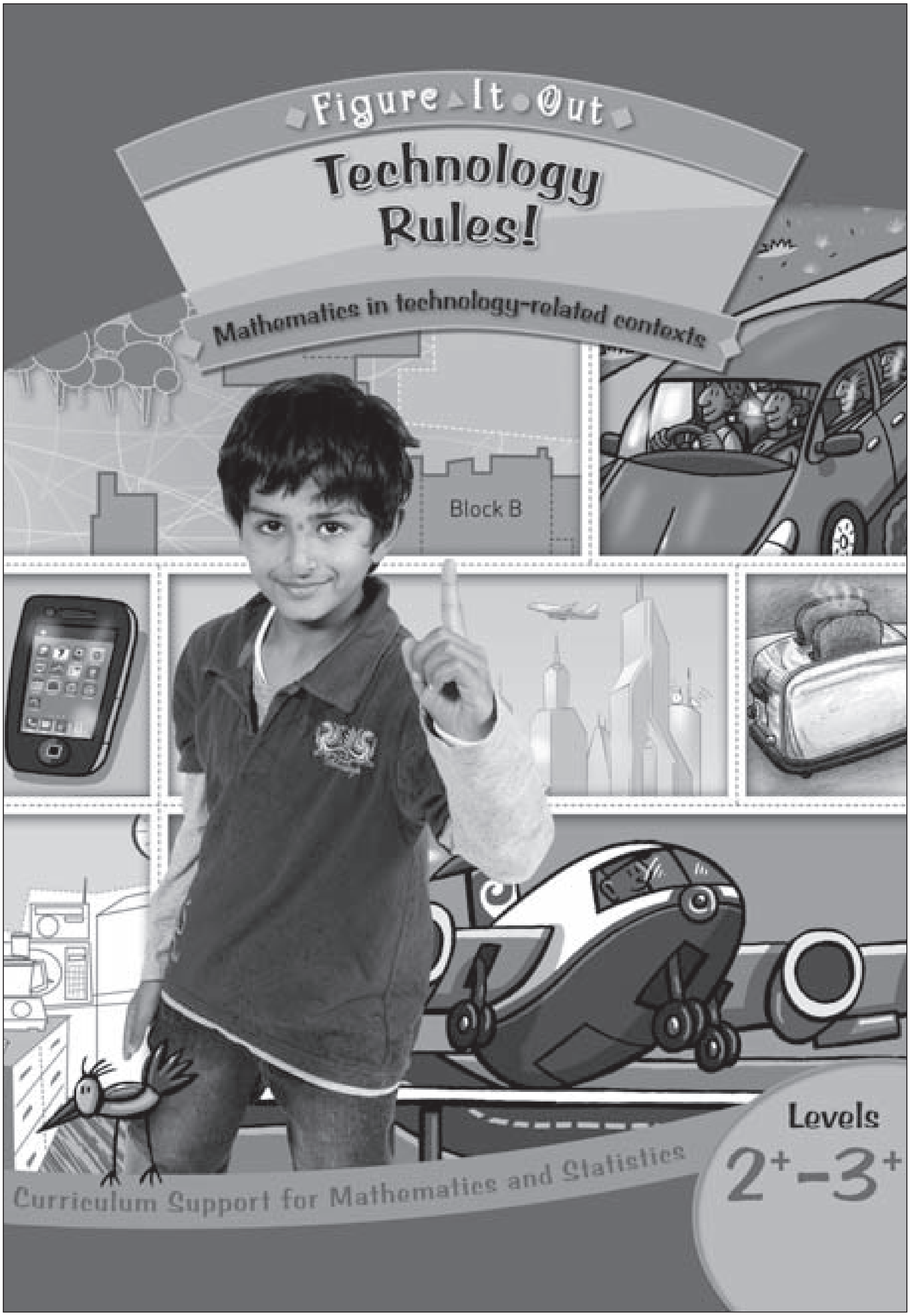
MINISTRY OF EDUCATION
Te Tāhuhu o te Mātauranga

Teacher Support Material
(including Answers)



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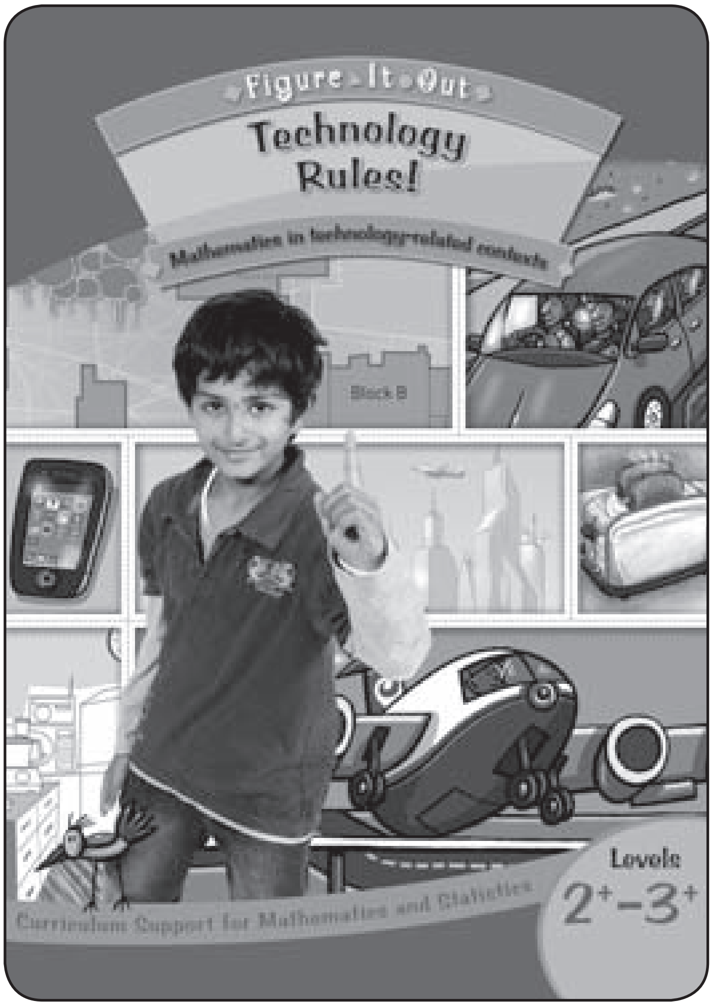
Teacher Support Material
(including Answers)



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^+ *Technology Rules!* 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 the mathematics and the technology-related context, as well as suggestions on teaching approaches. The *Teacher Support Material (including Answers)* for *Technology Rules!* 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

Technology Rules!

Teacher Support Material (including Answers)

Overview of Technology Rules!, Levels 2+–3+

Title	Focus	Page in students' book	Page in support material
Vending Machine Problems	Devising problem-solving strategies	1	6
Skewered Fruit	Listing possible outcomes systematically	2–3	8
A Changing World	Interpreting statistical information	4–5	11
Thirsty Dancers	Using problem-solving strategies	6	14
Dynamic Displays	Determining appropriate dimensions	7	15
Breakfast Decisions	Exploring combinations	8–9	17
Seat Heights	Exploring distributions and averages	10	19
Shipping Container Space	Exploring spatial orientation and transformations	11	22
Sampling Snacks	Conducting statistical investigations	12–13	23
Popular Products	Categorising and comparing	14–15	25
Communication Progress	Using basic facts and exploring probability	16–17	28
Right Way Up!	Using problem-solving strategies	18	30
Wheelchair Access	Working with spatial dimensions	19	32
Learning by Braille	Exploring code, combinations, and transformations	20–21	33
Tangram World	Finding areas by counting squares and using fractions	22–23	35
Ball Bounce	Making and comparing measurements	24	38

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 ensure that you 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:

- Pages 2–3: Skewered Fruit: Supporting students with using and understanding descriptions of rules and reasoning
- Page 7: Dynamic Displays: Supporting students with making comparisons
- Pages 14–15: Popular Products: Supporting students with talking about hypothetical conditions and consequences.

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: Vending Machine Problems

Achievement Objective

- Equations and expressions: Record and interpret additive and simple multiplicative strategies, using words, diagrams, and symbols, with an understanding of equality (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

Deductive reasoning is the process of using logic to solve problems. A simple way to start solving a problem is to write down what you know and what you need to find out. The simple act of writing out the combined cost of each pair of items (rather than the change that the machine gives) can help the students to identify the price of one item, which can then be used to find the price of other items. They can also use trial and error.

Exploring the technology-related context

Many modern technologies have their origin in antiquity, including the first vending machine. With industrialisation in the late nineteenth century, vending machines started to become familiar in western cities. New Zealand's Robert Dickie, credited with inventing the stamp vending machine, is an example of a lateral thinker and designer who produced effective solutions to technological problems.
(See www.nzedge.com/heroes/dickie.html)

Today, there are many varieties of vending machines, dispensing a wide range of products.

Designers must consider a number of factors in order to produce economical, reliable, safe, and tamper-proof machines. Vending machines are a good example of how technological innovation must cater for a range of human needs, fallibilities, and societal constraints.

Vocabulary alert

vending machine, technological system, household appliance, user, purchase

Answers

Activity

1. a. Phil and Maria's information can be used to work out these prices:
   - water: $2.00
   - fruit juice: $2.50
   - almonds: $1.00.

   b. Strategies will vary. Trial and error will work, but the most efficient way to get a solution is to first find the cost of the almonds. 2 packets of almonds gives $3 change. This means that the 2 packets cost $2 ($5 – $3 = $2), so each packet must be $1. This information can be used to find the cost of the water (water + almonds = $3). The cost of the water can be used to find the cost of the fruit juice. (You can't find out the cost of corn chips or a muesli bar because neither of these items is matched with a known price.)

2. Answers may vary. One option is for them to buy 2 packets of corn chips so that they can work out the cost of a single packet. Once they know the price of the corn chips, they can work out the cost of the muesli bar using the results of an earlier purchase (1 packet of corn chips and 1 muesli bar costs $4).

Mathematics and Statistics Notes

This activity involves choosing and using a strategy to solve a problem.

The following steps are useful when problem solving:
- understand and explore the problem
- find a strategy
- use the strategy to solve the problem
- look back and reflect on the solution.

Explore the problem-solving strategies on www.nzmaths.co.nz, for example, guess, act it out, draw, make a list, think, be systematic, keep track, look for patterns, and work backwards. Discuss with the students which strategies would be most useful for this problem.

Maria and Phil needed to make 5 purchases to find the cost of the 5 items. They used information from 4 purchases to find the cost of 4 items. Ask the students to investigate how many purchases are needed to find the cost of 1, 2, or 3 items. Is it possible to find the cost of 4 items using just 3 purchases? (The answer is no. The minimum number of purchases needed to solve problems of this nature will always equal the number of unknown costs.)

You could extend this investigation by asking students to design their own vending machine problems. Creating solvable problems can prove more difficult than actually solving them. The challenge is to provide enough clues for a solution to be found but not so many that the problem becomes too easy.

Technology-related student activities

- Gather lists or pictures of vending machines or machines that operate with money or cards. This would include parking machines, gate barriers, and so on.
- Brainstorm the problems facing machine designers. For example, designers would need to make sure fake coins would not work or that only one product was dispensed at a time.
  Note: Do not expect your students to explain how devices work but just to be aware of what they do. The concept of the black box within a technological system is an important one.
  (See www.techlink.org.nz/curriculum-support/strategies/tk-systems/level3.htm)
- List other examples of technological systems in which people give initial instructions or input and the rest is done by a machine. An example would be dialling a telephone number.
- Consider who would be happy with the introduction of a particular machine (for example, one that dispensed very sugary lollies) and who may not be so pleased.

Pages 2–3: Skewered Fruit

Achievement Objective

- Patterns and relationships: Connect members of sequential patterns with their ordinal position and use tables … and diagrams to find relationships between successive elements of number and spatial patterns (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:

- create, continue, and predict further members of sequential patterns with two variables (Number and Algebra, year 5).

Developing students' mathematical understanding

Making a generalisation involves identifying a pattern and using it to establish a general rule. In these activities, students are challenged to find numbers of arrangements for pieces of fruit on a kebab. By exploring the pattern that occurs as the number of pieces of fruit is increased, students can discover a general rule that will work for any number of pieces. The process of making generalisations is a core component of mathematical reasoning.

Exploring the technology-related context

Some people confuse *attributes* with *specifications*. Attributes are the general properties of a product. For example, fruit kebabs can be colourful and fresh; a coat can be waterproof, warm, or colourful; a car can be fuel-efficient; and a meal can be tasty and nutritious. Specifications are more measurable. For example, a biscuit may contain 280 kilojoules. Attributes and specifications are linked. For example, for a meal to be considered healthy, it would need to meet criteria for kilojoule, salt, and fat content.

Vocabulary alert

attribute, kebab, visual appeal, skewer, arrangement, variety, donated

Answers

Activity One

1. 5. 18 cm – 5 cm for the handle leaves 13 cm. If each fruit is 2.5 cm long, then 5 pieces will be 12.5 cm.
2. 4-piece kebab

A A A	A	A A A A	A A B	A	A A B A
	B	A A A B		B	A A B B
A B A	A	A B A A	A B B	A	A B B A
	B	A B A B		B	A B B B
B A A	A	B A A A	B A B	A	B A B A
	B	B A A B		B	B A B B
B B A	A	B B A A	B B B	A	B B B A
	B	B B A B		B	B B B B

3. a. The number of arrangements doubles for each additional piece of fruit.
   b. Yes, the number of arrangements is 16, which is double that for 3 pieces.
   c. 32 arrangements.

Activity Two

1. a. i. 3
      ii. 9
   b. Practical activity
   c. If you have 2 kinds of fruit, the number of arrangements doubles each time you add a new piece of fruit. If you have 3 kinds of fruit, the number of arrangements is multiplied by 3 (tripled) each time a new piece of fruit is added.
   d.

Number of kinds of fruit \ Number of pieces on the kebab	1	2	3	4	5
2	2	4	8	16	32
3	3	9	27	81	243
4	4	16	64	256	

2. 1 024 (4 x 4 x 4 x 4 x 4). See the last line of the table for the numbers of arrangements using 4 types of fruit.
3. No, doubling the number of kinds of fruit more than doubles the number of arrangements. The number of kinds of fruit is the factor by which the pattern goes up, so for 4 kinds of fruit you multiply by 4.
4. a. Keely realises that there are far too many arrangements for her to list them all. Even if she did spend hours doing this, some of the arrangements are less interesting than others because they have so little variety; for example, a kebab made using 5 pieces of apple is far less appealing than a kebab with 3 kinds of fruit. Many arrangements will look identical to the customers, for example, A B A B will look the same as B A B A.
   b. People will be more interested in the variety of fruit than in the way the fruit pieces are arranged. Keely could give each of her friends a different combination of fruit pieces to use (for example, 2 pieces of apple, 2 pieces of pineapple, and 1 piece of kiwifruit) and let them decide for themselves how to arrange them.

      Keely may have more of one type of fruit than another. This will also influence which arrangements the group makes.

Mathematics and Statistics Notes

In this activity, students list arrangements of fruit on a kebab.

Initially, materials such as multilink cubes can help students to identify different arrangements of fruit pieces. When the number of fruit pieces (or kinds of fruit used) is small, using a systematic approach to identify all the possibilities is less important. However, as the number of fruit pieces increases, it becomes very difficult to keep track of all possibilities.

Note: Concrete examples are very important for English language learners to model and demonstrate the language. You can use the cubes to help you model and explain some of the language.

Explore the first table with your students, helping them to make a link between the 2-piece kebab arrangements and the 3-piece arrangements.

For example, Keely's chart shows that AB gives ABA and ABB. Encourage the students to use a similar approach to find the number of 2-piece and 3-piece arrangements that can be made using 3 pieces of fruit. For example, have them write down all the 1-piece arrangements (A, B, C). To find the 2-piece arrangements, they add an A, B, and C to each of the 1-piece arrangements (AA, AB, AC, BA, BB …). To find the 3-piece arrangements, they add an A, B, and C to each of the 2-piece arrangements (AAA, AAB, AAC, ABA, ABB, ABC …).

In **Activity Two**, the focus shifts from listing arrangements to exploring the number of possible arrangements. As the amount of fruit increases, creating a systematic list of all the possibilities becomes impractical. Students are asked to use patterns to find a rule that can be used to work out the number of possible arrangements for any number of fruit. Solving a complex problem by exploring patterns is a powerful problem-solving skill and a key component of mathematical thinking.

Encourage the students to use mathematical language to describe the rule and their reasoning. For example, a *conjecture* (a statement that you believe to be true but have not yet proved) could be that “the number of arrangements is the number of pieces of fruit multiplied by the number of kinds of fruit”. This rule appears to work for the first two values in the table.

A *counter-example* (an example that shows that a conjecture is false) is that there are 8 arrangements for a 3-piece kebab using 2 kinds of fruit, not 6.

Extension

Once a rule has been identified, the next step is to explore why the pattern exists, relating it back to the original situation. Ask the students to explain why, when using two kinds of fruit, the number of arrangements doubles each time a new piece of fruit is added. They may find it helpful to relate the rule back to the 3-piece kebab example in the student book.

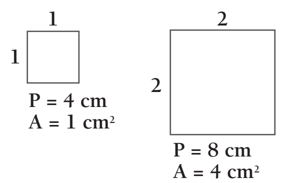
Finding and using a model and generalising ideas develops the key competency *thinking*.

Support for English Language Learners

Supporting students with using and understanding descriptions of rules and reasoning

To support your students, especially English language learners, you could model and record the vocabulary, using a speaking frame to show some ways they can describe a rule and their reasoning.

- Use the multilink cubes to model and explain vocabulary such as arrangements, variety, and pieces.
- Model a sentence that describes a conjecture (not using the fruit skewers example). Then record and display your sentence in a graphic organiser like the one below.

Conjecture	Reasoning	Counter-example or confirmation
My conjecture is that if I double the perimeter of a square, the area will also double. (The underlined words can be substituted.)	Changing the size affects length and area in the same way.	A square with a perimeter of 4 has an area of 1, but a square with a perimeter of 8 has an area of 4.  My conjecture is false.

- Erase the optional parts of the sentence describing a conjecture and work with students to co-construct a new sentence by filling in the gaps.
- Repeat the process with a sentence giving the reasoning and a counter-example or confirmation.
- Tell the students to talk in pairs, referring to the frame and making notes or writing sentences in their own graphic organisers as they are describing their conjectures, reasoning, and so on.
- Ask the pairs to share their ideas with the class.

Note that opportunities to repeat and recycle language in different contexts and over time are very important for English language learners. Working with other contexts that use arrangements could be useful.

Technology-related student activities

- Examine everyday items and make a list of their attributes (for example, a jacket, a car, a chair, shoes, or a food item).
- Rank attributes of similar items. For example, examine food packets and rank them in terms of their customer appeal or compare the extent to which different materials are waterproof.
- Examine an everyday item and attempt to list specifications. For instance, estimate the length, weight, and height of a desk and check your results.
- Interview an expert on the attributes and/or specifications of specific items (for example, commercial pizza, hāngi food, safety clothing).

Pages 4–5: A Changing World

Achievement Objective

- Statistical literacy: Compare statements with the features of simple data displays from statistical investigations or probability activities undertaken by others (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:

- investigate questions by using the statistical enquiry cycle independently:
  - gather and display category … data
  - interpret displays in context (Statistics, year 4).

Developing students' mathematical understanding

Making comparisons is an important part of most statistical investigations. In these activities, students use data to compare people's perceptions about the relative impact of technological discoveries. They are asked to interpret tables showing rankings and ratings.

Exploring the technology-related context

Technology can affect people in different ways. Sometimes it can be beneficial, and at other times its impact is extremely negative. What may assist one culture may not necessarily be welcomed by another.

Vocabulary alert

impact, discovery, invention, rankings, ratings, positive, neutral, negative, summary, advantage/disadvantage

Answers

Activity One

1. **a.** Antibiotics

   b. Answers will vary. The cellphone had 1 first-place ranking but 2 fifth-place rankings, whereas the car's rankings ranged from 2 to 4. Overall, the cellphone's "score" was 17 and the car's was 16, so there was very little difference.

   c. Answers will vary, depending on the method used. If totals are found for each column, the order (based on the lowest total being the highest ranked) would be: antibiotics, Internet, car, cellphone, aeroplane. Antibiotics had 3 first-place rankings and the aeroplane had 3 fifth-place rankings, which supports this conclusion.

2. Rankings and discussion will vary.

Activity Two

1. Comments will vary. For example, in the first table, where each item is ranked differently, antibiotics was voted as having the most impact. In the second table, everyone voted the impact of antibiotics as positive, but someone who had reacted badly to an antibiotic may well have given that item a neutral face. The ratings table has less variation because there are only three options (☺, 😐, and ☹), and each person can use each face more than once.

2. a. Ben gave 1 point for each happy face, 0 for a neutral face, and subtracted 1 for each sad face, then added up the totals.

   b. i. Answers will vary. The summary table is faster to read because it contains less detailed information. This helps you to quickly compare different inventions or discoveries.

   ii. The faces table shows all the ratings from each student, while the numerical table is just a summary. If you only use the summary table, you don't know how any one student ranked the various items – a summary of +3 could be 3☺s and 2 😐 faces or 4☺s and 1☹ face.

   c. i. Answers will vary. Ben could have given a score of 0 for an invention with a negative impact, 1 for an invention with a neutral impact, and 2 for an invention with a positive impact.

   ii. In the example in **i**, the rankings would be the same.

Mathematics and Statistics Notes

In this activity, students evaluate technological items according to their impact on people's lives.

Activities One and Two

In **Activity One**, students are asked to interpret rankings. In **Activity Two**, they interpret ratings. You can use these activities to explore the difference between rankings and ratings with your students.

Rankings

When items are ranked, each item is given a unique value. A problem arises when a person believes that two items are equivalent. Rankings may force them to differentiate between the two items unless they are given the option of equal rankings.

Rankings sometimes cause confusion because the first ranked item has a lower "score" than a lower ranked item.

Statistically, rankings should not be averaged because the distance between rankings is not uniform. For example, there may be a large difference between the items ranked first and second but only a small difference between the items ranked third and fourth.

Ratings

Ratings allow items to be given equal "scores". For example, a group member could give every item the same rating. This can make it harder to differentiate between items in a list and is particularly true when the range of ratings is small. For example, in **Activity Two**, there are only 3 rating options. However, it may be fairer than forcing survey participants to impose a hierarchy on items when perhaps none exists.

Ratings sometimes reflect people's individual tendencies. For example, some people may seldom give high ratings, others may give all high ratings. The more people who are surveyed, the more valid the end results will be.

Studies have shown that survey questions that involve ranking take around three times longer to complete than rating questions (Munson and McIntyre, 1979). Discuss possible reasons for this with the students.

Students could design two surveys to determine people's preferences, one that uses rankings and one that uses ratings. Discuss: *Do the items end up in the same order? Why or why not?*

Activity Two

Ben's group has used qualitative (non-numerical) data to rate the benefits of the inventions. This is useful visually because the faces have a natural association with positive and negative feelings. However, to analyse the information further, the information needs to be converted into quantitative data (numerical data).

Ben subtracted a point for each ☹ face. Integers are not introduced until level 4 of the curriculum, but students should be able to identify that a ☺ adds 1 point and a ☹ takes one away.

These activities provide an opportunity for students to develop the key competency *using language, symbols, and texts* through interpreting information and results in context.

Technology-related student activities

- Construct a table of inventions, listing positive and negative consequences.
- Follow the evolution of a technology and how it affected people. For example, show the development of writing implements from quills to pencils to pens.
- Debate "the most important invention or technology" (see http://science.howstuffworks.com/innovation/inventions/10-inventions-that-changed-the-world.htm).
- Investigate how some people receive a new technology, for example, the Luddites, Cargo Cults, use of goal-line technology and video replays in football (see http://news.bbc.co.uk/sport2/hi/football/8553463.stm).

Page 6: Thirsty Dancers

Achievement Objective

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

Developing students' mathematical understanding

A useful technique when solving a problem is to write out what you know and what you need to find out. In this activity, the number of students choosing one particular drink is used to find the numbers of students choosing other drinks. Students could use deductive reasoning or trial and error to solve this problem.

Exploring the technology-related context

Authentic contexts are important when teaching technology. Units based on topical events and needs give purpose to activities and allow students to be active participants in planning and evaluating their work.

Vocabulary alert

social, prefer, provide

Answers

Activity

1. a. 30. ($120 \div 4 = 30$; I know $12 \div 4 = 3$, so $120 \div 4 = 30$; or: $3 \times 4 = 12$ and half of 12 is 6, so half of 120 is 60 and half of 60 is 30; or: I know $\frac{1}{4}$ of 100 is 25 and $\frac{1}{4}$ of 20 is 5, so $25 + 5 = 30$.)

   b. 25. ($120 – 40 = 80$. $80 – 30$ [fruit punch] = 50 [lemonade and cola]. $50 \div 2 = 25$.)

   c. 35. ($40 – 5 = 35$)

2. a. Answers will vary. 120 is enough for 1 drink per student, but some students may want more than one drink.

   b. Discussion will vary, but iced water is a sensible choice. If all the other drinks run out, anyone can drink water.

Mathematics and Statistics Notes

This activity involves problem solving to calculate missing amounts. Trial and error is a legitimate approach, although it is usually less efficient than deductive reasoning.

Provide opportunities for the students to explain the strategies that they used to find the missing amounts. Those who used trial and error can discuss how they decided which values to trial. Help the students to articulate their thinking processes by asking them why they didn't start with certain values, for example, why they didn't start with 2 students choosing lemonade or 100 students choosing cola.

Using logic to solve problems develops the key competency *thinking*.

Technology-related student activities

- Conduct surveys to discover student preferences or special needs in food and drink for a particular event.
- Plan, prepare, and serve a meal based on preferences or needs.
- Work within a budget or with limited resources to produce a tasty and nutritious snack.
- Experiment with existing recipes to see if people's needs can be catered for (see www.techlink.org.nz/Case-studies/Technological-practice/Food-and-Biological/Gluten-free-cookies/index.htm).

Page 7: Dynamic Displays

Achievement Objectives

- Measurement: Use linear scales and whole numbers of metric units for length … (Geometry and Measurement, level 3)
- Shape: Represent objects with drawings and models (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 … the attributes of objects, choosing appropriate standard units … (Geometry and Measurement, year 5).

Developing students' mathematical understanding

Measurement skills are often used in everyday life. These skills (choosing units, estimating, measuring, using relationships) should begin at an early age, with students developing increasingly accurate methods of measuring over time.

Measurement experiences can be used to make links with other mathematics concepts and across curriculum areas.

Exploring the technology-related context

Products must be fit for purpose. That is, they must do what they have been designed to do. In this case, the dimensions of the display must be suitable for both the size of the books and the readers. Specifications are very important in design. In some cases, very precise measurement is required, as in engine design. A piece of furniture should also have aesthetic appeal. The form in relation to function issue is one that all designers are aware of.

Vocabulary alert

display, movable, fiction, consider

Answers

Activity

1. Answers will vary, but you should include how to display books of various sizes so that they are easily seen, will fit on the shelf, and can be easily accessed by the appropriate age group.
2. Practical activity. Answers may vary in different libraries.
3. a. Practical activity. Answers may vary but should be related to students' heights in these years.

   b. Diagrams will vary.

Mathematics and Statistics Notes

In this activity, students make measurements in order to determine dimensions for a library display unit.

If necessary, begin by exploring the language of comparisons, using language such as wider/narrower, taller/shorter, higher/lower.

Give the students time to plan how they are going to measure the best height for a display "roof". They need to realise that the reader normally looks down at these (from a standing position) rather than the display shelf being at eye level.

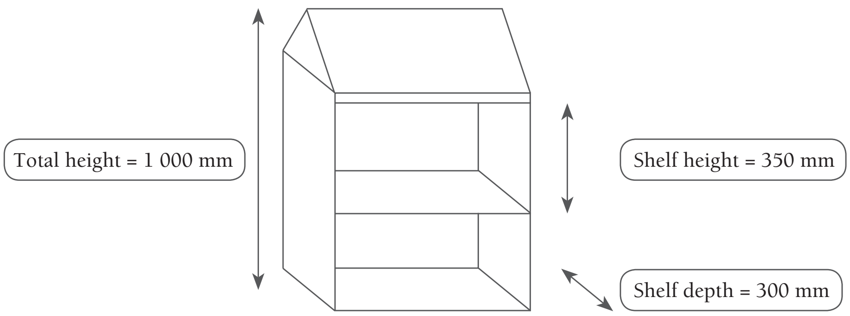
All measurement involves approximation. When someone says that their height is 168 cm, what is actually being said is that their height is 168 cm *to the nearest centimetre*. Discuss with the students the degree of accuracy that is appropriate in this context. Furniture makers usually work in millimetres because accuracy is important for different pieces to fit together. However, when measuring eye-level, less precision is required.

Students may need support to use measurement materials appropriately.

Discuss with the students how they can use their data to decide on the height of the display shelves. They may choose to make the height suitable for a short child, or they may choose a value somewhere closer to the middle. It is easier to look down at a display shelf than up, so it does not make sense to base the height of the display shelf on the tallest members of each group.

To determine the dimensions of the shelves, students could choose to find the largest book that needs to be accommodated.

Note that the diagram of the display unit does not need to be drawn to scale, but should provide sufficient information for a builder to be able to create it.



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

Support for English Language Learners

Supporting students with making comparisons

Language focus: Making comparisons using adjectives

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

After students have discussed question **1** in pairs, ask them to share their factors and record them. Show three pictures of display units of different heights. Co-construct a few sentences comparing the three units (according to their factors) and write them on the whiteboard, for example, *Unit 1 is taller than unit 2. Unit 3 is the tallest.*

Explain that adding "–er" and "–est" is how we make comparisons with many adjectives. Co-construct some examples with adjectives that follow other rules. Begin a comparisons 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
wide, wider, widest tall, taller, tallest	big, bigger, biggest	powerful more powerful the most powerful	good, better, best

You may also want to introduce sentences with "as ________ as" and "not as ________ as", recording these sentences on the whiteboard, too. Ensure that you give examples and illustrations to make the meanings clear.

If appropriate, you could talk about other ways of making comparisons, for example, with pronouns ("________ has more/less/fewer________ than ________ ") and/or with adverbs ("more effectively", "less efficiently").

Technology-related student activities

- Draw up a list of designs or products for which measurement is important.
- Investigate products or designs that some people find difficult to use because they are too high or too small, and so on. For example, some people have difficulty texting because the keys are too small for them.
- Examine magazine pictures of cars, houses, clothing, and so on and debate whether they would be designed mainly for form or function, or both.
- Examine a product and rate it according to its looks. For a wide range of creative mailboxes, search under "images" on the Internet.

Effectively planning and carrying out an investigation develops the key competency *managing self*.

Pages 8–9: Breakfast Decisions

Achievement Objectives

- Number strategies: Use a range of additive and simple multiplicative strategies with whole numbers, … decimals … (Number and Algebra, level 3)
- Number knowledge: Know basic multiplication and division facts (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:

- describe spatial and number patterns, using … rules that involve … simple multiplication (Number and Algebra, year 5).

Developing students' mathematical understanding

Making a generalisation involves identifying a pattern and using it to establish a general rule. In these activities, students explore the number of possible breakfasts that can be made using certain ingredients. They should be able to discover a general rule that can be used to find the number of possible combinations for any number of food or drink options. The process of making generalisations is a core component of mathematical reasoning.

Exploring the technology-related context

Access to affordable, reliable technology has enabled people to prepare meals quickly and efficiently. Microwave ovens, toasters, blenders, bread-makers, and juicers have provided people with the ability to produce a wide array of meals. A century ago, many food choices would have required special knowledge and skills and a large amount of time.

Vocabulary alert

technologies, refrigeration, appliance, option, multigrain, cereal, smoothie, combinations, liquid, spread, bonanza, mix-and-match

Answers

Activity One

1. 6. (3 options with ice cream, 3 with yoghurt: 3 + 3 = 6)
2. **a.** 6. (2 liquid options for each cereal: 2 x 3 = 6)

   b. 18. (For each of the 6 combinations in **2a**, there are 3 new combinations: 6 x 3 = 18.)
3. **a.** 12. (3 spread options for each toast type: 3 x 4 = 12)

   b. Number of pieces of toast x number of spreads

   c. 21. (3 x 7)
4. 14. (There are 7 fruit options [3 x 1 fruit, 3 x 2 fruits, 1 x 3 fruits] and 2 bases: 7 x 2 = 14.)
5. 72. (There are 12 toast options and 6 cereal options: 12 x 6 = 72.)
6. **a.** Discussion will vary. Points may include no commercially made products such as muesli and yoghurt, no blenders, no freezers for ice cream, no toasters.

   b. Most people tend to stick to one or two breakfast choices and have similar things nearly every day. For example, you might have cereal and fruit and a piece of toast every day, with something different in the weekend.

Activity Two

1. **a.** $2. ($1 + 2 x $0.50)

   b. $3. ($1.50 + 3 x $0.50)

   c. $8.50. ($1.50 + $3 + $4)

   d. Answers will vary.
2. Answers will vary.

Mathematics and Statistics Notes

These activities involve working out possible combinations of breakfasts and calculating the cost of different combinations. As for Skewered Fruit, pages **2–3**, the emphasis is on identifying patterns in order to make a generalisation.

The combinations that the students are exploring in **Activity One** differ from those in Skewered Fruit because the order in which items are combined has no relevance. For example, in Skewered Fruit, a skewer with 2 pieces of kiwifruit and 1 piece of orange can be arranged in 3 different ways (KKO, KOK, OKK). In Breakfast Decisions, a smoothie made with yoghurt and 2 fruits creates a single combination.

The most challenging question in **Activity One** is question **5**. Elspeth is combining toast options with cereal options. Students may intuitively feel that the number of options of each can be added together. This is because we talk about toast AND cereal. However, the actual number of combinations is worked out by multiplying the two values together. For each individual toast option, there are 6 cereal options. As a result, there are 12 x 6 possibilities.

To extend **Activity Two**, the students could use a supermarket website to find the retail cost of the breakfast items. The students could explore whether the prices Elspeth has chosen are realistic (for a fund-raising activity) and suggest alternative prices if necessary.

Finding and using a model and generalising ideas develops the key competency *thinking*.

Technology-related student activities

- Interview an older person about food choices and preparation when they were younger. Ask questions about growing food, commercially available ingredients, equipment, taste, and texture.
- Discuss how breakfasts could be produced without using modern technology, for example, bread, juice, and toast. How much longer would it take? What other aspects would be different?
- Plan a fund-raising breakfast. Decide what items to include and how to price them.
- Investigate other cultures' methods of food production.

Page 10: Seat Heights

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, sorting, and displaying … whole-number data … to answer questions
  - 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 category and whole-number data (Statistics, year 5).

Developing students' mathematical understanding

Statistical enquiry is the process of exploring problems using an investigative cycle (PPDAC: problem, plan, data, analysis, conclusion; see www.censusatschool.org.nz). Much of the value of a statistical investigation is lost if the focus is only on data gathering and making graphs. In this activity, students are presented with the challenge of choosing two chair heights for the students in their class. To reach a conclusion, they need to gather data, sort it into groups, and make decisions about which chair height will best suit each group.

Exploring the technology-related context

Ergonomically designed technologies ensure that people are not physically disadvantaged or endangered. Chairs should not cause backache or result in poor posture. Often, a product or environment may be suitable for one situation but not for another. For example, a classroom chair may not be suitable for watching a long movie.

Vocabulary alert

dangling, suitable, suit, comfortable

Answers

Activity One

1. Practical activity. Answers will vary.
2. **a.** All those with a knee-to-floor height of less than 46 cm

   b. Practical activity. Answers will vary.
3. **a.** The seat height that is equal to or just above or below the knee-to-floor measurement of most students in the class. (You could do a dot plot to see the range of measurements and then work out the best height for most students.)

   b. Some would have dangling feet, and some might be sitting on seats that are too low. Other aspects of comfort are beyond this measurement.

Activity Two

Methods will vary. For example, you might sort the class into a "short" group and a "tall" group and find a seat height that works for most of those in each group.

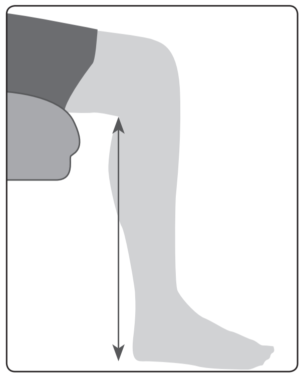
Mathematics and Statistics Notes

Activity One requires students to measure the seat heights in their class and to gather information about the knee-to-floor heights of their classmates.

The concept of variation is central to statistical thinking. Variation occurs in all parts of everyday life: the amount of cereal in a bowl, the amount of time it takes to get to school, the weather. Most students will have an intuitive understanding of variation, for example, not all 10-year-olds are exactly the same height. It would be unusual if all the students had the same popliteal length.

Discuss the steps on the PPDAC poster (www.censusatschool.org.nz/resources/poster), relating each step to the context of choosing chair sizes for a class. For example, Problem (What does it mean for a chair to be "suitable"?), Plan (plan how to gather data [D]), Analysis (see whether the data can be divided into two groups), Conclusion (choose two heights or make other recommendations).

Students need to decide what it means for a chair height to be "suitable". Is it better to have dangling feet or to be sitting on a chair that is too short? How much will students grow during a year? Are the conclusions likely to be different if data from another class is used instead or combined with existing class data? Is it realistic to have only two chair heights?



The technical name for knee height is popliteal length. CensusAtSchool provides information on how to measure popliteal length: www.censusatschool.org.nz/2009/documents/making-measures.doc

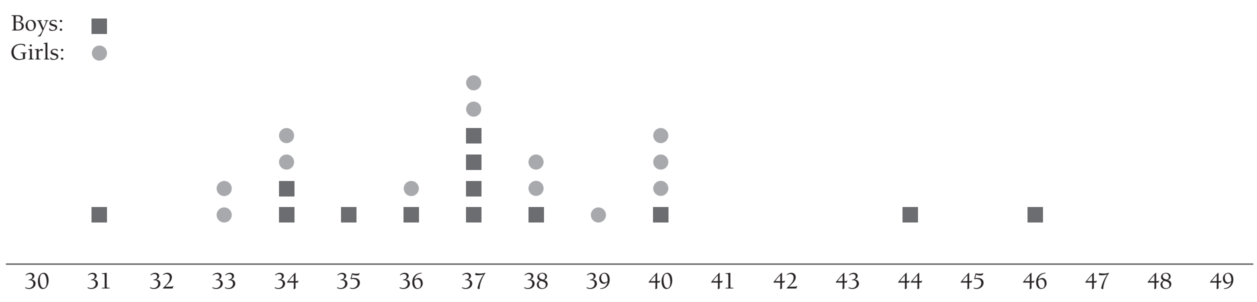
Ideally, the student will be seated with their legs bent at a right angle. This may present a problem if classroom chairs are too low or too high.

Check that students use the measurement equipment correctly, for example, measuring from zero and not the edge of the ruler. The ruler needs to be vertical. The popliteal lengths are likely to all be greater than 30 cm, which presents students with an additional challenge if they are using a 30 cm ruler. Discuss ways to address this.

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

The following graphs show the results of a random sample of 26 year 5 students using data from CensusAtSchool.

Year 5 Students' Popliteal Lengths in Centimetres



Discuss why "data detectives" need to look for clues that can be used to solve their investigative question. Encourage the students to look for patterns in the data they collect. Ask: *Are there distinct groups? Are there any unusually large or small values? Is there a difference between the popliteal lengths of male and female students?*

Classroom chairs come in a range of sizes. One manufacturer provides the following options:

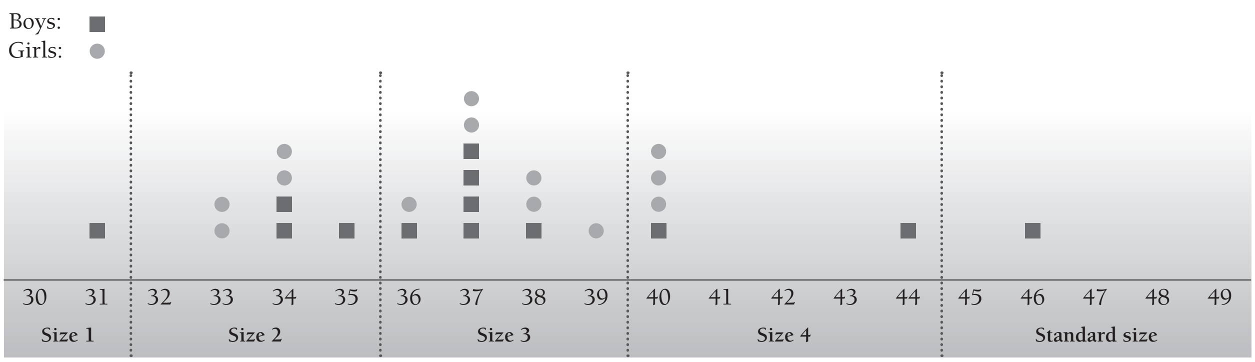
Years	Size	Seat height (mm)	Seat height (cm)
1 & 2	1	290	29
4 & 4	2	330	33
5 & 6	3	370	37
7 & 8	4	410	41

The dot plot shows that size 3 (the chair height recommended for year 5 and 6 students) is a perfect match for six of the year 5 students. However, an exact match between popliteal length and chair height may not be necessary for its user to find the chair comfortable. The range of popliteal lengths that suit each chair height is a further investigation.

Ask your students to use the manufacturer's information to identify how many of each chair size should be ordered for their class.

The class shown on the graph below clearly needs an assortment of chair sizes. If they decided that a seat 1 cm too high is acceptable, they would have one size 1 chair, seven size 2 chairs, twelve size 3 chairs, five size 4 chairs, and one standard chair.

Year 5 Students' Ideal Chair Sizes



The manufacturer has chosen 37 cm as an appropriate height for a chair for year 5 and 6 students. Ask your class: *How does this measurement relate to the data you have collected?* Discuss with the class what process the manufacturer may have used to determine the suggested chair height for each year level.

Discuss the practicality of providing chairs that meet the specific needs of every student in the class.

Using statistical information to make recommendations develops the key competency *thinking*.

Technology-related student activities

- Try out a variety of chairs or tables (for younger students, use the Goldilocks analogy) and comment on their comfort.
- Use the same chairs to try out different tasks – reading, painting, writing, eating a meal – and comment on their suitability.
- Interview older people about their experiences with technologies, their ease of use, and possible problems (for example, opening cans, climbing steps, using remote controls).
- A useful website for background information on ergonomics is http://casestudy-itgs.wikispaces.com/Social+Impacts+-+Ergonomic

Page 11: Shipping Container Space

Achievement Objective

- Transformation: Predict and communicate the results of translations, reflections, and rotations on plane surfaces (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:

- represent and describe the symmetries of a shape (Geometry and Measurement, year 4)

Developing students' mathematical understanding

Reflecting, rotating, and translating a shape changes its position, but its area remains the same. Students play a game that involves placing shapes of different area inside a "shipping container". This game can be easily adapted to incorporate the language of geometry (reflection and rotation).

Exploring the technology-related context

Optimisation is important for designers and manufacturers. Efficient use of materials, time, and energy all have an impact on decision making. Over time, storage and packing technology has changed, including the introduction of containers. (Try an Internet search on the history of freight containers.)

Packaging serves several functions. It stores and protects items, advertises them, and disseminates product information.

Vocabulary alert

shipping container, rotate, reflect, overlapping, strategy

Answers

Game

A game involving the placement of various shapes inside a rectangle

Mathematics and Statistics Notes

In this game, students use reflection and rotation to position shapes inside a rectangle.

Ask the students to identify whether they are rotating or reflecting the shapes shown on the spinner before they add them to the shipping container. Students who find this challenging could make paper copies of the shapes. If the paper copy needs to be flipped over, the transformation is a reflection.

See Digital Learning Object: Pentominoes (www.nzmaths.co.nz) for a similar activity.

The pieces on the spinner in the game can be used as a basis for further exploration by asking the students to:

- investigate how many different ways they can make the F shape using the smaller pieces
- combine the pieces to make a 5 x 5 square. Can they find more than one way to do this?

Have the students draw a 6 x 6 square. They take turns to colour in squares using the shapes on the spinner. Each player can only use each shape once. The winner is the last person to be able to place a shape within the square.

This alternative game can be adapted to make it more collaborative. Students still take turns placing or colouring in a piece, but the challenge is to have as few squares left uncoloured as possible.

The shipping container game and its variations provide a good opportunity to have the students listen actively to each other and build on others' ideas. The key competency *relating to others* involves recognising when to compete and when to co-operate.

Technology-related student activities

- Try to fit as many blocks as possible into a shoebox.
- Try to wrap a present (for example, a book) with as little wrapping paper as possible.
- Examine commercial packaging, such as for food items. How well do the contents fit into the packages? Do any appear to be misleading – are there fewer contents than first thought?
- Draw a plan of the classroom and suggest rearrangements of the furniture. What would need to be considered? (safety, ergonomics, ease of access ...)

Pages 12–13: Sampling Snacks

Achievement Objective

- Statistical investigation: Conduct investigations using the statistical enquiry cycle:
  - gathering, sorting, and displaying ... whole-number data
  - communicating findings based on the data (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:

- investigate questions by using the statistical enquiry cycle (with support):
  - interpret displays in context (Statistics, year 4).

Developing students' mathematical understanding

When using data to make comparisons, it is important to consider the validity of the data. The validity of the data depends on the purpose of the investigation: does the data measure what it is intended to measure? For example, when comparing samples of biscuits, finding the cost of individual biscuits would be valid if the investigative question is "Which biscuit is the cheapest?" If the investigative question is more complex, for example, "Which biscuit provides the best value for money?", the data is only valid if it is used in conjunction with additional information such as biscuit size and taste. Particular care needs to be taken when working with qualitative (descriptive) data and personal preferences.

Exploring the technology-related context

Commercial producers must comply with legal requirements as well as produce a desirable product. Public perception of a brand is also very important. Producers work for an optimum blend of regulatory compliance and consumer preferences, and they market accordingly.

Vocabulary alert

technologist, trialling, ingredient, health regulations, sample, blindfolded, pattern, value for money, criteria, varieties, texture, attributes, firmness, sweetness, juiciness, toothache

Answers

Activity

1. a. **i.** True. None of taster 4's ratings were higher than 3.

ii. False. Nobody gave sample 3 a rating higher than 3.

b. Answers will vary. Taster 2 tended to give samples quite high ratings. Taster 4 tended to give lower ratings. Sample 1 was rated higher than the other 3 samples.

2. a.

Biscuit		Cost of packet	Number in packet	Cost per biscuit
Sample 1	Grady's Round Wine	$2.80	40	7c
Sample 2	Saver Plain Round	$1.50	50	3c
Sample 3	Crunchy Snacker (plain wine)	$2.10	30	7c
Sample 4	Grady's Ovals	$2.40	30	8c

b. Sample 1: 6.25 g
Sample 2: 5 g
Samples 3 and 4: 8.33 g

c. Answers will vary. Mass, taste, and texture also need to be considered. For example, samples 1 and 3 both cost 7c per biscuit. However, the taste test shows that people tend to prefer the taste of sample 1 biscuits. Sample 2 biscuits are the cheapest, but they also weigh less than the other biscuits because there are more biscuits in the packet.

d. Answers will vary. The number of biscuits in a packet could be important if you are catering for a large group or are on a tight budget, but people don't want to eat biscuits that don't taste nice.

3. The question that Mr Blake's students are investigating is "Do biscuits that taste the best cost more?"

Problem: The investigative question that the students used was, "I wonder if the biscuits that taste best cost more?"

Plan: The students decided to use a taste test and also worked out the cost and the weight of each biscuit. They realised that the weight of the biscuits should be considered when looking at "cost". For example, if biscuits from one sample are much heavier than biscuits from another sample, their cost per gram is smaller.

Data: 4 students taste-tested the biscuits, giving them a rating from 1 to 5. This gave Mr Blake's class the data to make comparisons with. They also created a table showing the cost of individual biscuits.

Analyse: Patterns were found in the taste-test table. Sample 1 biscuits were rated the highest. The biscuits were analysed in terms of their individual cost and weight.

Conclusion: The investigative question was answered. Did you come up with any other ideas?

Activity Two

1.–2. Results and recommendations will vary.

Mathematics and Statistics Notes

This activity explores ways that a qualitative variable such as taste can be analysed.

Discuss with the students why measuring taste is more complicated than measuring a person's height. Ask *Is it possible to have a unit for taste?*

Taste is not completely subjective. Certain foods go well together – chocolate ice cream will have a wider appeal than onion ice cream. Food scientists investigate why some food combinations work and others don't. For example, why might people find the thought of a tuna milkshake disgusting? Food producers alter the taste of their products to suit consumer preferences. Discuss with the students how food producers find out what those preferences are (decisions to alter the taste of a food product are based on statistical investigations).

Discuss the advantages and disadvantages of using rankings instead of ratings to compare the 4 samples.
See the notes for A Changing World, pages **4–5**, for more information.

Activity One

Discuss the steps of the PPDAC cycle and explain why each step is important when conducting statistical investigations. An important part of this activity is evaluating how well Mr Blake's class made use of the cycle. Encourage the students to use this discussion when they apply the PPDAC cycle to their own investigation.

Activity Two

In this activity, students conduct their own food investigation, following the steps of the PPDAC cycle. Encourage your students to work collaboratively to decide how to gather data that can be used to make recommendations in question **2**.

Comparing ideas about the relative impact of technological products develops the key competency *participating and contributing*.

Technology-related student activities

- The students list their personal preferences, giving reasons, for a product such as breakfast cereals, and compare.
- Show brands and/or logos to the class and ask the students to identify the product.
- The students examine package labelling and discuss what is presented and why.
- The students prepare to cater for an event such as a parents' evening or a school production by devising recipes, or modifying existing ones, and testing the results. They request tasters' feedback on taste, texture, consistency, and freshness. Hygiene and healthy options could be focal points.
- The students design a logo that is suitable for marketing one of their recipes.

Pages 14–15: Popular Products

Achievement Objective

- Number knowledge: Know fractions … in everyday use (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:

- … find fractions of sets … and quantities (Number and Algebra, years 4 and 5).

Developing students' mathematical understanding

Classification in mathematics involves deciding whether objects (for example, numbers or shapes) share a specific property or meet certain criteria, making them distinct from other objects. In these activities, the students classify objects by deciding whether they are technological products or not.

Exploring the technology-related context

People involve themselves in technological practice to meet a need, solve a problem, or respond to an opportunity. This can result in an outcome of a product, system, or environment. The concept of fitness for purpose is important, and the outcome needs to do what it was intended to, preferably in a safe and efficient way. Natural products are not technological in themselves, but people use them to design technological outcomes, such as the use of wool in clothing and carpets and to mop up oil spills.

Vocabulary alert

technological, product, vote, pumice, aloe vera leaf, tally, category

Answers

Activity One

1. **a.** Technological products: book, TV remote control, photograph, toothbrush, video game, button, torch, radio, screwdriver, stapler, cellphone, pen
   Not technological: stone, pumice, worm, aloe vera leaf

   b. Technological products are developed by people; they are not objects developed naturally. For example, pumice is a type of volcanic rock that is formed naturally in the volcanic eruption process.

   c. 12 of the 16 items are technological products, so the fraction is $\frac{12}{16}$ or $\frac{3}{4}$.

2. Book, toothbrush, video game, cellphone. ($\frac{1}{10}$ of 20 is 2 votes. These items all received more than 2 votes.)

3. The book now has 4 out of 20 votes, which is $\frac{4}{20}$ or $\frac{1}{5}$.

Activity Two

1. **a.–c.** Products, votes, and tallies will vary.

2. **a.** Categories and tables will vary.

   b. Answers will vary.

   c. Fractions will vary. To find the fraction, divide the total number of votes for each category by the total number of votes cast (number of people in the class).

   d. Choices and discussion will vary.

Mathematics and Statistics Notes

This activity requires students to identify simple fractions. Using multilink cubes to represent the votes may make it easier for students to work out the fractions. More confident students can simplify their fractions.

For help in developing fractions concepts, see NDP *Book 7: Teaching Fractions, Decimals, and Percentages*.

Comparing and contrasting ideas develops the key competency *relating to others*.

Support for English Language Learners

Supporting students with talking about hypothetical conditions and consequences

Language focus: talking about hypothetical conditions and consequences

Complex sentences with "if" are frequently used in *Technology Rules!* to express real or hypothetical conditions and consequences. (For example, pages **2–3**, **6**, and **8–9** use real conditions and the correct verb forms for these.)

The last question in **Activity Two** tells students to talk about the hypothetical situation of products not existing and a consequence of this. One simple way of doing this in English is using the following sentence structure:

- If pens didn't exist, I would write with pencils.
- If TV remote controls didn't exist, I wouldn't change the channel from the couch.

You could support English language learners to use this structure by providing models and explaining and illustrating the following key points:

- The part of the sentence with "if" is the condition (or situation).
- In this case, the condition or situation is imaginary or hypothetical.

- The other part of the sentence (the main clause) is the consequence.
- The verb that follows "if" is in the past form.
- The main clause consists of subject + would/n't + verb.

Note that there are many variations on this structure (for example, using "should" or "could" instead of "would"). It's generally best to focus on one structure at a time.

Some students will benefit from using a speaking frame like the one below to help them take part in the discussions.

Condition			**Consequence**	
If	__________________	didn't exist	I would/wouldn't	__________________
If	__________________	didn't exist	I would/wouldn't	__________________
If	__________________	didn't exist	I would/wouldn't	__________________

Technology-related student activities

- The students explain why birds' nests, beaver dams, cobwebs, and monkeys using sticks are not technological. They could explore the use of non-technological products in earlier times, such as using cobwebs to stop bleeding. They could also investigate the use of bone to fashion fishhooks, weapons, and ornaments and how artists use bone today and what technology they use to work with it.
- The students examine everyday objects, such as bottle openers, drink tear-tabs, cellphones, cheap spectacles, and batteries, and talk about whether they are fit for purpose. Are there any items that may work sometimes but not always?
- Show pictures of items, for example, candlesticks, earplugs, shoe polish, fish knives, braces, and close-up shots of components of everyday objects, such as bicycle forks and umbrella handles. Ask the students to identify what the purpose of each object is.

Pages 16–17: Communication Progress

Achievement Objectives

- Number knowledge:
  - Know the basic addition and subtraction facts (Number and Algebra, level 2)
  - Know basic multiplication and division facts (Number and Algebra, level 3)
- Equations and expressions: Record and interpret additive and simple multiplicative strategies, using words, diagrams, and symbols, with an understanding of equality (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 this activity and game, students make expressions using four numbers. The goal is to create expressions that are equal to the numbers 0 to 9. By exploring different sets of four numbers, students can identify whether some dates provide fewer options than others and then use this information to develop a strategy for playing the game. Of course, there is not much they can do about luck!

Exploring the technology-related context

Very few inventions are the result of one person's or group's endeavours. Many technologies are modifications of previous efforts, sometimes from hundreds of years ago. Research into the history of some everyday technologies can reveal fascinating insights into their development.
For example, see http://inventors.about.com/od/astartinventions/a/FamousInvention.htm

Communication technologies have progressed rapidly in the last hundred years. Earlier expensive, large, and unreliable systems have given way to robust and efficient systems that can be accessed by most people.

Vocabulary alert

invention, innovation, associated, impact, communication, expression, equation

Answers

Activity

1. Depending on which card you use, you may or may not find an expression to match each number between 0 and 9. Each card can be used for several different numbers, but some dates provide fewer options than others.
2. Answers will vary.
3. **a.–b.** Answers will vary. Years with zeros, for example, 2007, tend to have a smaller range. This is because 0 either eliminates values (2×0) or has no impact ($2 + 0$).

Game

A game using basic facts.

Mathematics and Statistics Notes

The activity and game provide an opportunity to practise basic facts.

When working with numbers and operations, there are a number of conventions about the order of operations. These conventions are summarised by the acronym BEDMAS: brackets, exponents, divide and/or multiply, add and/or subtract. For example, when using these conventions, $2 + 3 \times 4 = 2 + 12$; without the conventions, students would read this $2 + 3 \times 4$ as 5×4. Students at this level are not expected to use these conventions, so brackets have been used in the examples below to make them mathematically correct. If you want to extend some of your students, group them together and have them apply the conventions to their expressions.

Examples of equations that can be found using the digits in 1843:

$0 = 8 - 4 - 3 - 1$
$1 = 8 - 4 - 3 \times 1$
$2 = 8 - 4 - 3 + 1$
$3 = (8 \div 4 - 1) \times 3$
$4 = 8 \div 4 + 3 - 1$
$5 = 8 \div 4 + 3 \times 1$
$6 = 8 - 4 + 3 - 1$
$7 = (4 - 3) \times 8 - 1$
$8 = (4 - 3) \times 8 \times 1$
$9 = (4 - 3) \times 8 + 1$

The students may find it helpful to use digit cards to identify possible equations, changing the order of the digits as they explore possible equations.

Discuss the special roles that 0 and 1 play. For example, 0 can be used to eliminate other digits, and it has no effect on the total when it is added or subtracted. A 1 can be used to create three consecutive numbers, for example, $1 = 3 \times 2 - 4 - 1$, $2 = (3 \times 2 - 4) \times 1$, $3 = 3 \times 2 - 4 + 1$. Remind students that you can't divide a number by 0. This is a mathematical rule.

Encourage students to investigate why some dates offer a much greater range of possible equations than others. They could analyse all the dates on the cards and present their findings to the class.

It may seem strange to students to write an equation with "the answer" on the left side of the = sign, for example, $5 = 3 + 2 + 1 - 1$. Many students interpret the = sign as "the result when you solve a problem". Remind the students that the = sign means "is the same as". Understanding this at an early age will help them use this symbol correctly when they are introduced to more complicated equations.

Evaluating the usefulness of each set of 4 digits develops the key competency *thinking*.

Technology-related student activities

- The students research the evolution or development of a particular technology, such as flying machines.
- They investigate a particular inventor, such as John Britten, or the inventions of an earlier civilisation such as ancient Rome.
- Challenge the students to go without a particular technology, such as television, for a period of time. They report on their experiences and how they overcame any problems that arose.
- Ask students to imagine a world without telephones, television, or radios. They can research other ways to communicate, such as Morse telegraphs, pigeons, and semaphore.
- Have students explore http://science.howstuffworks.com/innovation/inventions/10-inventions-that-changed-the-world.htm

Page 18: Right Way Up!

Achievement Objective

- Shape: Represent objects with drawings and models (Measurement, level 3)

Developing students' mathematical understanding

Deductive reasoning involves using a logical and systematic approach to solve problems. In this activity, students need to find a simple way to write down the result of each function. This should enable them to identify whether the functions they have used are effective in achieving the correct orientation or have resulted in a loop that simply returns the cups to a previous iteration.

Exploring the technology-related context

Developing a technology can take a lot of time and effort. If a particular design has a number of systems within it, it can be difficult to ensure that each functions appropriately. For example, a car has steering, braking, and electrical systems, and it may take a lot of trialling to produce a fully functioning prototype. Car designers must also comply with safety requirements and include systems to protect drivers and passengers in the event of crashes or system failures.

Vocabulary alert

reprogram, modify

Answers

Activity

1. **a.** The moves so far are:

Start	U U ∩ U ∩
(Komal's) D	U ∩ U U ∩
B	U ∩ U U ∩
C	U U U ∩ ∩
A	∩ U U ∩ U

b. A→B→A. (A again, to reverse it back to UUU∩∩, then B to get it to ∩UUU∩, then A to get UUUUU)

c. Answers will vary. For example, you can do it in 4 steps if you use D→C→B→A. (Komal and Uncle Arun used 7 steps on their first attempt.)

2. Answers will vary. The fastest way (3 steps) is:

Start	U ∩ U U ∩
C	U U U ∩ ∩
B	∩ U U U ∩
A	U U U U U

Mathematics and Statistics Notes

The students may find it helpful to use materials in their investigation, for example, cups or double-sided counters.

Recording trials is an important part of problem solving. In this exercise, a written or pictorial record will help the students to discover if their instructions are effective in finding the correct orientation or creating a loop that leads to an earlier iteration. Ask the students to decide how to represent the orientation of the cups so that they can keep a running record.

Discuss with the students the two types of commands available: changing orientation by turning cups over (A) and swapping positions (B, C, and D). Extend the activity by asking the students to investigate which sequences are needed to swap cup positions, for example, swapping the cups in:

3rd and 4th place (Answer: D→C→D)
1st and 2nd place (Answer: C→B→C)
1st and 3rd place (Answer: D→C→B→D→C→D→C)
2nd and 5th place (Answer: it's impossible)

Ask: *What patterns can you see? Which cup never changes position?*

Discuss with the students whether the results of this investigation would be useful when reorienting another arrangement of cups, for example, **∪∪∩∩∪**. Ask *Why or why not*?

Challenge the students to generalise their findings by asking them what advice they can give to Uncle Arun so that he isn't limited to trial and improvement. For example:

- Cup 5 always stays put.
- To invert a cup in positions 2, 3, and 4, you need to move it to position 1.

Invite the students to add a fifth command, for example, E: Turn the third cup over. The students can explore which new command is the most useful. This type of thinking is similar to that involved in designing computer software. Encourage the students to demonstrate the effectiveness of their new command.

Recording information in systematic, concise, and coherent ways develops the key competency *using language, symbols, and texts*.

Technology-related student activities

- Examine a product and identify its systems. A bike, for example, could have steering, propulsion, warning, and protective systems.
  Sometimes, the systems may not be easily identified or understood, for example, the black box. You could ask your students to identify products that have black box systems (for example, computers and cameras).
- Examine Rube Goldberg or Heath Robinson drawings of humorous systems. Have students design their own. See www.wired.com/gadgetlab/2010/03/rube-goldberg-video-gallery
- Examine everyday products or designs and suggest modifications to improve safety. For example, how could an electric kettle be made safer?

Page 19: Wheelchair Access

Achievement Objectives

- Position and orientation:
  - Create and use simple maps to show position and direction
  - Position and orientation: Describe different … pathways from locations on a map (Geometry and Measurement, level 2)
- Measurement: Use linear scales and whole numbers of metric units for length … (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 personal locations and give directions, using simple maps (Geometry and Measurement, year 4).

Developing students' mathematical understanding

Being able to successfully interpret maps and plans is an important skill. Exploring a 2-dimensional representation of a familiar environment is a good way to develop map-reading skills.

Exploring the technology-related context

User-friendliness is an important concept in technology. Ideally a product, system, or environment should be safe and pose few problems for users, including people with special needs. Sometimes, completely new technologies are needed to assist these people.

Vocabulary alert

user-friendly, consider, route, wheelchair-friendly, suitable, alternative, recommended, diameter

Answers

Activity

1. **a.** Discussion will vary. Challenging areas may include stairs, rough ground, or narrow walkways.

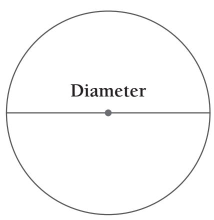
   b.–c. Practical activity. Answers will vary.

2. Answers will vary.

Mathematics and Statistics Notes

In this activity, students investigate the wheelchair-friendliness of their school. They use their findings to mark routes on a school map.

Give your students an outline map of your school and ask them to locate and label the main buildings and features. For more work on mapping, see Around School in *Geometry*, levels 3–4, Figure It Out. Working in pairs or in a group to complete this task develops the key competency *participating and contributing*.



To illustrate the shape of a turning space, ask two students to link arms. Tell the students to walk a few paces and then turn around without unlinking their arms. They should see that the turning space is circular. The width of a circle is known as the diameter. The students can use a variety of strategies to check whether a turning space has a diameter of 1 500 mm. One approach is for two students to work with a 750 mm piece of string. One student holds one end of the string in the middle of an area. The second student circles the first student, holding the string taut.

Technology-related student activities

- Explore the local community, looking for examples of designs that could pose difficulties for people.
- Design a user-friendly device for someone with a particular challenge, for example, someone with arthritis who has difficulty putting on socks.
- Suggest modifications to improve the user-friendliness of existing products, such as bikes, instruction manuals, computers.

Useful websites include:
www.baddesigns.com/examples.html
www.techlink.org.nz/student-showcase/materials/matthew.htm

Pages 20–21: Learning by Braille

Achievement Objectives

- Patterns and relationships: … use tables … and diagrams to find relationships between successive elements of number and spatial patterns (Number and Algebra, level 3)
- Transformation: Describe the transformations (reflection …) 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:

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

Developing students' mathematical understanding

Finding patterns and relationships is an important mathematical skill and one that often produces a sense of pleasure or satisfaction. In these activities, students explore patterns in the Braille alphabet and observe the systematic approach that Louis Braille used when creating the symbols. They also learn how the Braille system has been adapted for use in mathematics.

Exploring the technology-related context

The development of language and symbols has been crucial for technological innovation. With the development of non-verbal ways to express themselves and record ideas, designers were able to reach and inform large numbers of people, who could, perhaps, extend or modify the original ideas. With the advent of the printing press in the fifteenth century, the audience became global, and the pace of technological innovation picked up greatly.

Braille became the means for blind people to access written material. Like most new technologies, it was influenced by previous developments; other codes and language constructions helped Louis Braille produce an effective code.

Technology is about meeting needs, responding to opportunities, and solving problems. Louise Braille achieved all three. Today, as well as books and other written material, some banknotes and building signs have information written in Braille.

Vocabulary alert

Braille, cell, blind, visually impaired, raised, print, combinations

Answers

Activity One

1. **a.** The second 10 letters are the same as the first 10 letters, with the addition of another dot in the bottom left corner (first column, third row).

   b. The “w” does not follow the pattern. All the other letters in the third row are the same as the letters in the second row, but with another dot in the bottom right corner.

   (Note that the pattern of the letters after “w” is shifted across in the grid, m→x, n→y, o→z.)

2. **a.** The letters that reflect down the centre line are: c, g, and x. The letters that reflect through an imaginary line through the middle of row 2 are: k, l, o, r, w, x and y.

   b. t and x (t and x have half-turn rotational symmetry.)

Activity Two

1. **a.** 423

   b. 106

   c. 2718

2. **a.** The answer should be ⠼⠋⠚ so that the equation is 40 + 20 = 60.

   b. The answer should be ⠼⠁⠓ so that the equation is 3 x 6 = 18.

   c. The answer should be ⠼⠋ so that the equation is 15 – 9 = 6.

3. Equations will vary.

Mathematics and Statistics Notes

In these activities, students examine the Braille alphabet, looking for patterns and examples of symmetry.

Explore examples of reflective symmetry in the Latin alphabet, for example, A, M, and E. Discuss whether the reflections are horizontal or vertical.

Some letters have rotational symmetry, for example, N and S. Others have both reflective symmetry and rotational symmetry, for example, H and X.

The symbol for W can be used to introduce the idea of “special cases” – a single instance when a generalised rule does not work.

Exploring alternative ways of denoting letters, numbers, and symbols develops the key competency *using language, symbols, and text*.

Technology-related student activities

- Interview a visually impaired person who can read Braille to discover the positive and/or negative aspects of the code.
- Have students identify a particular key on a computer keyboard, place a finger on another key, close their eyes, and attempt to locate that letter by touch. Have them try to spell out their name by this method. Some keyboards have raised areas to assist visually impaired people.
- Suggest and develop other ways of communicating with blind people. For instance, they could make a simple electrical circuit with a switch and a buzzer. This could then be used to send a code message. Students could investigate international codes, such as Morse.
- Identify hazards for blind people in the community and ways in which they may be assisted to avoid those hazards. For instance, tactile ground surface indicators (TGSI) (panels with raised dots) are often placed at pedestrian crossings.
- Design a board game for a blind person or modify an existing one.

Useful websites include:
www.braillebookstore.com
www.nyise.org/blind/barbier.htm

Pages 22–23: Tangram World

Achievement Objectives

- Number strategies: Use a range of additive and simple multiplicative strategies with whole numbers, fractions, decimals … (Number and Algebra, level 3)
- Number knowledge: Know fractions … in everyday use (Number and Algebra, level 3)
- Measurement: Find areas of rectangles … by applying multiplication (Geometry and Measurement, level 3)
- Shape: Represent objects with drawings and models (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:

- apply additive and simple multiplicative strategies and knowledge of symmetry to:
  - combine and partition whole numbers
  - find fractions of sets, shapes, and quantities (Number and Algebra, year 5).

Developing students' mathematical understanding

Comparing the size of different shapes requires a shared unit. In this activity, students are presented with seven tangram pieces and asked to decide how much each piece should cost. This involves finding out what fraction of the tangram square each piece is. Students then explore whether there is a relationship between area and perimeter (the distance around the outside of a shape).

Exploring the technology-related context

Designers can often create original products by adapting existing products for new purposes or by constructing an item from a number of smaller items, each playing its own part. The tangram shelves are a good example of this.

Using the tangram pieces, students will be able to construct representations of familiar figures. From various types of polygons, new shapes will emerge. These representations will be in stylised form, where the object represented is recognisable but is not realistic. Designers often use these stylised forms to produce logos, which help establish a brand through an instantly recognisable image.

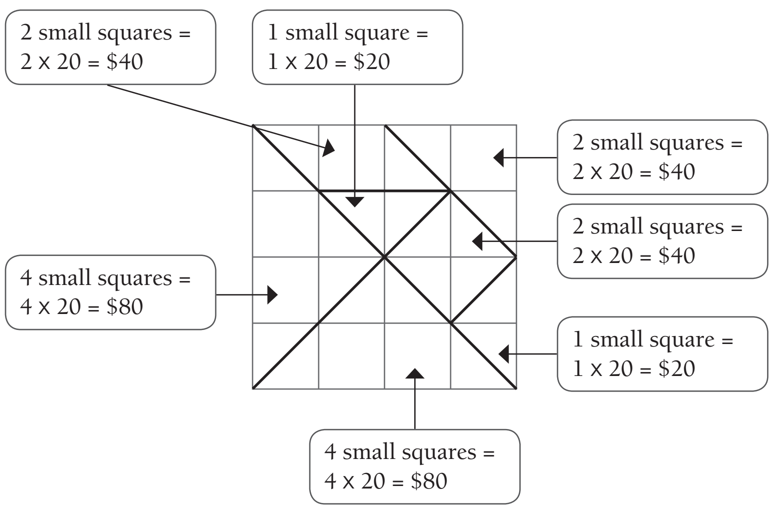
Vocabulary alert

existing, adapting, tangram, display unit, comparison, kit, combinations, area, perimeter

Answers

Activity One

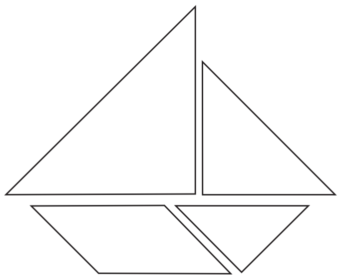
1. a. One way to approach this problem is to find the area of each shape in terms of small squares.
The tangram square is made up of 16 smaller squares. Each small square should be worth \$20 each (320 ÷ 16 = 20). Therefore the costs are as follows:



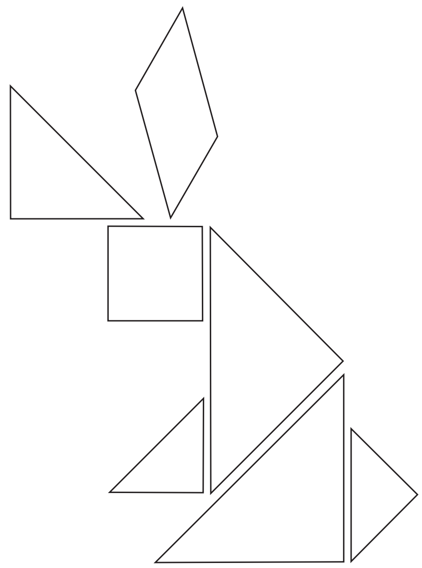
An alternative approach is to use fractions. For example, the largest triangles each take up one-quarter of the tangram square, so they should be one-quarter of the price. $320 ÷ 4 = $80.

b. Discussion will vary.

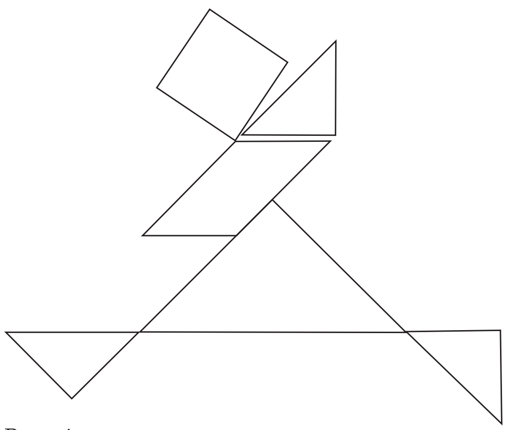
2.



Boat: 80 + 40 + 40 + 20 = $180



Rabbit:
40 + 40 + 40 + 20 + 80 + 80 + 20 = $320



Running man:
40 + 20 + 40 + 80 + 20 + 20 = $220

3. a. Combinations will vary, but they must add up to no more than $200.

b. Designs and pieces will vary.

4. a. The parallelogram and the middle-sized triangle have the same perimeter.

b. The perimeter of the smallest triangle is half the perimeter of the largest triangle.

c. As a rule, shapes with the same area don't have the same perimeter. For example, the parallelogram, the middle-sized triangle, and the square all have an area of 2 small squares. However, the perimeter of the square is four "diagonal" units, whereas the other two shapes have a larger perimeter of four "horizontal or vertical" units and two diagonal units.

Mathematics and Statistics Notes

In this activity, students explore the area and perimeter of the shapes in a tangram square. Make sure that students are familiar with the name of each shape: triangle, square, and parallelogram. A very good website for the history of tangrams, tangram puzzles, and online activities is www.tangrams.ca

Activity One can be solved using fractions. Note that the tangram square can be divided into several different units. For example, the largest triangle makes up one-quarter of the tangram square. If the cost of each piece is based on its area, the large triangle should be one-quarter of $320. $320 ÷ 4 = $80. A common convention when describing area is to use square units. However, the tangram square could also be divided into small triangles (64 half squares), or the smallest tangram shape could be used as a unit (2 small triangles).

Students who find **Activity One** challenging can be given a paper copy of the tangram square. Cutting up and rearranging the parallelogram will show that the parallelogram has an area equivalent to 2 of the 16 squares that make up the tangram square.

While the class is working, circulate to identify the strategies that students are using. Ask specific students to share their strategies with the class.

Discuss the concept of equivalence with the class. For example, $\frac{4}{16}$ is equivalent to $\frac{1}{4}$ and $\frac{2}{16}$ is equivalent $\frac{1}{8}$.

In question **4**, the students explore the relationship between the perimeter and the area of a shape.

The students do not need to use measurement to compare the perimeters of the tangram shapes. All of the shapes have sides that are made up of diagonal or horizontal and/or vertical units within the tangram square, as shown in the table below (and in the diagram under **Extension**).

Shape	Horizontal/vertical units	Diagonal units
Triangle 1	2	2
Triangle 2	4	2
Triangle 3	4	4
Square	0	4
Parallelogram	4	2

Note that the perimeter of the largest triangle is only twice the perimeter of the smallest triangle, even though its area is 4 times larger.

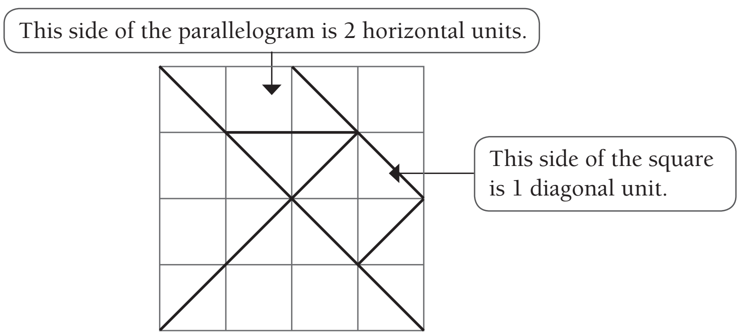
Intuitively, it makes sense that some connection exists between area and perimeter: a large shape should have a large perimeter; a small shape should have a small perimeter. In the tangram square, the two shapes with the same perimeter have the same area. However, exploring different shapes reveals that two shapes with the same area can have different perimeters. Things are not as straightforward as they seem!

Extension

Ask students to solve the following puzzle:

The cost of the silver trim used on the shelves is shown in the table. The cost is based on the number of vertical or horizontal units and the number of diagonal units that make up the perimeter of each shape. Use the table below to work out which shape corresponds to each letter, then the cost per vertical or horizontal edge unit and the cost per diagonal unit.

Shape	Cost of shelving
A	\$10
B	\$12
C	\$14
D	\$14
E	\$20



The problem can be solved by identifying which shapes match each letter. For example, the smallest triangle has a perimeter that is half that of the largest triangle, so they are shapes A and E respectively. The parallelogram and the middle triangle have the same perimeter, so they must be C and D. The square (B) is made up of 4 diagonals, so the cost of a diagonal unit is \$12 ÷ 4 = \$3. This information can be used to find the cost of a vertical or horizontal edge using a different shape. For example, the smallest triangle costs $10 and has 2 diagonals and 2 vertical or horizontal sides. $10 – 2 x 3 = $4 for the remaining 2 sides, so they must be $2 each.

Making connections develops the key competency *thinking* (in this case, both lateral and logical).

Technology-related student activities

- Use tangrams to construct an image for a birthday card.
- Investigate logos and design their own to brand a school production, gala, or sports team.
- Identify or describe the component parts of items such as a bicycle wheel, a piano, or a torch.

A useful website is: www.tangrammit.com
An Internet search for images of logos from tangrams will bring up a huge range for the students to explore.

Page 24: Ball Bounce

Achievement Objectives

- Measurement: Use linear scales and whole numbers of metric units for length, … weight (mass), … and time (Geometry and Measurement, level 3)
- Statistical investigation: conduct investigations using the statistical enquiry cycle:
  - gathering, sorting, and displaying multivariate … whole-number data (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:

- measure … the attributes of objects, choosing appropriate standard units … (Measurement, year 5).

Developing students' mathematical understanding

Sometimes objects are compared with each other, and at other times they are compared to an ideal standard. Standards are usually expressed in terms of minimum or maximum requirements and sometimes provide a range of acceptable values. The need for standards reflects the variability that exists in all objects, whether natural or man-made. The standard required for a basketball used in an international game will be much higher than the standard for a basketball used for an inter-school basketball game, which may in turn be higher than the standard required for a primary school PE lesson. This activity requires students to think about methods that they could use to gather data about bounce and provides an example of how such data is used in real life.

Exploring the technology-related context

Balls used for various sports are made from particular materials, which give the balls their performance properties. Often, there may be a variety of different balls for one particular sport. In golf, for instance, there is a large range (within a specified size). Different balls will fly further, take spin, or reduce the tendency to slice.

Any product is "fit for purpose" when its material and design provide the desired performance. People also have to take factors such as cost and safety into consideration when acquiring sporting goods.

Products have performance properties. This activity provides an opportunity to introduce vocabulary about performance attributes for specific products. For example, a rugby ball or a netball can be rated according to flight, bounce, grip, and durability.

Vocabulary alert

international, strict conditions, attribute, perform, circumference, surface, criteria

Answers

Activity

1. a. Likely rankings are shown in the table, although there may be some variation depending on the balls used.

Ball	Mass	Size
Tennis	4	4
Golf	5	5
Basketball	1	1
Cricket	3	3
Table tennis	6	6
Soccer	2	2

b. Practical investigation

c. Answers will vary. For a ball to travel a long distance, it needs to have mass. For example, a golf ball will travel much further than a table tennis ball. However, the size of a ball is also a factor. You would need a lot of external force to make a basketball travel as far as a golf ball.

When each ball is used in its sport, it is propelled rather than simply dropped, and this aspect is part of the design. For example, a basketball needs to bounce back more quickly than a soccer ball so that the basketball player can run while bouncing the ball. Balls that are hit with a piece of sports equipment are smaller than balls that are kicked or thrown.

2. Practical activity. Answers will vary.

Mathematics and Statistics Notes

In this activity, students compare the mass, size, and bounce of sports balls. They devise a way to measure the bounce of a ball.

Factors to consider when devising an experiment:

- controlling as many variables as possible, for example, the height from which the ball is dropped and dropping the ball rather than pushing it
- making useful and accurate measurements
- repeating trials
- other aspects of bounce. For example, is the amount of time it takes for a ball to stop bouncing relevant?

The students can compare the size and mass of each ball without using formal measurements. Determining the relative bounce of each ball is more complex. Differences in the students' rankings could lead to some interesting debates and will show how important it is to conduct a controlled experiment when comparing objects.

The students should incorporate more than one trial for each ball into their investigation to increase the validity of their experiment. There is likely to be variation in the results of each trial. Discuss reasons for this with the class.

The concept of variation is central to statistical thinking. Although variation can be found in all objects, the variability considered acceptable depends on the context in which the items are being used. Bouncing a ball 20 000 times to check whether it loses any of its bounce may be necessary for an international basketball. The school's basketballs are unlikely to meet international basketball criteria. Discuss reasons for this with the class.

Measuring the bounce of a ball would be very difficult if you were working on your own. Working with a classmate or a group to conduct the investigation develops the key competency *participating and contributing*.

Technology-related student activities

- Investigate the idea of fitness for purpose. As a class, brainstorm the fitness for purpose of particular balls used out of context. For example, ask: *How would a rugby ball perform in a game of football or netball? What would happen if you tried to play table tennis with a golf ball?*
- Students research and discuss how technology may give an advantage to sportspeople. Ask *Would modern athletes always beat those from an earlier time?*
- The students could further investigate fitness for purpose and performance qualities by constructing an item with different materials. For example, they could build a model bridge of the same design out of straws, then paper, then wood, and then test the designs with weights.

Useful websites include:
www.techlink.org.nz/curriculum-support/papers/knowledge/tech-products/page2.htm
www.garrettsbridges.com
www.ballsout.com/info_balls.htm
http://soccerballworld.com/History.htm
www.livestrong.com/article/336471-the-history-of-rugby-balls

Number of kinds of fruit \ Number of pieces on the kebab	1	2	3	4	5
2	**2**	**4**	**8**		
3					
4					

Number of kinds of fruit \ Number of pieces on the kebab	1	2	3	4	5
2	**2**	**4**	**8**		
3					
4					

Number of kinds of fruit \ Number of pieces on the kebab	1	2	3	4	5
2	**2**	**4**	**8**		
3					
4					

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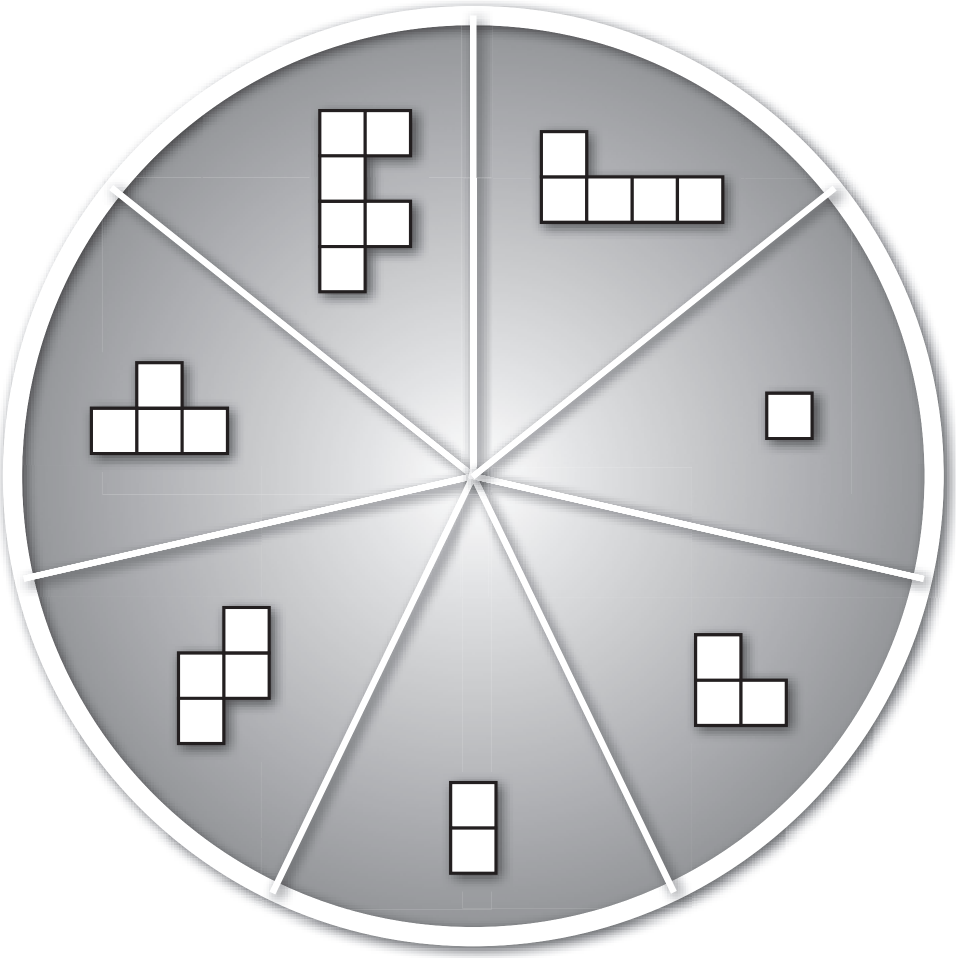
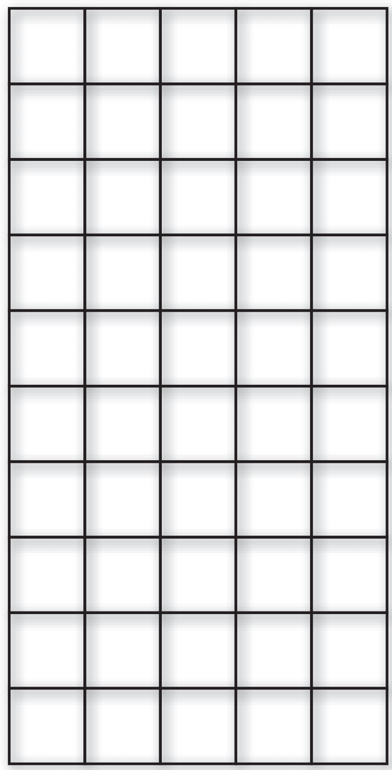
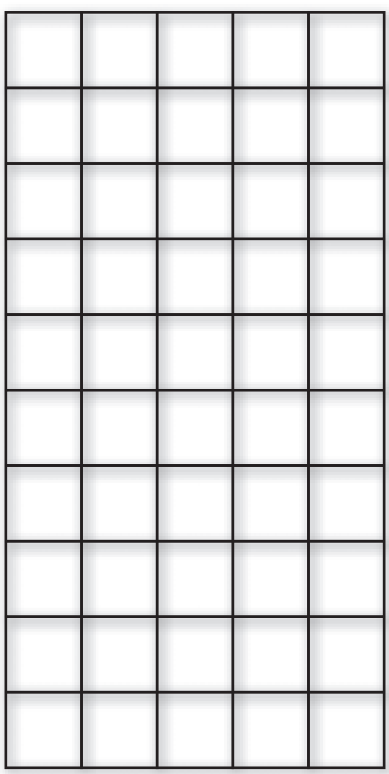
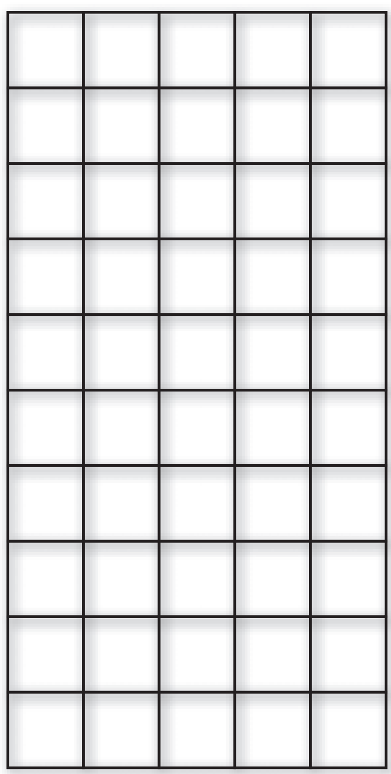
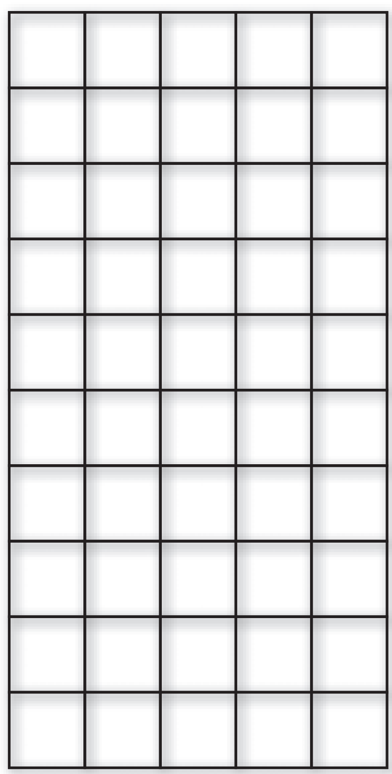




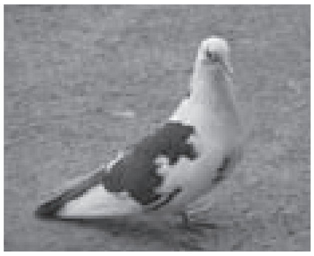






Copymaster: Communication Progress pages 16–17

2900 BC



Carrier pigeon

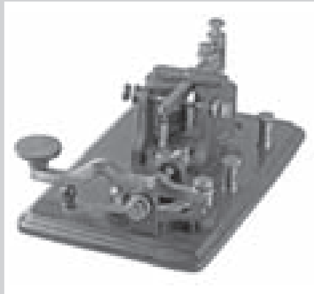
(Roman Empire and Egyptians)

1793

Semaphore

(Claude Chappe)

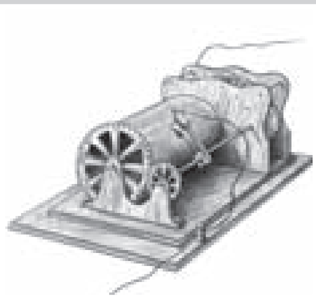
1838



Telegraph

(Samuel Morse)

1843



Fax

(Alexander Bain)

1876

Telephone

(Alexander Graham Bell)

1904

Radio

(Guglielmo Marconi)

1927

Television

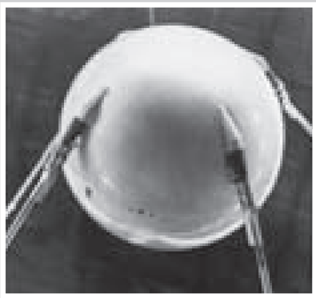
(Philo Farnsworth)

1949

Communication satellites

(Arthur C. Clarke)

1957



Sputnik

(First satellite)

Copymaster: Communication Progress pages 16–17 continued

1971

Email

(Ray Tomlinson)

1973

Mobile phone

(Martin Cooper)

1938

Photocopier

(Chester Carlson)

1989

World Wide Web

(Tim Berners-Lee)

2007

Smart phone

Internet-multimedia-enabled smart phone

Note: In reality, very few inventions appear suddenly out of nothing. Many people contribute to the process over time, and sometimes there is argument over who the inventor was or the date of an invention. For this reason, these details may vary in different sources of information. The pictures on the cards are illustrative only and in most cases do not depict the original model.

Copymaster: Learning by Braille pages 20-21

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