1.70 [for a single LED and a pack of 3 LEDs] + $4.80 for two single batteries + $0.20 for 30 cm of wire)
2. a. 80 LEDs, 40 batteries, 6 m (600 cm) of wire
   b. i. 9. (4 x 20-pack LEDs + 4 x pack of 10 batteries + 1 x 6 m spool of wire)
   ii. $130.40. ($8.00 x 4 + $24 x 4 + $2.40)
3. a. 3 for $1.20 ($0.40 per LED) or 20 for $8.00 ($0.40 per LED)
   b. Single battery or a pack of ten ($2.40 per battery)
   c. 12 m for $3.60 (30c per metre)
4. a. $130.40. (40 batteries x 2.40 each = $96. 80 LEDs x 0.40 = $32. 12 m of wire is too much, so they should still buy 6 m at $2.40. Total = 96.00 + 32.00 + 2.40 = $130.40.)
   b. No. The batteries are the same for singles as packs of ten. An LED 4-pack is more expensive than a 3-pack plus a single.
5. a. Answers will vary. The cheaper the cards are, the more they are likely to sell. However, after they have made 20 cards, they will need to buy leaf switches and may lose customers if they put the price up.
   b. i. The electronic circuit materials cost $6.50 for each card ($130.40 ÷ 20 = $6.52), leaf switches are $1.50 each, and the cardboard and envelope are $1.50. The total cost of the materials, including a leaf switch, is $9.52, but Meri and Joe will probably want to make some profit. Suggested charge: $11.00 (answers will vary).
   ii. The materials for 5 cards cost $47.60 ($9.52 x 5). The answer should be somewhere between $47.60 (no profit) and 5 times the answer to **b i**. A discount will encourage people to buy a pack of 5, but Meri and Joe still want to make a profit. Suggested price: $52.00 (answers will vary).

Mathematics and Statistics Notes

In this activity, the students use number strategies to find the unit price of items.

The information can be organised in a table:

LEDs		**Unit price**
Single	$0.50	$0.50
3-pack	$1.20	$0.40
4-pack	$1.80	$0.45
Pack of 20	$8.00	$0.40

Button cell batteries		**Unit price**
Each	$2.40	$2.40
Twinpack	$5.00	$2.50
Pack of 3	$7.50	$2.50
Pack of 10	$24.00	$2.40

Copper wire		**Unit price (per metre)**
30 cm pre-cut length	$0.20	$0.67
1 m length	$0.50	$0.50
6 m spindle	$2.40	$0.40
12 m spindle	$3.60	$0.30

To find the cost of each unit, the students need to divide by 2, 3, 4, 6, 10, 12 and 20. A useful strategy is to divide in steps. For example, dividing by 4 is the same as dividing by 2 and then dividing by 2 again. Similarly, dividing by 2 and then by 10 gives the same result as dividing by 20. You could use materials such as multilink cubes to demonstrate this. For example, if 20 ÷ 4 = 5 is a known basic fact, use cubes to demonstrate that 20 ÷ 2 = 10 and then 10 ÷ 2 = 5 gives the same result as dividing 20 by 4. Ask students to explore and test this relationship further using known facts. For reinforcement of this concept, see Proportional Packets from NDP *Book 6: Teaching Multiplication and Division.*

If students struggle to add or multiply prices, adapt the task by asking the student to work with cents. For example, for question **1**, use 120 + 50 + 230 + 230 + 20 instead of $1.20 + $0.50, and so on.

Ask students to find examples of specials in supermarket advertising materials and to compare the special price with the ordinary price. They can also compare the unit prices on the shelf labels in supermarkets. Often "specials" are more costly than the non-specials of the same product in larger amounts.

In question **5**, there is no "right" answer for the cost of a single card or a pack of 5. Students need to consider how much profit is needed for the enterprise to be worthwhile, while at the same time choosing a price that will encourage people to splash out and buy a "value pack" of 5 cards.

Dealing with uncertainty and variation and deciding whether a price is reasonable helps students to develop the key competency *thinking*.

Technology-related student activities

Learning about electrical circuits would probably fit within the science learning area, but students can use this authentic context to produce a technological solution. With a small amount of knowledge, teachers can facilitate students' learning by helping them design functional electronic models. There are several commercial products available that would augment the typical school resource kit of batteries, wire, and bulbs and allow young students to make robust circuits. Some kits will have simple instructions, or a parent may be available to help.

Websites such as www.can-do.com/uci/lessons99/electricity.html are useful (search under "easy circuits").

- Emulate Meri and Joe and make electronic birthday cards with LEDs.
- Investigate using an LDR (light-dependent resistor) and a buzzer in a circuit to construct a simple burglar alarm.
- Construct a doll's house for the junior school. Place simple circuits for lights, door bells, and switches.
- Construct portable fans with small electric motors and blades made from soft material.
- Design and construct quiz boards to reinforce mathematical understanding. (This would make a good science fair project.) See:
  - www.darkstar.cc/Discovery/ElectricExam.htm
  - http://teachingtreasures.com.au/K-10Projects/quizboard/quizboard.htm

Electronic components for each of the above activities should cost less than $10.00.

Pages 6–7: Problem Pikelets

Achievement Objectives

Number strategies: Use a range of additive and simple multiplicative strategies with whole numbers [and] fractions … (Number and Algebra, level 3)

Measurement: … use appropriate units and devices to measure … capacity (Geometry and Measurement, level 2)

Mathematics Standards

The approaches and thinking that students demonstrate as they engage with these tasks and problems can provide evidence in relation to the mathematics standards. For example:

- apply basic addition and subtraction facts, simple multiplication facts … to:
  - combine or partition whole numbers
  - find fractions of … quantities (Number and Algebra, year 4).

Developing students' mathematical understanding

Numeracy involves developing mathematical skills and knowledge to meet the demands of everyday life. In this activity, students scale up ingredients used in a pikelet recipe. Being able to adapt a recipe to cater for groups of different sizes is a useful everyday skill.

Exploring the technology-related context

Technologists do not merely follow recipes. They need to modify and trial possible outcomes before going into full-scale production. Scaling up and batch production may produce a range of new considerations. Functional models assist them to make decisions about ingredients, quantities, and production methods.

Vocabulary alert

functional models, prototypes, evaluate outcomes, manufacturing, pikelets, lumpy, runny, baking powder, adapted, batch

Answers

Activity One

1. Piripi used too much flour (and may not have mixed his ingredients properly), Ben used too much milk, Helen used too much sugar, and Maia used too much baking powder.
2. **a.** 3 cups ($4 \times \frac{3}{4}$)

   b. There are several ways to solve this, for example, double the recipe 4 times ($25 \times 2 = 50$ pikelets, $50 \times 2 = 100$ pikelets, $100 \times 2 = 200$ pikelets, $200 \times 2 = 400$ pikelets) or multiply the recipe by 16 (work out how many times 25 goes into 400: $25 \times 4 = 100$, $100 \times 4 = 400$, $4 \times 4 = 16$ times).

   c. 175 pikelets. There are 7 quarters in $1\frac{3}{4}$, so you can make 7 batches. $25 \times 7 = 175$.

Activity Two

1. **a.** 2 batches. $3 \times 15 = 45$ pikelets, 2 batches makes 50 pikelets.

   b. 3 or 2 batches. 8×4 pikelets = 32 pikelets. $7 \times 3 = 21$ pikelets. $32 + 21 = 53$ pikelets. 2 batches makes 50 pikelets, so 3 batches will be plenty. However, the number of pikelets is close to 50, so Ben could make 2 batches and make the pikelets slightly smaller.
2. **a.** 6. The recipe is supposed to make 25 pikelets. Piripi has only managed to make 4 giant pikelets. $25 \div 4 = 6.25$.

   b. **i.** $\frac{1}{2}$. One giant pikelet is equivalent to 6 small pikelets, ½ of 6 = 3.

   ii. $\frac{2}{3}$ ($\frac{4}{6}$)

   iii. $\frac{10}{6}$ or $1\frac{2}{3}$

Mathematics and Statistics Notes

In this activity, students work with fractions and capacity in the context of cooking.

Discuss the mathematics involved in cooking. Some students will have experience of cooking, while others may never have stepped foot in the kitchen except to open the fridge!

Explore the measuring devices that are used when baking. Standardisation of measurement is an important concept. Cups come in a variety of shapes and sizes, but the cup measure referred to in recipes is 250 mL. Measure the capacity of a range of cups and see which is closest to 250 mL. Discuss the role that standardisation plays in cooking but point out that not all cooks or cultures rely on standardised measurements.

Students who struggle to solve fraction problems may benefit from using materials.

Activity One

In question **2**, the students need to first work out that to make 100 pikelets you need 4 batches. They can then calculate $4 \times \frac{3}{4}$ (rather than finding $\frac{3}{4} \times 100$).

A diagram will show how many $\frac{1}{4}$ cups are in $1\frac{3}{4}$ cups of sugar.

Extension

Explore metric equivalents of measurements such as teaspoons or tablespoons and use them to calculate equivalences, for example, a teaspoon holds 5 mL and a tablespoon holds 15 mL. How many teaspoons are equivalent to 1 tablespoon?

These activities require students to think flexibly and to discern whether their answers are reasonable, developing the key competency *thinking*.

Technology-related student activities

It takes skill to read instructions and produce the perfect pikelet, but students involved in food technology should be aware of the purpose behind the activities and be able to modify and trial possible outcomes. Models assist them to make decisions about ingredients, quantities, and production methods.

- Discuss the dietary needs of students in this age group.
- Research commercial responses to particular dietary needs, for example, gluten-free products.
- Research methods and equipment used by commercial food producers, for example, arrange to visit a fast-food outlet.
- Discuss the role of sugar and milk substitutes in baking.
- Research regulations around safety and hygiene. This could be done in tandem with food production for a class or school event.

Pages 8–9: Patent Problems

Achievement Objective

- Probability: Investigate simple situations that involve elements of chance, recognising equal and different likelihoods and acknowledging uncertainty (Statistics, level 2)

Mathematics Standards

The approaches and thinking that students demonstrate as they engage with these tasks and problems can provide evidence in relation to the mathematics standards. For example:

- compare and explain the likelihoods of outcomes for a simple situation involving chance, acknowledging uncertainty (Statistics, year 4).

Developing students' mathematical understanding

The terms "chance" and "probability" are used almost interchangeably. Chance reflects the randomness of an event, for example, the result when a dice is thrown. Probability is the likelihood of an event occurring, for example, the likelihood of throwing a 5 on a dice is $\frac{1}{6}$. Experimental situations help students develop their understanding of chance and probability. Data-handling skills, such as gathering and organising data, also come into play. Meaningful learning takes place when a student's intuitive understanding of probability is challenged by the results of an experiment.

Exploring the technology-related context

Technological innovations can earn large amounts of money, and patent laws have been developed to protect inventors' rights of ownership. These laws can be difficult to police, especially on a global scale. There are fascinating stories about patent disputes and specialist patent lawyers are busy people. Today, the pirating of products and intellectual property is a worldwide concern. Also, sometimes people dispute who actually invented a particular item; television's origins are apparently claimed by Scotland, Russia, and the US.

Vocabulary alert

inventor, patent, invention, permission, claiming the rights, virtual reality, everlasting, teleporter

Answers

Game

A game to develop your understanding of chance and probability

Activity One

1.–2. Conjectures, experiments, and results will vary. Note that while an experiment can suggest the likelihood of a particular outcome, it can't provide a definite answer. The more trials you do in a chance experiment, the more accurate any conclusion will be.

Activity Two

1. a. Outcomes will vary. Suggestions include:
   i. getting a 3 within 10 throws (based on option B)
   ii. getting 4 numbers the same in 5 throws (based on option A)

   b. Using the suggestions above, possible justifications include:
   i. If you throw a dice 10 times instead of 5, you double the chance of getting a 3.
   ii. Throwing the same number 4 times out of 5 is clearly more difficult than 2 times out of 5.

2. i. True. The chance of not getting a 2 or a 4 is the same as the chance of not getting a 5 or a 6 (or any other pair of numbers).
   ii. False. Getting a 6 or a 3 are equally likely.
   iii. The chance of getting 5 of the same number is extremely small, so "almost impossible" is a reasonable description.

Mathematics and Statistics Notes

Game

The game involves choosing an outcome and seeing whether the outcome can be obtained within 5 throws of a dice. Some outcomes are easier to obtain than others.

Activity One

Probability can be a difficult concept for students to grasp. In this activity, students examine the relative likelihood of a number of different outcomes.

Discuss the language of probability with the students:

- When we throw a dice 5 times, there is no way to state with confidence what the *outcome* will be. However, some outcomes are more likely than others. For example, we would be surprised if we threw five 4s in a row.
- The *likelihood* of an event occurring (for example, getting a 3 within 5 throws) is the same as its *probability*.
- The *theoretical probability* of an event can sometimes be worked out by calculating all the possible outcomes and seeing how many times a particular event is represented. This approach is not practical in this situation.
- *Experimental probability* involves conducting a number of trials and using the results to estimate the probability of an event. The more trials we do, the closer the experimental probability of an event will be to its actual or theoretical probability. This is sometimes referred to as the *law of large numbers*.

The concept of *variation* is an important one in statistics. Individual students may get quite different results, but if students compare their results, they will get a clearer idea about the likelihood of each outcome being met. It is good for students to see that increasing the number of trials in an experiment increases the validity of any conclusion.

It is important to link these three different concepts:

- Individual students will obtain their own unique set of results.
- After a large number of trials, a pattern will emerge. This pattern should reflect the theoretical probabilities (where these can be calculated).
- Theoretical probability can tell us which outcomes are more likely, but it cannot predict the next outcome.

Probability is most useful when predicting long-term or long-run results. Even if we know the theoretical probability of every outcome, this will not give us any certainty about short-term outcomes in, say, a game. Throwing four 5s in a row is unlikely, but it's not impossible. Chance is a factor in most games. Dealing with uncertainty and variation helps students develop the key competency *thinking*.

Activity Two

Students may find it difficult to devise new outcomes. If so, give them some suggestions and ask them to consider whether the outcomes are very likely or very unlikely. Examples include:

- getting 5 numbers that are all the same
- throwing a dice 5 times and not getting an even number
- throwing a dice 5 times and getting at least one 1 or one 2
- throwing a dice 5 times without getting 2 numbers the same.

Support for English Language Learners

Supporting students with understanding and expressing degrees of probability

English has many ways of expressing probability, including:

- adjectives such as “likely” and “unlikely”
- adverbs such as “maybe”, “probably”, “definitely”
- modal verbs such as “may”, “might”, “must”
- sentences with “if” (which express a condition and a consequence but often have elements of probability too).

The sentence structures and other grammatical rules that express probability are often complex and may be challenging for some students. As well as probability, sentences will often have other elements, such as time relationships and consequences or reasons.

You can support students with this language by providing:

- many examples of the language (and records, such as charts displayed on the classroom walls)
- opportunities to explore the sentence structures and grammatical rules
- explanations of the sentence structures and grammatical rules
- opportunities to co-construct sentences
- opportunities to create their own sentences
- feedback on their use of the language.

Language areas like probability are large and complex. You will need to select small chunks to focus on at one time and keep adding more each time students encounter the language.

Note that using a cline ranging from 0% certain to 100% certain can be a useful strategy for teaching and revising the meanings of different forms for expressing degrees of probability. For examples of clines, see ESOL Online at http://esolonline.tki.org.nz/ESOL-Online/Teacher-needs/Pedagogy/Vocabulary

As always, students also benefit from being able to make connections to their prior knowledge, including cultural and linguistic knowledge. ESOL Online provides a link to an example of a teacher using the Korean game Yut-nori in teaching probability. See ESOL Online at http://esolonline.tki.org.nz/ESOL-Online/Teacher-needs/Reviewed-resources/Cross-curricular

Technology-related student activities

- Learn about the importance of obtaining a patent, for example, the ownership and marketing of the ballpoint pen. See http://inventors.about.com/library/weekly/aa101697.htm
- Investigate the inventors of technological products such as aeroplanes, television, the electric fence, and bicycles. Emphasise that inventors seldom work in isolation and that most inventions actually result from several people's ideas and work.
- Research the history of a relatively modern technology such as the telephone. Invite older people to share their stories of dial phones, party lines, and expensive toll charges.
- Predict how a technology in common use may evolve (for example, what will a telephone look like and do 20 years from now?) and make a concept drawing.

Pages 10–11: Drop Zone

Achievement Objectives

- Statistical investigation: Conduct investigations using the statistical enquiry cycle:
  - gathering … multivariate whole number data …
  - identifying patterns and trends in context …
  - communicating findings, using data displays (Statistics, level 3)
- Measurement: Use linear scales and whole numbers of metric units for length … and time. (Geometry and Measurement, level 3)

Mathematics Standards

The approaches and thinking that students demonstrate as they engage with these tasks and problems can provide evidence in relation to the mathematics standards. For example:

- measure time and the attributes of objects, choosing appropriate standard units and working with them to the nearest tenth (Geometry and Measurement, year 5).

Developing students' mathematical understanding

Statistical thinking involves the exploration and use of patterns and relationships in data. There are four key processes:

- describing data – connecting the information in a table or graph with the real-life context
- organising and reducing data – ordering, grouping, and summarising data
- representing data – creating visual representations
- analysing and interpreting data – recognising patterns and trends and using them to make inferences and predictions.

In these activities, the students use data to evaluate different types or models of parachutes.

Exploring the technology-related context

Modification is an important principle in technology. Many solutions to problems don't suggest themselves immediately, and often people need to change their original ideas, perhaps many times. Edison's experiments to construct the light bulb are an obvious example. Edison's trials, and those in this activity, are not strictly controlled scientific experiments or fair tests. They are more trial and error, which has been a factor in many technological developments. Of course, science can assist technologists and technology can assist scientists.

Vocabulary alert

parachute, model, prototype, version, mass production, modify, characteristic, modification.

Answers

Activity One

1. **a.** Alex's plastic bag parachute had the slowest descent (9 seconds).
   b. Circle with a hole
   c. No, because the largest parachute he made had the worst result.
2. Based on the best results for each person, the best model might be a plastic, circular parachute, about 30 cm in diameter, with a hole in the centre and 6 strings. (You can't be totally sure about this because you don't know the shape and of Alex's parachute or the size of any but Isaac's.)

Activity Two

1. **a.** **i.–iv.** Practical activity
   b. Results and discussion will vary but should include some link between the data gathered and features you kept in later designs.
   For example, if changing the shape of the parachute improved the performance, you should keep the new shape (as long as the area is approximately the same).
2. Discussion will vary.
3. **a.** Practical activity
   b. A design may work well one time and badly the next. It's important not to trust just one drop, which may have been a lucky success, but to find a pattern of results.
   c. Results and reasons will vary.

Mathematics and Statistics Notes

In these activities, the students analyse the results of experiments. Clarify that a slow descent is a positive attribute of a parachute.

Ensure that the students understand the principle of a "fair test". Fair testing is where one variable is changed and its effect is measured while other variables are kept constant. For more information and practical examples, see:

- www.sciencebuddies.org/science-fair-projects/project_experiment_fair_test.shtml
- www.ise5-14.org.uk/prim3/new_guidelines/Investigations/Fair_test.htm

Activity One

Graphs communicate information by summarising and organising collections of data. Discuss how graphs make it easy to compare results. Ask the students to discuss what the graphs show. Remind them to refer to the numbers as time in seconds.

Discuss the difference between discrete and continuous data. Discrete data is data that can be counted in units, for example, the number of pets that people have. Continuous data is data that is measured, for example, a person's height. In this activity, the students are working with continuous data in the descent time and discrete data in the variables of shape, material, and number of strings.

Isaac used a line graph to show the results of the changes he made to his parachute. Theoretically, it would be possible to create a parachute with a width corresponding to any value on the horizontal axis, for example, 22.8 cm, or 33.25 cm. Meri, Alex, and Amanda all made category changes. It wouldn't make sense to have a parachute that has 3.125 strings or that is made from a graduated blend of plastic and foil. For these reasons, a line graph is suitable only for Isaac's data. Meri, Alex, and Amanda all correctly used bar graphs.

Activity Two

The students could cut out a section of a cardboard egg container and attach the container section to the parachute to hold a weight such as a golf ball. If they find it hard to time the parachute drop, suggest that they try a lighter weight, such as a multilink cube.

When investigating the effect of design changes on descent times, it is important to change only one variable for each trial. If more than one variable is changed, it will be impossible to be sure which variable caused any resulting change in descent time.

Students should perform at least three trials for each model. (They will probably want to do more.) They can decide whether to use the best result, the median, the total for all three, or the worst. The median (the middle value when the values are placed in order of size) won't be affected by unusual results. In real life, a parachute that sometimes performs badly is a big issue!

Interpreting visual representations of information develops the key competency *using language, symbols, and texts*. Working as a team to design a parachute provides students with an opportunity to develop the key competency *participating and contributing*.

Technology-related student activities

Model parachutes and paper planes often feature in "technology challenge" activities. These can be fun and informative, and students can learn about the performance properties of materials and designs for little cost and in a short time period. Such activities can be part of a larger unit but by themselves do not constitute a technology programme.

Sample parachute making instructions are included in the copymaster. A description of Leonardo's parachute design can be found here: www.raes.org.uk/raes/careers/education/education_makeapara.htm

Pages 12–13: Land Rush!

Achievement Objective

- Position and orientation: Use a co-ordinate system or the language of direction and distance to specify locations and describe paths (Geometry and Measurement, level 3).

Mathematics Standards

The approaches and thinking that students demonstrate as they engage with these tasks and problems can provide evidence in relation to the mathematics standards. For example:

- describe locations and give directions, using grid references and points of the compass (Geometry and Measurement, year 5).

Developing students' mathematical understanding

The game reinforces the use of compass directions to describe movement about a grid. Although a compass is shown on the page, it is worth discussing with students before they start the game where they think north is. A common convention of maps is to make the top of the page north. Online maps seldom include an indication of north–south orientation because their designers assume that people will know that the top of the screen is north.

Exploring the technology-related context

Control systems can be mechanical or electronic. The control that they exert can be manual or automatic. From something as simple as switching on a light to manipulating gears on a bicycle to operating a robotic camera in a satellite, control systems assist people in a great many ways.

Vocabulary alert

overcome, low-gravity, claim, rover, transmitter, control tower, grid line, command

Answers

Game

A game to develop your understanding of direction and describing paths.

Mathematics and Statistics Notes

In this activity, students play a game of strategy using compass directions.

Some students will be familiar with the game Dots and Boxes. In Dots and Boxes, players can place a line anywhere on the grid; it doesn't need to be connected to any other line. However, in Land Rush!, the path each rover takes must be continuous.

Students may like to add adaptations or rules of their own. For example, if a player makes a mistake when drawing in the compass directions they have chosen, there could be a consequence, such as missing a turn.

The game can be played with more than 2 players.

This game develops the key competency *thinking*.

Extension

If students number each vertical and horizontal line on the game board, they can use co-ordinates to describe the path of the rover.

The NRICH website has a related activity that demonstrates how grids can be used to create problem-solving opportunities. See http://nrich.maths.org/2813

Technology-related student activities

- Using a simple pneumatic apparatus, construct a diorama with a moving part to illustrate a children's story. See www.csiro.au/helix/sciencemail/activities/pneumaticfrog.html
- Programmable robots. There are some reasonably priced robots available from electronics outlets. These can be programmed to perform basic movements. For those unable to acquire robots, there are web-based programmes available, such as www.sonic.net/~nbs/webturtle/
- Discuss how robotics has helped people. Could there be any harmful effects?
- Sending radio instructions to Mars would involve dealing with a time lag: although Mars is the closest planet to Earth, the lag would be over 5 minutes. What would this mean in terms of instructing a robot?

Pages 14–15: Tailspin

Achievement Objectives

- Statistical investigation: Conduct investigations using the statistical enquiry cycle:
  - gathering, sorting, and displaying multivariate … whole number data to answer questions …
  - communicating findings, using data displays (Statistics, level 3).
- Shape: Represent objects with drawings and models (Geometry and Measurement, level 3)
- Measurement: Use linear scales and whole numbers of metric units for length, area … (Geometry and Measurement, level 3).

Mathematics Standards

The approaches and thinking that students demonstrate as they engage with these tasks and problems can provide evidence in relation to the mathematics standards. For example:

- investigate summary and comparison questions by using the statistical enquiry cycle:
  - gather, display, and identify patterns in … whole-number data
  - interpret results in context (Statistics, year 5).

Developing students' mathematical understanding

Statistical thinking involves the exploration and use of patterns and relationships in data. There are four key processes:

- describing data – connecting the information in a table or graph with a real-life context
- organising and reducing data – ordering, grouping, and summarising data
- representing data – creating visual representations
- analysing and interpreting data – recognising patterns and trends and using them to make inferences and predictions.

In these activities, the students use measurement data to determine a suitable length for a rat-costume tail.

Exploring the technology-related context

"Fit for purpose" is an important concept. Developers of new products need to know if they will do what they are designed to do, but they may wish to avoid the expense of making a prototype only to discover that it is a costly mistake. Developing functional models of new systems or mechanisms may help this to be avoided. (For rats' tails, the tail has to be the right weight so that it doesn't just wrap around legs as the rat spins.)

Vocabulary alert

models, technological idea, existing, musical production, one-size-fits-all, occupy, wings, estimate, generous, tripping

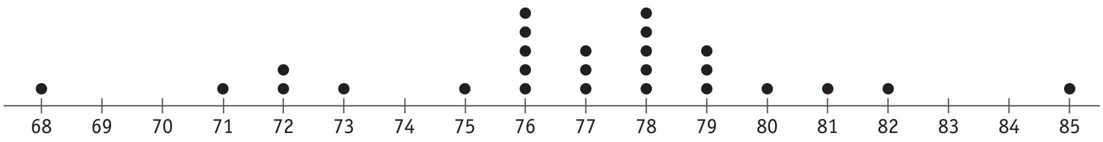
Answers

Activity One

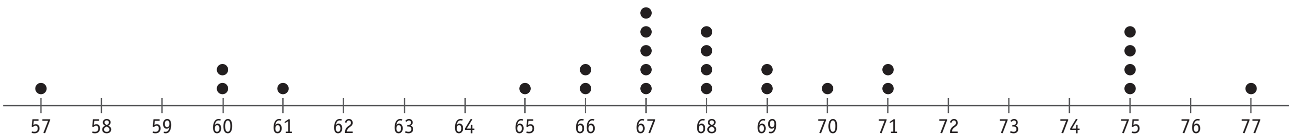
1. **a.–b.** Practical activity. Information will vary, depending on the individual measurements of class members.
2. **a.** Data and graphs will vary. Consider this sample data:

Student	Floor-to-hip height (in cm)	Preferred tail length (in cm)
Rangi	78	60
Angela	81	75
Peter	77	68
Arun	80	69
Toby	78	68
Moira	79	67
Maryanne	78	60

Dot plot: Floor-to-hip Heights in Our Class



Dot plot: Tail Lengths for Our Class



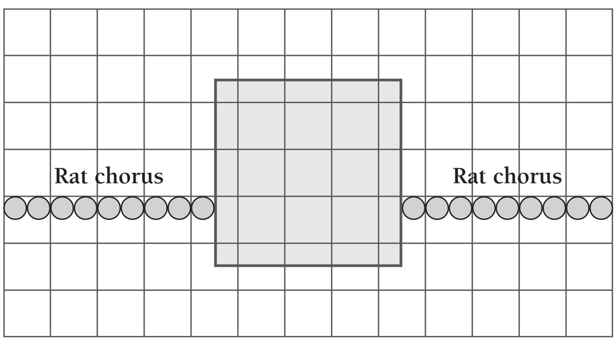
b. Conclusions from graphs will vary. The sample graphs show a large range of heights and preferred tail lengths. Most of the sample students would suit a tail between 65 and 71 cm.

3. a. One option is find an "average" tail length that lies in the middle of the data, for example, 67 cm. However, a safer option would be to choose a tail length that suits the shortest person in the class.

b. Answers will vary. In this example, a 67 cm tail might be too long for the shortest person in the class.

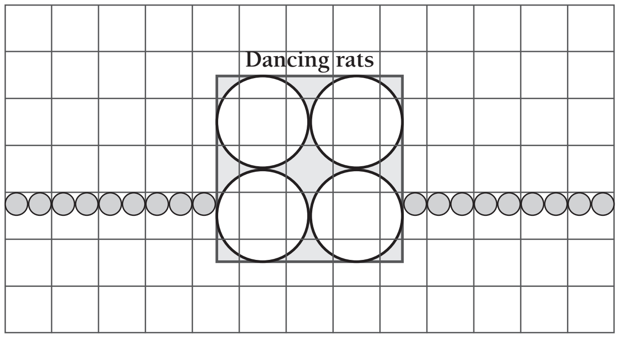
Activity Two

1.–2. Drawings will vary. There is 9 m of space left for the chorus (13 m – 4 m for the centre square). If the rats are 50 cm (0.5 m) wide, 2 rats will fit in each metre. 9 x 2 = 18 rats. For example, with the rats drawn in:



3. a.–b. Each spinning rat will make a circle with a radius approximately equal to the length of the rat's tail (imagine spinning round with your tail swinging at full stretch). If each rat has a 1 m tail, then each circle will be 2 m wide. The centre square is 4 m x 4 m, so only 2 spinning rats will fit across the bottom and 2 will fit across the top.

c. Diagrams will vary. For example:



Mathematics and Statistics Notes

In this activity, students collect data to help make decisions and create a scale drawing of a school stage.

Activity One

This activity provides an example of using data to inform decisions.

Statistical investigations should begin with a question or problem. In this situation, the problem is: How long should the rats' tails be?

It can be hard to see a pattern within a list of numbers, but when the information is displayed as a dot plot, groups within the data are revealed. Students can decide whether to make the tails a uniform length or to provide sizes (long, medium, short). Alternatively, the length of the tail could be based on individual differences, for example, 5 cm shorter than the hip-to-floor length.

Activity Two

Use a student to demonstrate how much space a person needs when they are spinning with a tail. Use a piece of rope to show that the spinning tail forms a circle. Pin one end of a piece of string to the carpet. Fix a piece of chalk to the other end and rotate the string to create a circle. Explore the relationship between the length of string and the circle it creates. Using a 1 m rope will make question **2** easier.

Question **3** will help the students to see the relationship between their scale drawings and real life. Consider using chalk to draw the positions from model drawings onto the school stage. The students can stand on a chair to view chalk markings from a bird's-eye view.

These activities provide an opportunity for students to develop the key competency *thinking* by creating models and using statistical information to make decisions.

Technology-related student activities

Explore the following scenarios to make products that are "fit for purpose":

- The board of trustees is planning to make sunhats compulsory. Make dyed models out of muslin to explore which colour is preferable to the students, parents, and the board of trustees and which is most effective.
- Make photo frames for presents. Experiment with cardboard to determine the best design for stands.
- The school wants to advertise its upcoming production. Make models of posters with cheap paper to investigate the best fonts and colours.

Pages 16–17: Bird Scarers

Achievement Objective

- Statistical investigation: Conduct investigations using the statistical enquiry cycle:
  - gathering, sorting, and displaying … whole number data … to answer questions
  - identifying patterns and trends in context, within and between data sets
  - communicating findings, using data displays (Statistics, level 3).

Mathematics Standards

The approaches and thinking that students demonstrate as they engage with these tasks and problems can provide evidence in relation to the mathematics standards. For example:

- investigate summary and comparison questions by using the statistical enquiry cycle:
  - gather, display, and identify patterns in … whole-number data
  - interpret results in context (Statistics, year 5).

Developing students' mathematical understanding

Statistical thinking involves the exploration and use of patterns and relationships in data. There are four key processes:

- describing data – connecting the information in a table or graph with a real-life context
- organising and reducing data – ordering, grouping, and summarising data
- representing data – creating visual representations
- analysing and interpreting data – recognising patterns and trends and using them to make inferences and predictions.

In these activities, the students explore data related to the durability of plastic bags.

Exploring the technology-related context

People often use objects and materials in creative and new ways. They recognise that the performance properties of a particular object may be suitable to solve a different problem or meet a new need. This could save time and money and could even benefit the environment.

Vocabulary alert

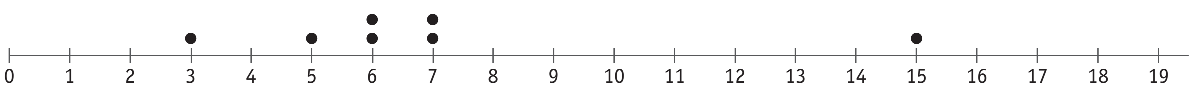
bird scarer, adapt, cost-effective, rip, vineyard, evaluate, reliable, outlier, false conclusion

Answers

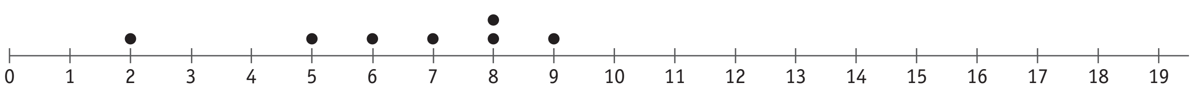
Activity One

1. a.

Eseta's Supermarket Bags



Isabella's Bin Liners



b. i. The bag that lasted the longest was a supermarket bag. However, if we ignore this bag and the bin liner that only lasted 2 days, it does seem that, overall, the bin liners lasted a bit longer than the supermarket bags.

   ii. The statement is true. The worst bin liner only lasted 2 days, and all the supermarket bags lasted longer than this.

c. Answers will vary depending on how much notice you take of the ones that are different from most of the rest – the best supermarket bag (15 days) and the worst bin liner (2 days). Overall, bin liners were stronger and there was less variation in how long they lasted. There was much more variation in the supermarket bags and, apart from the 15-day one, they lasted fewer days.

2. a. The supermarket bag that lasted 15 days is an outlier because it lasted so much longer. The bin liner that only lasted 2 days could also be an outlier. Perhaps it was faulty.

   b. Answers will vary. Isabella and Eseta might choose to ignore the bag that lasted 15 days on the grounds that it was unusually strong, and therefore not typical. But the experiment didn't use many bags, so the outliers may not be as unusual as they look. (In other words, if they had trialled a lot more bags, they would have had a clearer picture.)

Activity Two

1. a. Practical activity

   b. Other factors besides strength might include noise, movement, whether the bags get easily tangled, or their position on the pole (it might be windier at the top). (You might also want to check that you only choose bags that don't already have a hole in the bottom of them.)

   c. Decisions will vary.

Mathematics and Statistics Notes

In these activities, students interpret the results of a statistical investigation and then conduct a similar investigation themselves. For their investigation, have them discuss and then apply the PPDAC statistical enquiry cycle: problem, plan, data, analysis, conclusion. (See www.census@school.org.nz)

Activity One

It can be hard to see a pattern within a list of numbers, but when the information is displayed as a dot plot, patterns within the data are revealed. A dot plot shows how the data is grouped and whether there are any outliers.

Understanding variation is central to the development of statistical thinking. Variation occurs in every aspect of life: the amount of cereal in a bowl, the time it takes to get to school, the weather. Most students will have an intuitive understanding of variation. They will understand, for example, that not all 10-year-olds are exactly the same height. Whatever the source of the data, some variation is to be expected. It would be unusual if all the bags in the investigation had ripped at the same time unless this was the result of extreme weather.

Although variation is to be expected, it can be useful to compare the amount of variation within two data sets. For example, there is greater variation in the supermarket bag data than in the bin liner data. This tells us that the bin liners were more consistent in durability than the supermarket bags. (Note that, in reality, we would want a much larger sample before making such comparisons.)

Outliers are data values that are significantly smaller or larger than the rest of the data. When analysing data, it is important to treat outliers with care. It can be tempting to dismiss them as abnormalities, but an examination of outliers can provide useful information. Points to consider in this example include:

- When there are only a small number of "trials" (in this case, bags), it is hard to tell whether an apparently large or small value is an outlier. Because the sample was so small, the bag that only lasted 2 days has a big impact on our assessment of the durability of the bin liners. If 100 bags had been used and 1 bag lasted for a significantly longer or shorter time than the others, we could call this bag an outlier with much greater confidence.

- There may be a simple explanation for the outlier. For example, it may have been flawed in some way. Was it a lower quality bag to begin with? Was it attached to the pole differently? Was it lower or higher to the ground? Was it in the sun or the shade? Did it snag on something? Investigating these possible causes may provide useful information that can be used to refine the bird scarers.

Activity Two

It is important to keep in mind the purpose of the investigation. Isabella and Eseta investigated one aspect of the bird scarers, namely, their durability. The question they posed informed the way they set about gathering data. Discuss with the students how they could gather data related to other attributes of effective bird scarers.

See Chilling Out in *Measurement*, Figure It Out, Level 4+, for an activity involving students making an anemometer and measuring wind speed. See also Wind Chill in *Energy*, Figure It Out, Levels 3+–4+.

Related information:

- www.niwa.co.nz/news-and-publications/publications/all/wa/14-4/wind
- www.eeca.govt.nz/efficient-and-renewable-energy/renewable-energy/maps/wind

By learning how to interpret statistical information, students are developing the key competency *using language, symbols, and texts.*

Technology-related student activities

Suggesting adaptations for products or objects is a useful exercise for students, as imagination and creativity are required.

- Provide a range of everyday objects for students to suggest adaptations – for example, a glass, a mirror, a shoe box. (Note: objects can be changed to achieve desired results. For example, an old plate could be broken up to make a mosaic.)
- Students research examples of accidental inventions (these are related to adaptation, where serendipity is recognised and acted upon).
- Students think of a desired outcome and then brainstorm how unusual objects could be used to produce that outcome, such as a plastic-bag bird scarer.

Pages 18–19: Inventive Thinkers

Achievement Objectives

- Measurement: Use linear scales … and time (Geometry and Measurement, level 3)
- Number strategies: Use a range of additive … strategies with whole numbers … (Number and Algebra, level 3)

Mathematics Standards

The approaches and thinking that students demonstrate as they engage with these tasks and problems can provide evidence in relation to the mathematics standards. For example:

- measure time … , choosing appropriate standard units and working with them … (Geometry and Measurement, year 5)

Developing students' mathematical understanding

Timelines are a useful way to display information. They are often used in social science contexts. They show the order in which events occurred and the periods of time between them. Timelines need to follow conventions used in other data displays, in particular, they must have a uniform scale and clear labels.

Exploring the technology-related context

Some technological innovations have resulted from "know how". Sometimes creative leaps have been made from opportune discoveries. Others have been developed over long periods of laborious trialling. Many breakthroughs are inspired by need, but others that start off as a luxury soon become a necessity.

New Zealanders have produced many technological innovations. Māori developed effective food production and storage systems, early pioneers invented agricultural mechanisms, and modern Kiwi technologists are well represented in a number of high-tech fields.

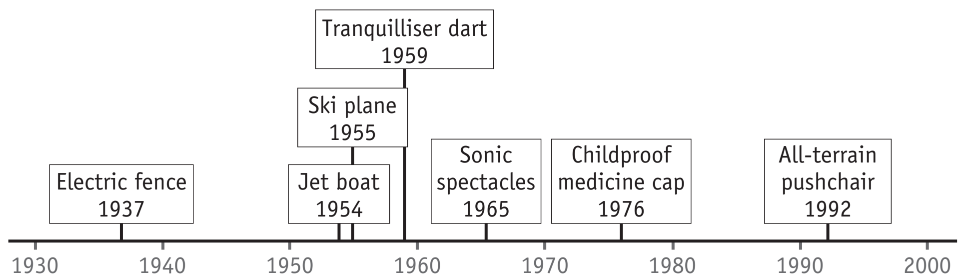
Vocabulary alert

inventions, all-terrain, amphibious, bungee jumping, childproof, version, propeller, tranquilliser, patented, dyslexia, technical skills, pharmacist, veterinarian, disposable syringe

Answers

Activity One

1. a. The objects on your timeline should be in this order: 1937 (electric fence); 1954 (jet boat); 1955 (ski plane); 1959 (tranquilliser dart); 1965 (sonic spectacles); 1976 (childproof medicine cap); 1992 (all-terrain pushchair).

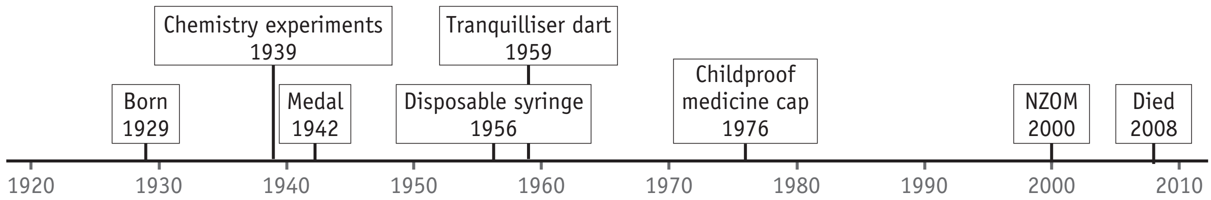


b. A timeline places the inventions in the order they were created.

2. 242 cm (2.42 m) because the inventions are 242 years apart (1992 – 1750 = 242)

Activity Two

1. Your timeline should look like this:



2. 79 (2008 – 1929 and May is after his birthday in February.)

Mathematics and Statistics Notes

In these activities, students create timelines and work with dates.

Constructing a timeline involves more than simply placing years in the correct order. The students need to see a timeline as a number scale, with uniform spacing between consecutive years. Ask your students to create their timelines before you discuss with them the conventions that they should follow. This will provide you with valuable information about their prior knowledge. Have them discuss their timelines and explain the methods they used to create them. Discuss useful units (months, years, or decades).

- What year should the timeline start at? Why doesn't it need to start at 0?
- What scale did the students use (if any)? How did they decide how long to make the timeline? How did they work out the width for each year?

One way to decide on a useful scale for the timeline is to work out how many years it needs to cover. For example, Colin Murdoch was born in 1929 and died in 2008. 2008 – 1929 = 79 years ≈ 80 years. If a timeline is 240 mm long (a length chosen because it is a multiple of 80), then each year will be represented by 3 mm. If A3-sized paper is used, the timeline could be 40 cm long, with each year represented by 0.5 cm (5 mm).

Timelines can be used to reinforce understanding of place value. Consider making a large timeline for the classroom wall, marking the years between each decade. If the scale is large enough, the students can be asked to approximate where July or December would be in a given year and position their birth date on the line. Point out that, unlike a counting number line, this involves dividing each year into 12 small units rather than 10.

The game Squeeze – Guess My Number (NDP *Book 4: Teaching Number Knowledge*, page 15) can be adapted for this level and context by playing "Squeeze – guess my date!" Give the students a number line from 0 to 2010 (or the current year). For each date guessed, a classmate says "later" or "earlier" until the correct date is found.

Take care when using online timeline makers; many of these pay no attention to scale and simply place events in chronological order.

The context in **Activity Two** provides an opportunity for developing number strategies.

Creating visual representations of text information helps develop the key competency *using language, symbols and texts.*

Technology-related student activities

- Consider Ingrid's list, or any other inventions, and suggest how they changed people's lives. Another way of looking at this is to imagine life without a particular invention or technology.
- Choose one invention and imagine what prompted the inventor to make it. Research the invention to see whether this was the case.

- Design a solution for a common need.
- Make a table of inventions and suggest the types of people who rely on them. For example:

Invention or technology	Needed by
Electric fence	Farmers, people wanting security ...
Sunglasses	Pilots, skiers, drivers ...

Pages 20–21: Call Chaos

Achievement Objective

- Number strategies: Use a range of additive and simple multiplicative strategies with whole numbers … (Number and Algebra, level 3)

Mathematics Standards

The approaches and thinking that students demonstrate as they engage with these tasks and problems can provide evidence in relation to the mathematics standards. For example:

- apply additive and simple multiplicative strategies … to:
  - combine or partition whole numbers (Number and Algebra, year 5).

Developing students' mathematical understanding

Most games involve a mixture of strategy and luck. Sometimes the need for a strategy only becomes apparent after starting the game. In these games, students collect cards and use them to make totals. The goal is to get the largest total possible without going over 50. In each round, students need to keep a running total in their mind or on paper in order to decide which card to discard or keep. This will help them to take sensible risks. Of course, there is not much they can do about luck!

Exploring the technology-related context

No technology is perfect. Faults, breakdowns, decay, and obsolescence are facts of life. High demands can overload systems, misuse can be dangerous, and waste products can pollute the environment. Some manufacturers may not want their products to be too durable or efficient because that would lower consumer demand. Today there are legal requirements for technologies to be as safe as possible, and systems are needed to ensure a failure will not endanger lives, for example, control systems in aircraft.

Vocabulary alert

bandwidth, network, base station, first-generation, names of face cards (jack, queen, king), receive, overloaded, earnings, discard

Answers

Games One and Two

Practical activities to develop number strategies

Mathematics and Statistics Notes

In these games, students use doubling and addition strategies to calculate earnings.

Game One requires students to double numbers. Ask the students to share their strategies for quick doubling. Some doubles, for example, $2 \times 15 = 30$, may be “known facts”. The students should keep a record of their calculations. They can use addition strategies to keep a running total so that they know when they have reached 300 cents. **Game Two** requires students to work with multiples of 5.

After the game, encourage the students to share any strategies they used. For example, looking for ways to "make tens" is one way to keep track of the running total during a round.

Playing a game is a good opportunity for students to develop the key competency *participating and contributing*. Some students may need guidelines or rules for co-operative play.

Technology-related student activities

- List safety systems in the community, for example, signs, railings, traffic lights, insulators.
- Research community systems, such as power, phone, or sewerage systems and how they deal with overload or failure.
- Research technologies such as cellphones, computers, or hot-air balloons to discover times or places when they don't perform well.
- Choose one technological outcome and design safety features for it. See http://en.wikipedia.org/wiki/Automobile_safety
- Discuss personal items, such as toys, cameras, or shoes, that have not performed as well as expected.

Pages 22–24: I Spy Symmetry!

Achievement Objective

- Position and orientation: describe the transformations (reflection, rotation, translation, or enlargement) that have mapped one object onto another (Geometry and Measurement, level 3)

Mathematics Standards

The approaches and thinking that students demonstrate as they engage with these tasks and problems can provide evidence in relation to the mathematics standards. For example:

- represent and describe the results of reflection, rotation, and translation on shapes (Geometry and Measurement, year 5).

Developing students' mathematical understanding

Transformations and symmetry involve the manipulation of an element or group of elements by means of translation, reflection, or rotation. The human brain is constantly presented with new and often complex information. As a result, our minds look for patterns that can help us make sense of this information. People find visual patterns appealing. This may explain why transformations such as reflection, rotation, and translation are found in decorative motifs throughout the world. Exploring transformations and symmetry presents students with ways of interpreting and reflecting on their physical environment.

Exploring the technology-related context

Product design often follows the concept of "form follows function": there is no point having a wacky chair that isn't balanced. The same applies to a pair of glasses or a building. In the design of many items and structures, balance is a primary consideration. Symmetry provides balance and strength because weight is evenly distributed.

Functional products, such as buildings, bridges, and gates can also reflect a community or a culture in their design. Shape, decorative elements, and colour can make a powerful symbolic statement.

Vocabulary alert

symmetry, reflective symmetry, kōwhaiwhai pattern, appearance, relevance, kaumātua, rotation, translation, element, repeating

Answers

Activity One

1. **a.** The school entranceway is symmetrical primarily because this makes it pleasing to the eye. The chair needs symmetry to ensure it sits squarely and distributes weight evenly. Symmetry is important for the goggles to fit your face and seal around your eyes to keep water out. Shoes (as a pair) are symmetrical so that they give support and balance to your feet as you move. The butterfly needs symmetrical wings to balance its flight. Symmetry helps an electric plug fit easily into the socket, but electricity would still flow through a plug if each pin was a different shape. You could argue that a symmetrical hopscotch grid is necessary so that you can balance as you play, but you could still jump on an asymmetrical one.

   b. The decoration on the entranceway, the hat design, and the coloured soles of the shoes use symmetry for appearance.

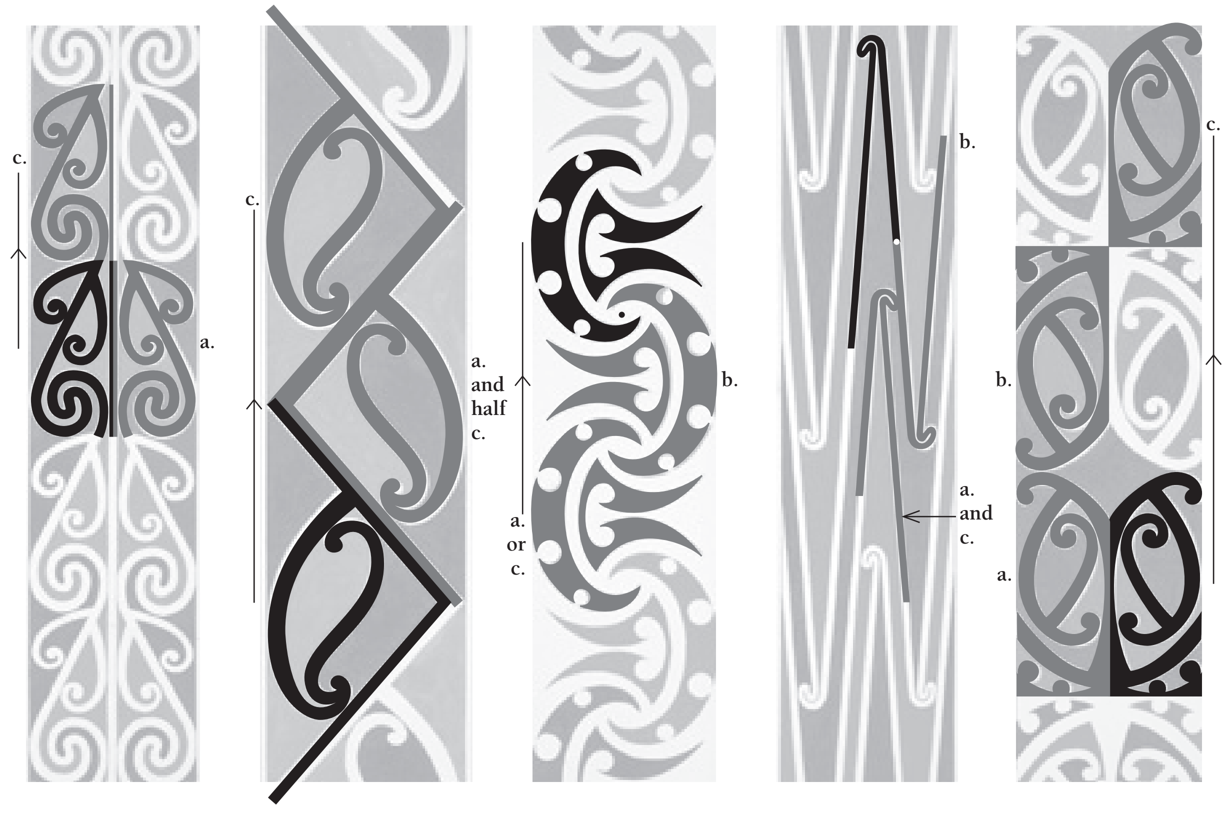
2. Practical activity. Answers will vary.

3. Answers will vary. Humans and other animals (including birds and fish) are symmetrical in their body shape and number and placement of legs and arms. But no one has a perfectly symmetrical face or body. Leaves have a certain symmetry, but only perfectly formed ones have full reflective symmetry. Insects such as the butterfly have reflective symmetry to balance their movements in flight. Shellfish may be symmetrical (especially bivalves, which have two joined halves), but many grow in spiral shapes, so are not symmetrical. It is very unusual to find symmetry in landforms. Volcanoes (such as Rangitoto, Ngāuruhoe, Taranaki, and Fuji) often appear symmetrical when seen from some angles but not others.

Activity Two

The repeating element of each pattern is shown in black.

The other transformations are labelled **a.** reflection, **b.** rotation, and **c.** translation. The third and fourth patterns have a dot to mark the point of rotation.



Activity Three

1. The table below shows the types of transformations found in each pattern. In some of the patterns, you will find more than one example of a particular type of transformation.

	Reflection	Rotation	Translation
a.	✓	✓	✓
b.	✓		✓
c.	✓	✓	✓
d.	✓	✓	✓

Note: pattern **b** involves reflection (to reverse direction) *and* translation.

2. a.–b. Practical activity

Mathematics and Statistics Notes

In these activities, students explore symmetry and transformations in cultural patterns. Note that, when we think of symmetry, we tend to think of reflective (mirror line) symmetry. In fact, symmetry can also be rotational or translational. Rotational symmetry is the result of turning about a point (centre), even if it is not obvious where this point is. Translation is the result of movement in a straight line. Many designs that use symmetry involve combinations of two or more of these different transformations.

Activity One

Discuss reflective symmetry and how symmetry creates balance. Ask the students to imagine sitting on a chair with legs that are asymmetrical. Encourage them to identify objects in the classroom or the school grounds with at least one line of symmetry.

We tend to find designs that are symmetrical visually appealing. This could be because the symmetry creates a sense of strength and harmony.

Discuss whether symmetry is only found in man-made objects and challenge students to find examples of symmetry that are not man-made. Can they find non-living examples of symmetry? Even archetypal volcanoes like Taranaki, Ngāuruhoe, Rangitoto, or Fuji are only more-or-less symmetrical when viewed from some angles.

Ask the students to find examples of famous buildings that do not have obvious symmetry, for example, the Sydney Opera House. In the absence of symmetry, how has the architect achieved a pleasing design?

Activity Two

Have the students find and describe transformations in the cultural patterns. To describe reflection, they should try to identify the line of reflection (mirror line); to describe translation, the direction and distance of the movement; to describe rotation, the centre and amount of turn (most often, a half-turn).

See South Pacific Journey on nzmaths for a related Figure It Out, Level 3 geometry activity.

A useful starting place is to use the digital learning objects at www.nzmaths.co.nz. Geometry, Level 3 has an excellent activity titled Pasifika Patterns. Another good introductory activity is Pattern Pieces in *Geometry*, Figure It Out, Level 3.

Many classrooms and schools have a number of kōwhaiwhai patterns evident in art or student text materials. Find examples of rotation, reflection, and transformations in the artwork that the students are already familiar with. Parents may be able to provide examples of cultural items that use transformations, for example, tapa cloth, tivaevae.

Activity Three

This activity provides an opportunity for students to represent their own culture and values in a meaningful way. Asymmetrical patterns can make designs using transformations more visually interesting.

Computers can be used to produce effective results with relative ease. Designs created using "paint" programmes are easily copied and transformations can be made electronically. These designs could be displayed around the classroom doorway.

Exploring the cultural significance of designs provides an opportunity for students to develop the key competency *relating to others*. Using the language of geometry to identify and describe transformations helps them to develop the key competency *using language, symbols, and texts*.

Technology-related student activities

- Examine local structures and find out whether their shapes or designs have particular meanings.
- Repeat the above for well-known international structures, such as the London Eye or the Eiffel Tower.
- Investigate cultural patterns that are relevant to the students in your class. Invite someone from the community to discuss with the students the significance of these patterns.
- Investigate logos and discuss their function.
- Create a design for a school or community structure. See www.techlink.org.nz/Case-studies/Classroom-practice/Materials/CP902-Marae-Panels/index.htm

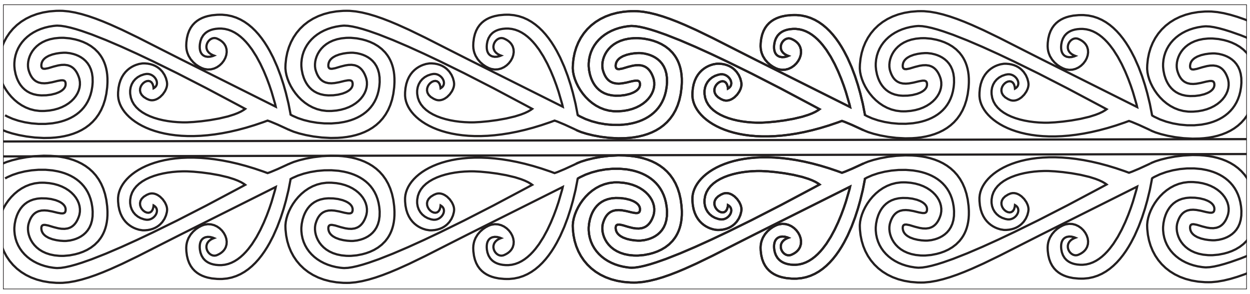
Copymaster: Land Rush! pages 12-13

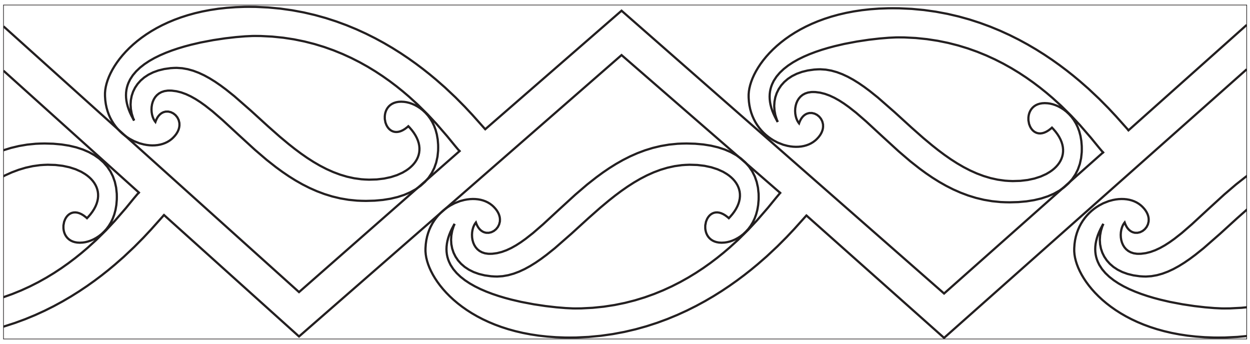
Copymaster: Tailspin pages 14–15

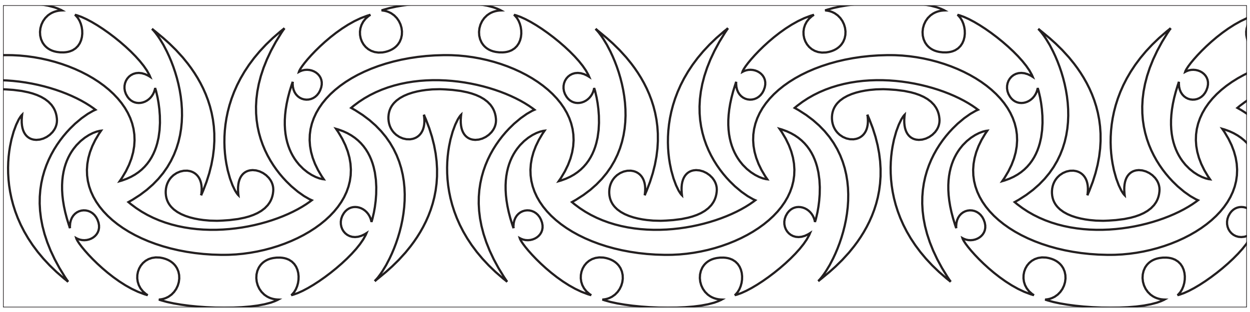
Student	Floor-to-hip height (in cm)	Preferred tail length (in cm)

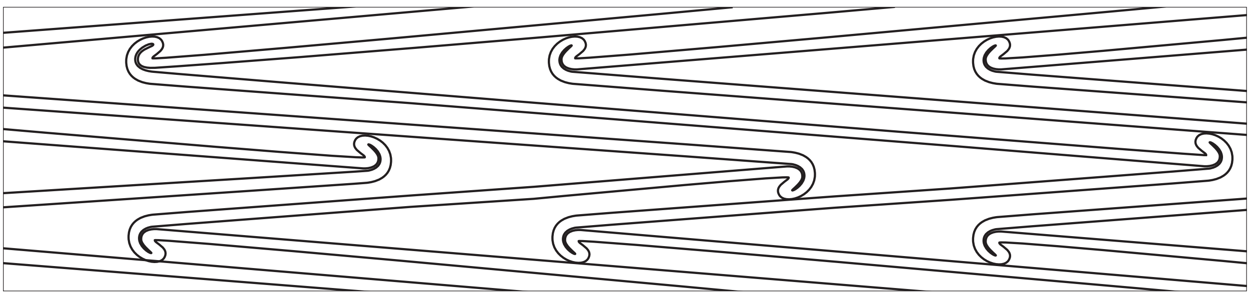
Student	Floor-to-hip height (in cm)	Preferred tail length (in cm)

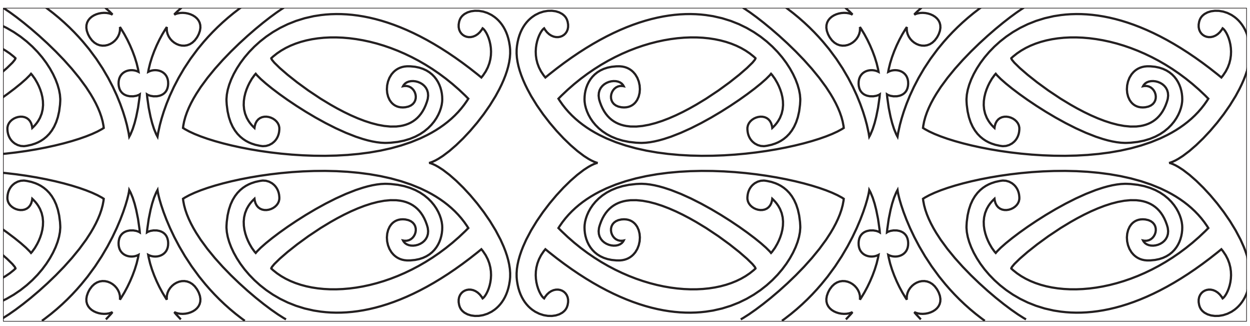
Copymaster: I Spy Symmetry! pages 22-24











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