CHAPTER 2

# APPROACHES TO PROBLEM-SOLVING METHODOLOGY: DATA ANALYSIS

## Key knowledge

**After completing this chapter, you will be able to demonstrate knowledge of:**

**Approaches to problem solving**

- types of graphic solutions suitable for educating, persuading and informing audiences
- design tools for representing the functionality and appearance of graphic solutions such as input-process-output charts (functionality) and annotated diagrams/mock ups (appearance)
- formats and conventions suitable for graphic solutions such as titles, text styles, shapes, lines and arrows, sources of data and legend, colours and contrasts
- software functions and techniques for efficiently and effectively manipulating data to develop graphic solutions, and for validating data
- techniques for testing graphic solutions.

## For the student

Following on from Chapter 1 where you conducted an investigation into an issue, in Chapter 2 you will create a digital solution that graphically presents the findings of the investigation. Graphical data solutions are necessary for data analysis and interpretation. Graphic solutions can draw attention to trends and patterns in numerical data and information that might not otherwise be obvious.

## For the teacher

This chapter is based on Unit 1, Area of Study 1 and, together with Chapter 1, provides the key knowledge required to complete Unit 1, Outcome 1. At the end of Chapters 1 and 2, students should be able to acquire, secure and interpret data and design and develop a graphic solution that communicates their findings of an investigation. Students are able to use any software tool to create their graphic solution.

# Approaches to problem solving

When an information problem exists, a structured **problem-solving methodology (PSM)** needs to be followed to ensure that the most appropriate solution is found and implemented.

Without a structured approach and methodology, problem-solving can become a hit or miss affair. It is therefore important to adopt an agreed structure to solving problems. The obvious advantage of consistency is that when new problems arise, individuals or groups know which approach to follow.

## The four stages of problem solving

1. Analysis: Understand all aspects of the problem and state what is required of the solution.
2. Design: Decide what has to be done to achieve the solution.
3. Development: Build the solution with either off-the-shelf or custom-made hardware and software.
4. Evaluation: Determine whether the solution has solved the original problem, and check the requirements of the user to see if they have been met.

Within these four stages of the problem-solving methodology, various activities take place. In the previous chapter, we explored how to acquire, secure and interpret data through investigating an issue. This chapter continues the investigation of an issue and focuses on how to design and develop a graphic solution that communicates the findings of the investigation.

The VCAA has not prescribed specific software to create the graphic solution, and this choice is up to schools. In this chapter, both spreadsheet and web-authoring software will be covered. They will both be used to create an **infographic**.

## Functions of a spreadsheet

Spreadsheets can be used for many purposes that involve calculations (see Figure 2.1). For example, spreadsheets can be used for account keeping or stock control, to present budget information as part of a project, or to store and manipulate data from surveys or results of an investigation.

The rows and columns collectively are called a worksheet. A number of worksheets can be included in a spreadsheet file.

**Spreadsheet functions** include:

The ability to perform complex mathematical functions. Mathematical functions include the ability to:

- perform basic arithmetic operations (+, –, /, *)
- perform statistical or other mathematical functions (average, minimum, maximum, median, standard deviation).

The ability to perform complex logical functions. Logical functions include the ability to:

- create decision statements such as `IF()` or `SUMIF()`
- use a `LOOKUP()` table to extract data needed for a calculation from another worksheet
- use `AND()`, `OR()` or `NOT()` to create complex formulas.

The ability to produce different types of graphs and charts, including the ability to:

- graph a series of data using a range of graph types, including bar and pie
- format a plot area and gridlines.

The ability to format data to meet the graphics needs of the user. Formatting functions include the ability to:

- insert labels (such as headings and subheadings)
- insert headers and footers (filename, page and date)
- insert notes and comments (to explain a function or provide help)
- insert borders and shading to add more meaning to the layout.

Spreadsheets will help you to manipulate data to develop graphs and charts. Spreadsheets can also accommodate small to massive data sets, include a large variety of charting tools and types, include chart style galleries that allow users to format each component of their graphic solution, allow users to enhance graphic representations, provide tools that enable users to highlight data trends and present appealing, persuasive graphical summaries.

| | | |
|---|---|---|
| Total number of sandwiches sold | Monday | 611 |
| | Tuesday | 680 |
| | Wednesday | 813 |
| | Thursday | 698 |
| | Friday | 737 |
| | Saturday | 992 |
| | Sunday | 944 |
| Total weekly sandwiches sales for SSB Hawthorn | | 5475 |

Total staff required

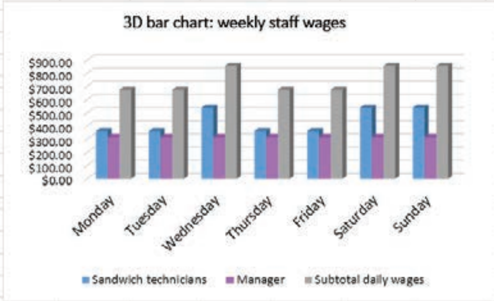
| | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday |
|---|---|---|---|---|---|---|---|
| Sandwich technicians | 2 | 2 | 3 | 2 | 2 | 3 | 3 |
| Manager | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

Staff wages

| | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday |
|---|---|---|---|---|---|---|---|
| Sandwich technicians | $360.00 | $360.00 | $540.00 | $360.00 | $360.00 | $540.00 | $540.00 |
| Manager | $315.00 | $315.00 | $315.00 | $315.00 | $315.00 | $315.00 | $315.00 |
| Subtotal daily wages | $675.00 | $675.00 | $855.00 | $675.00 | $675.00 | $855.00 | $855.00 |

Cost of ingredients

| Vegi Max | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday |
|---|---|---|---|---|---|---|---|
| Lettuce | $44.80 | $57.60 | $63.40 | $52.40 | $51.80 | $81.00 | $85.00 |
| Tomato | $89.60 | $115.20 | $126.80 | $104.80 | $103.60 | $162.00 | $170.00 |
| Cucumber | $44.80 | $57.60 | $63.40 | $52.40 | $51.80 | $81.00 | $85.00 |
| Beetroot | $78.40 | $100.80 | $110.95 | $91.70 | $90.65 | $141.75 | $148.75 |
| Carrot | $56.00 | $72.00 | $79.25 | $65.50 | $64.75 | $101.25 | $106.25 |
| Total | $313.60 | $403.20 | $443.80 | $366.80 | $362.60 | $567.00 | $595.00 |




Management would appreciate it if you could indicate whether or not they should increase weekly stocks of ingredients. Currently, we have enough stock for 4500 sandwiches/week. If the weekly juice sales (see Task 1) exceed (are greater than >) 4500, we need to increase stock, otherwise we can maintain the current level of stocks.

| | |
|---|---|
| Do we need to increase stock levels? | Yes/No |
| | Yes |

**FIGURE 2.1** Modern spreadsheet packages allow calculations of formulas, experimenting with 'what–if?' scenarios, as well as the arrangement and graphical representation of statistical data.

To make manipulating the data more efficient and to make the resulting information more effective, spreadsheets may involve features such as the ability to:

- sort rows of data based on the values in a specified column
- program **macros** to automate calculations or formatting
- use hyperlinks to link worksheets together for ease of navigation and use
- use relative and absolute cell references to ensure accuracy of formulas
- name a range of cells to make formulas more meaningful when testing
- protect cells to ensure that the integrity of the formula is not affected
- check the range to ensure that accurate data is entered into the solution.

## Analysing the problem

Refer to the PSM on pages xii–xiii.

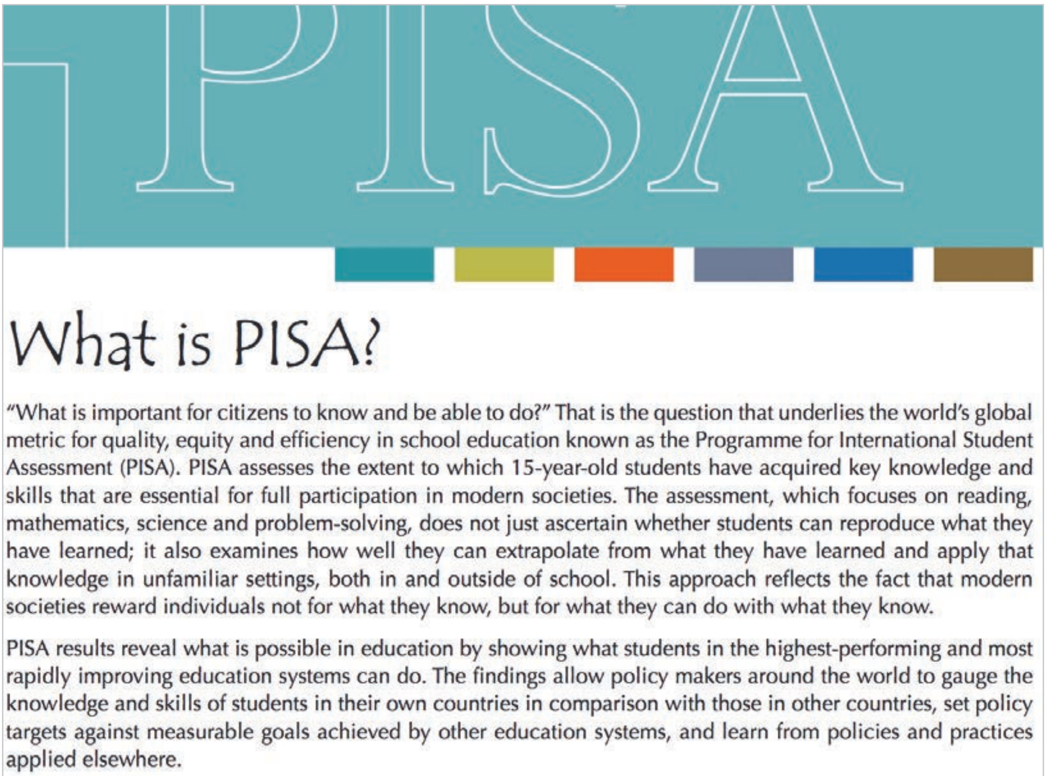
In any problem-solving task, you should follow the PSM and analyse the problem. Once you have defined the problem, the remainder of the analysis stage can commence. Within the problem-solving methodology, the analysis stage is often considered to be the most crucial. Getting the analysis stage correct and having a clear picture of what is required will provide you with the appropriate building blocks for the latter stages.

### CASE STUDY THE NUMBER OF STUDENTS UNDERTAKING STEM SUBJECTS IS INSUFFICIENT FOR AUSTRALIA'S FUTURE NEEDS

There is a worldwide shortage of Science, Technology, Engineering and Mathematics (STEM)graduates. The situation includes Australia, where the Australian Industry Group report (2013) suggests skills learned through each STEM discipline are critical for national productivity and global competitiveness, but warns that 'Australia's participation in STEM skills at secondary school and university are unacceptably low' (p. 1). There is clearly a shortage of students studying STEM subjects at secondary school and continuing them at university. When looking at Australia's PISA and TIMSS results (Table 2.2), there is evidence to show that Australia is not doing as well in this space. To test out the hypothesis that not many students study STEM subjects, we will undertake an investigation of the Year 11 and 12 students at RubyMede College and their STEM choices and rationales (continued in Part 2, on page 35).

Two key international assessments are the Programme for International Student Assessment (PISA), shown in Figure 2.2, and the Trends in International Mathematics and Science Study (TIMSS). PISA, coordinated by the Organization for Economic Cooperation and Development (OECD) assesses reading, scientific and mathematical literacy, focusing on knowledge and skills gained through education but applicable to everyday choices and the solving of real world problems. PISA tests 15-year-olds from 74 different countries, while TIMSS tests students in Grades 4–8 and is the longest running and most extensive international test of science and mathematics learning.

Australian Industry Group (Producer). (2013). *Lifting our Science, Technology, Engineering and Maths (STEM) Skills*. Retrieved from http://www.aigroup.com.au/portal/binary/com.epicentric.contentmanagement.servlet.ContentDeliveryServlet/LIVE_CONTENT/Publications/Reports/2013/Ai_Group_Skills_Survey_2012-STEM_FINAL_PRINTED.pdf


PISA

What is PISA?

"What is important for citizens to know and be able to do?" That is the question that underlies the world's global metric for quality, equity and efficiency in school education known as the Programme for International Student Assessment (PISA). PISA assesses the extent to which 15-year-old students have acquired key knowledge and skills that are essential for full participation in modern societies. The assessment, which focuses on reading, mathematics, science and problem-solving, does not just ascertain whether students can reproduce what they have learned; it also examines how well they can extrapolate from what they have learned and apply that knowledge in unfamiliar settings, both in and outside of school. This approach reflects the fact that modern societies reward individuals not for what they know, but for what they can do with what they know.

PISA results reveal what is possible in education by showing what students in the highest-performing and most rapidly improving education systems can do. The findings allow policy makers around the world to gauge the knowledge and skills of students in their own countries in comparison with those in other countries, set policy targets against measurable goals achieved by other education systems, and learn from policies and practices applied elsewhere.

PISA 2012 Results in Focus: What 15-year-olds know and what they can do with what they know, OECD 2014, p. 3

**FIGURE 2.2** What is PISA?

## Designing solutions

Once the analysis stage is complete and a general idea of the solution is in mind, it is time for the design stage. Designing a solution often occurs without using a computer at all – the solution may just be drafted on paper. The main advantages of designing a solution on paper are that you can sketch your ideas quickly and easily, and that you can make changes easily without affecting the development of a solution.

## ISSUE What students know and can do: student performance in mathematics and science

- Shanghai-China has the highest scores in mathematics, with a mean score of 613 points – 119 points, or the equivalent of nearly three years of schooling, above the OECD average. Singapore, Hong Kong-China, Chinese Taipei, Korea, Macao-China, Japan, Liechtenstein, Switzerland and the Netherlands, in descending order of their scores, round out the top 10 performers in mathematics.
- On average across OECD countries, 13% of students are top performers in mathematics (Level 5 or 6). They can develop and work with models for complex situations, and work strategically using broad, well-developed thinking and reasoning skills. The partner economy Shanghai-China has the largest proportion of students performing at Level 5 or 6 (55%), followed by Singapore (40%), Chinese Taipei (37%) and Hong Kong-China (34%). At the same time, 23% of students in OECD countries, and 32% of students in all participating countries and economies, did not reach the baseline Level 2 in the PISA mathematics assessment. At that level, students can extract relevant information from a single source and can use basic algorithms, formulae, procedures or conventions to solve problems involving whole numbers.
- Between 2003 and 2012, Italy, Poland and Portugal increased their shares of top performers and simultaneously reduced their shares of low performers in mathematics.
- Boys perform better than girls in mathematics in only 37 out of the 65 countries and economies that participated in PISA 2012, and girls outperform boys in five countries.
- Shanghai-China, Hong Kong-China, Singapore, Japan and Finland are the top five performers in science in PISA 2012.
- Between 2006 and 2012, Italy, Poland and Qatar, and between 2009 and 2012, Estonia, Israel and Singapore increased their shares of top performers and simultaneously reduced their shares of low performers in science.
- Across OECD countries, 8% of students are top performers in science (Level 5 or 6). These students can identify, explain and apply scientific knowledge and knowledge about science in a variety of complex life situations.

PISA 2012 Results in Focus: What 15-year-olds know and what they can do with what they know, OECD 2014, p. 4

## Snapshot of performance in mathematics, reading and science

- Countries/economies with a mean performance/share of top performers above the OECD average
- Countries/economies with a share of low achievers below the OECD average
- Countries/economies with a mean performance/share of low achievers/share of top performers not statistically significantly different from the OECD average
- Countries/economies with a mean performance/share of top performers below the OECD average
- Countries/economies with a share of low achievers above the OECD average

**TABLE 2.1** A sample from the snapshot of performance in mathematics and science

| | Mathematics | | | | Science | |
|---|---|---|---|---|---|---|
| | Mean score in PISA 2012 | Share of low achievers in mathematics (Below Level 2) | Share of top performers in mathematics (Level 5 or 6) | Annualised change in score points | Mean score in PISA 2012 | Annualised change in score points |
| OECD average | 494 | 23.0 | 12.6 | –0.3 | 501 | 0.5 |
| Shanghai-China | 613 | 3.8 | 55.4 | 4.2 | 580 | 1.8 |
| Singapore | 573 | 8.3 | 40.0 | 3.8 | 551 | 3.3 |
| Hong Kong-China | 561 | 8.5 | 33.7 | 1.3 | 555 | 2.1 |
| Chinese Taipei | 560 | 12.8 | 37.2 | 1.7 | 523 | –1.5 |
| Korea | 554 | 9.1 | 30.9 | 1.1 | 538 | 2.6 |
| Macao-China | 538 | 10.8 | 24.3 | 1.0 | 521 | 1.6 |
| Japan | 536 | 11.1 | 23.7 | 0.4 | 547 | 2.6 |
| Liechtenstein | 535 | 14.1 | 24.8 | 0.3 | 525 | 0.4 |
| Switzerland | 531 | 12.4 | 21.4 | 0.6 | 515 | 0.6 |
| Netherlands | 523 | 14.8 | 19.3 | –1.6 | 522 | –0.5 |
| Estonia | 521 | 10.5 | 14.6 | 0.9 | 541 | 1.5 |
| Finland | 519 | 12.3 | 15.3 | –2.8 | 545 | –3.0 |
| Canada | 518 | 13.8 | 16.4 | –1.4 | 525 | –1.5 |
| Poland | 518 | 14.4 | 16.7 | 2.6 | 526 | 4.6 |
| Belgium | 515 | 19.0 | 19.5 | –1.6 | 505 | –0.9 |
| Germany | 514 | 17.7 | 17.5 | 1.4 | 524 | 1.4 |
| Viet Nam | 511 | 14.2 | 13.3 | m | 528 | m |
| Austria | 506 | 18.7 | 14.3 | 0.0 | 506 | –0.8 |
| Australia | 504 | 19.7 | 14.8 | –2.2 | 521 | –0.9 |
| Ireland | 501 | 16.9 | 10.7 | –0.6 | 522 | 2.3 |
| Slovenia | 501 | 20.1 | 13.7 | –0.6 | 514 | –0.8 |

PISA 2012 Results in Focus: What 15-year-olds know and what they can do with what they know, OECD 2014, p. 5

**TABLE 2.2** Singapore, Korea, and Hong Kong SAR were the top-performing countries in TIMSS 2011 at the fourth grade. For multiple comparisons of average mathematics achievement, read across the row for a country to compare performance with the countries listed along the top of the chart. The symbols indicate whether the average achievement of the country in the row is significantly lower than that of the comparison country, significantly higher than that of the comparison country, or if there is no statistically significant difference between the average achievement of the two countries.

| Country | Average scale score | Singapore | Korea, Rep. of | Hong Kong SAR | Chinese Taipei | Japan | Northern Ireland | Belgium (Flemish) | Finland | England | Russian Federation | United States | Netherlands | Denmark | Lithuania | Portugal | Germany | Ireland | Serbia | Australia |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Singapore | 606 (3.2) | | | | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ |
| Korea, Rep. of | 605 (1.9) | | | | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ |
| Hong Kong SAR | 602 (3.4) | | | | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ |
| Chinese Taipei | 591 (2.0) | ▽ | ▽ | ▽ | | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ |
| Japan | 585 (1.7) | ▽ | ▽ | ▽ | ▽ | | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ |
| Northern Ireland | 562 (2.9) | ▽ | ▽ | ▽ | ▽ | ▽ | | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ |
| Belgium (Flemish) | 549 (1.9) | ▽ | ▽ | ▽ | ▽ | ▽ | △ | | | | | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ |
| Finland | 545 (2.3) | ▽ | ▽ | ▽ | ▽ | ▽ | △ | | | | | | | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ |
| England | 542 (3.5) | ▽ | ▽ | ▽ | ▽ | ▽ | △ | | | | | | | | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ |
| Russian Federation | 542 (3.7) | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | | | | | | | | | | ▲ | ▲ | ▲ | ▲ |
| United States | 541 (1.8) | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | | | | | | | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ |
| Netherlands | 540 (1.7) | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | | | | | | | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ |
| Denmark | 537 (2.6) | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | | | | | | | | ▲ | ▲ | ▲ | ▲ |
| Lithuania | 534 (2.4) | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | | ▽ | ▽ | | | | | | ▲ | ▲ |
| Portugal | 532 (3.4) | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | | ▽ | ▽ | | | | | | ▲ | ▲ |
| Germany | 528 (2.2) | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | | | | | ▲ | ▲ |
| Ireland | 527 (2.6) | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | | | | | ▲ | ▲ |
| Serbia | 516 (3.0) | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | | |
| Australia | 516 (2.9) | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | ▽ | | |

SOURCE: IEA's Trends in International Mathematics and Science Study – TIMSS 2011, Grade 4 ©2003 IEA, The Netherlands

## CASE STUDY THE NUMBER OF STUDENTS UNDERTAKING STEM SUBJECTS IS INSUFFICIENT FOR AUSTRALIA'S FUTURE NEEDS

### Hypothesis

Are there insufficient students undertaking STEM subjects to meet Australia's future needs?

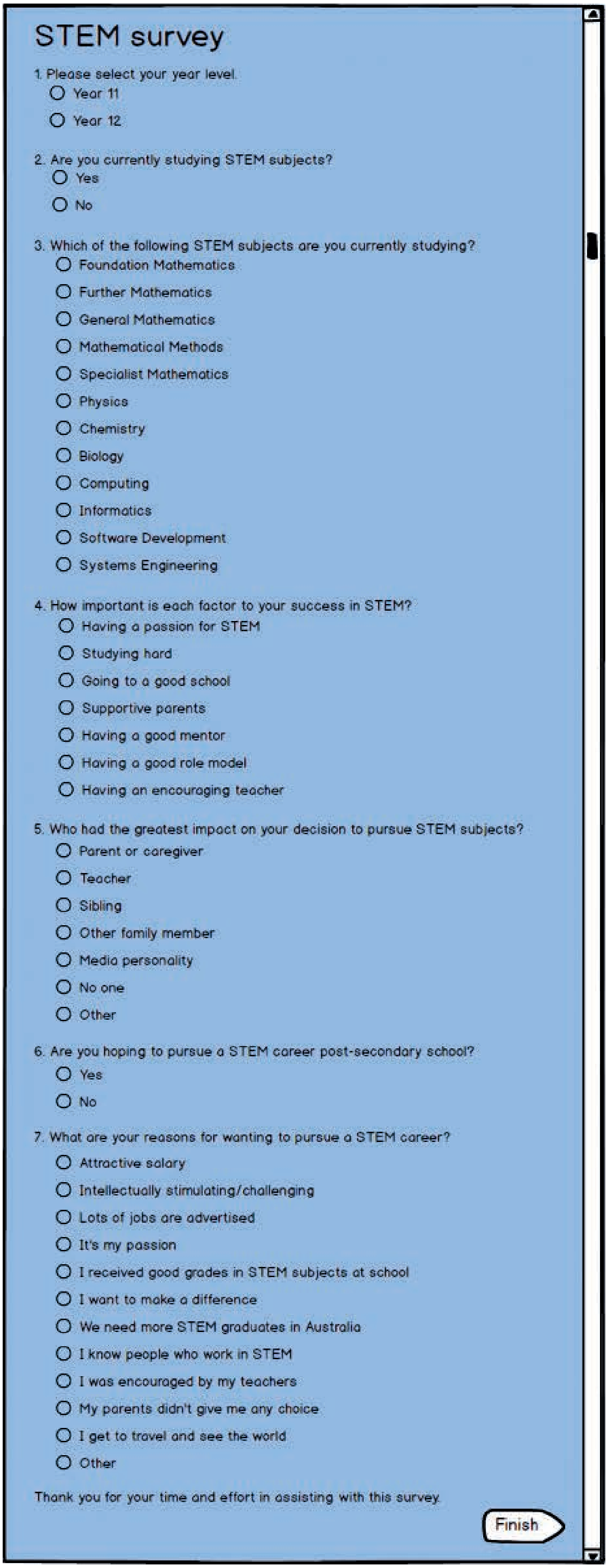
### Identify the type of data that will be collected

The data will be collected from a variety of sources including:

- VCE students studying STEM subjects at RubyMede College – numerical data
- PISA and TIMSS results – numerical data
- government and industry reports – qualitative data.

### Identify the data collection tool that will be used

- Questionnaires will be used to elicit primary data from students at RubyMede College.
- The internet will also be used to support any findings and supplement the investigation.



STEM survey

1. Please select your year level.
- Year 11
- Year 12

2. Are you currently studying STEM subjects?
- Yes
- No

3. Which of the following STEM subjects are you currently studying?
- Foundation Mathematics
- Further Mathematics
- General Mathematics
- Mathematical Methods
- Specialist Mathematics
- Physics
- Chemistry
- Biology
- Computing
- Informatics
- Software Development
- Systems Engineering

4. How important is each factor to your success in STEM?
- Having a passion for STEM
- Studying hard
- Going to a good school
- Supportive parents
- Having a good mentor
- Having a good role model
- Having an encouraging teacher

5. Who had the greatest impact on your decision to pursue STEM subjects?
- Parent or caregiver
- Teacher
- Sibling
- Other family member
- Media personality
- No one
- Other

6. Are you hoping to pursue a STEM career post-secondary school?
- Yes
- No

7. What are your reasons for wanting to pursue a STEM career?
- Attractive salary
- Intellectually stimulating/challenging
- Lots of jobs are advertised
- It's my passion
- I received good grades in STEM subjects at school
- I want to make a difference
- We need more STEM graduates in Australia
- I know people who work in STEM
- I was encouraged by my teachers
- My parents didn't give me any choice
- I get to travel and see the world
- Other

Thank you for your time and effort in assisting with this survey.

Finish

**FIGURE 2.3** A questionnaire for students about STEM subjects

## How data will be gathered

The questionnaire used for this investigation can be seen in Figure 2.3. It has seven questions and some space to add free text if participants want to clarify or add some more information. The questionnaire will be completed electronically over the internet and will take no longer than 10 minutes to complete.

## Create participation information statement and consent forms

As the participation information statement and consent forms are combined, they can be incorporated into the start of the questionnaire. Participants of the questionnaire will need to provide consent to take part (Figure 2.4). This can be done by agreeing to take part in the questionnaire and then pressing 'start'. If the participant chooses not to take part, they just need to press 'no.' The survey is anonymous and will not collect information that can identify the participants.

## Identify risks to privacy and security and have strategies in place to minimise them

The researcher will only have access to the data she will be collecting for her study from the participants who have agreed to be part of the research. The researcher will not have access to any other data collected by RubyMede for its own purposes. Identifiable data will be coded and de-identified and only collated data will be reported. The research will be carried out online and all data collected will be stored on the computer's hard drive and backed up to the school's network drive on a password-protected computer. The data will also be stored in a password-protected file to ensure that the data collected cannot identified.

## Collecting data

The researcher sent the URL of her questionnaire to all VCE students in her school. There are more than 210 students in Years 11 and 12. Many of the students did not want to participate, but the researcher secured 43 completed questionnaires from students at her school. The participation rate represents approximately 20 per cent of students from the population. Even though 44 students participated, one of the respondents did not complete the questionnaire. It is acceptable for questionnaires to be incomplete because participation is voluntary. See the report information in Figure 2.5.

STEM

STEM survey at RubyMede College

1. The number of students undertaking STEM subjects is insufficient for Australia's future needs.

Primary investigator: Sienna ____

Information for consent

Worldwide, there is agreement that there is a shortage of STEM (Science, Technology, Engineering and Mathematics) graduates. The situation is also relevant in Australia where the Australian Industry Group Report (2013) suggests skills learned through each STEM discipline are critical for national productivity and global competitiveness, but warns that 'Australia's participation in STEM skills at secondary school and university are unacceptably low'. There is a clear shortage of students studying STEM subjects at secondary school and then continuing with it at university. This questionnaire will ask students at RubyMede College about their subject choices at VCE.

As a student undertaking VCE, I would like to invite you to tell me about the STEM subjects you are taking at VCE. The study consists of a voluntary, anonymous, online survey that should take you no longer than 10 minutes to complete. While we encourage you to complete the whole survey, you may stop at any time and only those responses you have already answered will be used in the study.

Results will be collated before being used to assist me with my investigation. If you would like further information about any aspect of the project before agreeing to participate, please do not hesitate to contact me.

Sienna ____ (12K)
RubyMede College

Email: ______@rubymede.vic.edu.au

I look forward to your input.

◉ Yes, I agree to participate. Please click on 'Start'.
○ No, I do not wish to participate.

Start

**FIGURE 2.4** Respondents must consent to participate in this questionnaire.

## Report info

| | |
|---|---|
| **Report date:** | Wednesday, March 4, 2015 2:12:07 PM EST |
| **Start date:** | Monday, March 2, 2015 8:27:00 PM EST |
| **Stop date:** | Wednesday, March 4, 2015 12:27:00 PM EST |
| **Stored responses:** | 44 |
| **Number of completed responses:** | 43 |

**FIGURE 2.5** The report generated from the online survey shows number of respondents who completed the questionnaire. Even though there were 44 responses, there were only 43 completed responses.

## Data capture

Part of the data that was captured from the questionnaire is shown in Figure 2.6. At this stage, it is important to just present the data from the questionnaire.

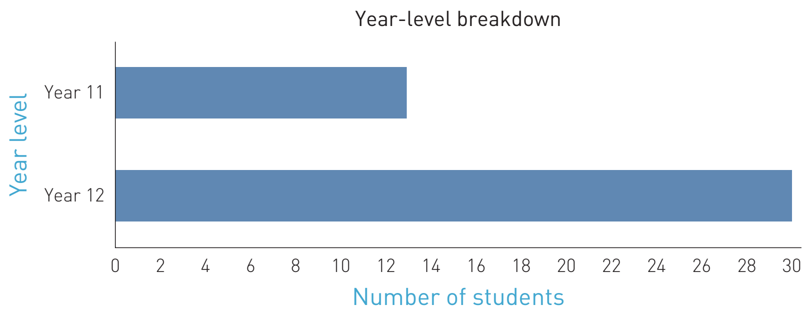



**FIGURE 2.6** Student year-level breakdown of those who participated in the questionnaire

The **absolute frequency** is the total number of times a variable is observed in a given range. For example: Year 11 = 13 Year 12 = 30. The **relative frequency** is the number of times a variable is observed, in relation to the total number of values for the variable. For example: Year 11 = 13 ÷ 44 = 0.2955. Expressed as a percentage, this is 29.55%. In each calculation, you would move the decimal place two places to the right. For example: Year 12 = 30 ÷ 44 = 0.6818 = 68.18%. The same rule applies for the tables that follow. The **adjusted relative frequency** removes the 'not answered' variable, so that: Year 11 = 13 ÷ 43 = 30.23 Year 12 = 30 ÷ 43 = 69.77.

**TABLE 2.3** Frequency table

| Choices | Absolute frequency | Relative frequency (%) | Adjusted relative frequency (%) |
|---|---|---|---|
| Year 11 | 13 | 29.55 | 30.23 |
| Year 12 | 30 | 68.18 | 69.77 |
| Sum | 43 | 97.73 | 100 |
| Not answered | 1 | 2.27 | – |
| **Total answered: 43** | | | |

Approximately 70 per cent of the respondents of the questionnaire were Year 12 students and 30 per cent were Year 11. Of those who participated, all were studying STEM subjects.

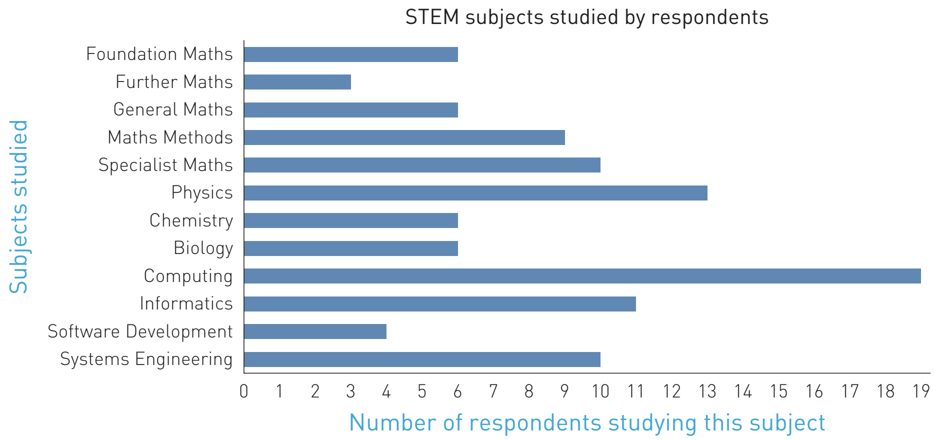



**FIGURE 2.7** STEM subjects students studied

**TABLE 2.4** Frequency table

| Choices | Absolute frequency | Relative frequency by choice (%) | Relative frequency (%) | Adjusted relative frequency (%) |
|---|---|---|---|---|
| Foundation Maths | 6 | 5.83 | 13.64 | 13.95 |
| Further Maths | 3 | 2.91 | 6.82 | 6.98 |
| General Maths | 6 | 5.83 | 13.64 | 13.95 |
| Maths Methods | 9 | 8.74 | 20.45 | 20.93 |
| Specialist Maths | 10 | 9.71 | 22.73 | 23.26 |
| Physics | 13 | 12.62 | 29.55 | 30.23 |
| Chemistry | 6 | 5.83 | 13.64 | 13.95 |
| Biology | 6 | 5.83 | 13.64 | 13.95 |
| Computing | 19 | 18.45 | 43.18 | 44.19 |
| Informatics | 11 | 10.68 | 25 | 25.58 |
| Software Development | 4 | 3.88 | 9.09 | 9.3 |
| Systems Engineering | 10 | 9.71 | 22.73 | 23.26 |
| Sum: | 103 | 100 | – | – |
| Not answered: | 1 | – | 2.27 | – |
| **Total answered: 43** | | | | |

Absolute frequency in Table 2.4 shows the number of times a subject was selected in the survey. For example, Computing was selected 10 times, as shown in Figure 2.7.

**Relative frequency by choice** (%) in Table 2.4 is the total number of times a subject was selected divided by the sum in the absolute frequency column. For example:
Computing = 19 ÷ 103 = 18.45 (rounded up).

**Relative frequency %** in Table 2.4 is the total number of times a subject was selected divided by the total number of participants. For example:
Computing = 19 ÷ 44 = 43.18.

The **adjusted relative frequency (%)** in Table 2.4 is the total number of times a subject was selected divided by the total number of participants, with the 'not answered' participant removed. For example:
Computing = 19 ÷ 43 = 44.19 (rounded up).

It appears that Computing is very popular among students, with 44 per cent of this cohort studying it. Physics was the next most popular, with 30 per cent studying it, with Informatics next on 26 per cent. The least popular subjects, according to the questionnaire, were Further Maths and Software Development.

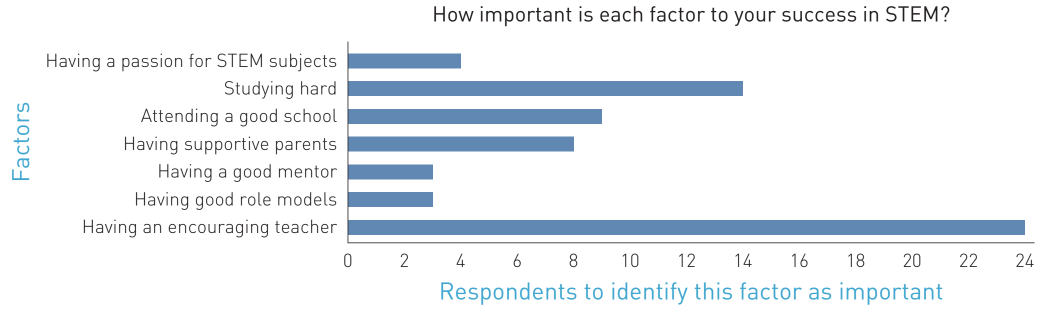



**FIGURE 2.8** Identifying factors to experiencing success in STEM

For advice on interpreting frequency tables, see the margin notes on pages 38 and 39.

**TABLE 2.5** Frequency table

| Choices | Absolute frequency | Relative frequency by choice (%) | Relative frequency (%) | Adjusted relative frequency (%) |
|---|---|---|---|---|
| Having a passion for STEM subjects | 4 | 6.15 | 9.09 | 9.3 |
| Studying hard | 14 | 21.54 | 31.82 | 32.56 |
| Attending a good school | 9 | 13.85 | 20.45 | 20.93 |
| Having supportive parents | 8 | 12.31 | 18.18 | 18.6 |
| Having a good mentor | 3 | 4.62 | 6.82 | 6.98 |
| Having good role models | 3 | 4.62 | 6.85 | 6.98 |
| Having an encouraging teacher | 24 | 36.92 | 54.55 | 55.81 |
| Sum: | 65 | 100 | – | – |
| Not answered: | 1 | – | 2.27 | – |
| **Total answered: 43** | | | | |

The top three factors identified as important to success in STEM were having encouraging teachers, studying hard and going to a good school. From the data, respondents believed that having an encouraging teacher was important.

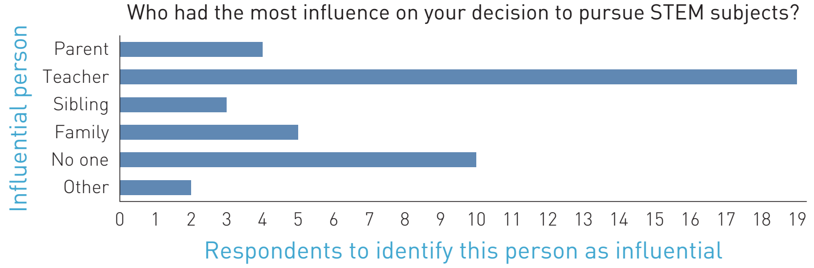



**FIGURE 2.9** Influence on decision to pursue STEM subjects.

**TABLE 2.6** Frequency table

| Choices | Absolute frequency | Relative frequency (%) | Adjusted relative frequency (%) |
|---|---|---|---|
| Parent | 4 | 9.09 | 9.3 |
| Teacher | 19 | 43.18 | 44.19 |
| Sibling | 3 | 6.82 | 6.98 |
| Family | 5 | 11.36 | 11.63 |
| No one | 10 | 22.73 | 23.26 |
| Other | 2 | 4.55 | 4.65 |
| Sum: | 43 | 97.73 | 100 |
| Not answered: | 1 | 2.27 | – |
| **Total answered: 43** | | | |
| Text input: | | | |
| My neighbour | | | |
| Sheldon from *The Big Bang Theory* | | | |

Respondents indicated that their teacher had the most influence on their decision to study STEM. The next largest category was ‘no-one.’ Family and parents rated around the same.


**FIGURE 2.10** Reasons for pursuing a STEM career

**TABLE 2.7** Frequency table

| Choices | Absolute frequency | Relative frequency by choice (%) | Relative frequency (%) | Adjusted relative frequency (%) |
|---|---|---|---|---|
| Attractive salary | 1 | 1.96 | 2.27 | 2.33 |
| It is intellectually challenging/stimulating | 2 | 3.92 | 4.55 | 4.65 |
| High level of job vacancies | 4 | 7.84 | 9.09 | 9.3 |
| I am passionate about it | 3 | 5.88 | 6.82 | 6.98 |
| Good grades in STEM subjects at school | 6 | 11.76 | 13.64 | 13.95 |
| I want to make a difference | 4 | 7.84 | 9.09 | 9.3 |
| We need more STEM graduates in Australia | 2 | 3.92 | 4.55 | 4.65 |
| I know people who work in STEM | 5 | 9.8 | 11.36 | 11.63 |
| My teachers encouraged me | 5 | 9.8 | 11.36 | 11.63 |
| My parents didn't give me any choice | 2 | 3.92 | 4.55 | 4.65 |
| I will be able to travel and see the world | 11 | 21.57 | 25 | 25.58 |
| Other | 6 | 11.76 | 13.64 | 13.95 |
| Sum: | 51 | 100 | – | – |
| Not answered: | 1 | – | 2.27 | – |
| **Total answered: 43** | | | | |

Respondents were asked why they wanted to pursue a STEM-based career after secondary school and many indicated that they were able to see the world and travel through their chosen career. The next most popular response was because they received good grades in STEM subjects at school.

## Data analysis

Once data has been collected, it needs to be analysed. The researcher needs to identify any patterns, give meaning to the data and draw conclusions.

As noted previously, only 20 per cent of the possible VCE students from the College participated in this questionnaire, which represents a very small percentage of students. The data obtained from the questionnaire alone does not provide a clear picture of STEM subject enrolments at the school. However, when the respondents are compared with actual enrolments, it reveals that 53 per cent of STEM students responded to this questionnaire, indicating that fewer than 40 per cent of students undertake STEM subjects at RubyMede College.

**TABLE 2.8** The following table represents the questionnaire data compared with the *actual* enrolments in STEM subjects at RubyMede College.

| Subjects | RubyMede subject enrolments | Questionnaire participants |
|---|---|---|
| Foundation Maths | 14 | 6 |
| Further Maths | 20 | 3 |
| General Maths | 17 | 6 |
| Maths Methods | 19 | 9 |
| Specialist Maths | 13 | 10 |
| Physics | 15 | 13 |
| Chemistry | 13 | 6 |
| Biology | 19 | 6 |
| Computing | 21 | 19 |
| Informatics | 22 | 11 |
| Software Development | 8 | 4 |
| Systems Engineering | 12 | 10 |
| Total | 193 | 103 |

# Purpose of graphic solutions

See David McCandless's 'Information is Beautiful' TEDTalk.

**Graphic solutions** are pictorial diagrams that show interdependencies between **variables**. They are one of the most commonly used methods of representing data and information, and can make reading data and information more interesting, less time-consuming and more understandable.

They allow data to be compared at a glance. Graphic solutions are particularly useful for summarising a series of numbers and their interrelationships, and they can assist in identify trends and patterns in your data. The following section discusses the types of graphic solutions that may be appropriate for your Outcome.

If you need greater **clarity** from a set of information or to identify patterns or relationships with data sets, you may require a graphic solution. A graphic solution visually represents analysed data. It is an elegant way to represent complex information or large amounts of data.

For example, if we want to:

- compare data, we might use a bar chart
- show a distribution of data, we might use a histogram

- show a relationship between two data sets, we might use a scatter diagram
- show a composition of data that changes over time, we might use an animation or simulation.

Often, before we start this process, we have a rough idea of what the solution might look like based on the desire to inform, persuade or educate. We inform when we provide information or tell facts, such as reporting on a current issue. We persuade when we influence a decision or action, or change a person's opinion. We educate when we teach and provide knowledge and skills through a learning process. For example, data obtained about the number of elderly pedestrians injured crossing a major intersection can inform the local government about the black spot. That same data can be visually represented in another way to persuade the engineering department of the local government to make some adjustments to the intersection to prevent further injuries. The data can also be used to educate the elderly about the need to be vigilant when crossing the intersection. The appropriate graphic solution will need to be selected based on how the data will be used to persuade, inform or educate.

# Types of graphic solutions

## Charts

Charts, also called graphs, represent detailed data in visual form. The most common forms of charts are column graphs, bar graphs, pie graphs and line graphs. Charts generally use a scale and/or a series of data sets that are indicated along two axes. However, in the case of pie graphs, they use the divisions of the whole to communicate the quantities of data. Charts may use two-dimensional or three-dimensional representation for visual impact.

Other types of charts you may find useful for your infographic include histograms, bubble charts, doughnut graphs and area charts.

You should choose the correct type of chart for your data.

Columns and bar graphs arrange data vertically (columns, Figure 2.11) or horizontally (rows, Figure 2.10 on page 41). They are handy for presenting data changes over a period of time or for showing comparisons across different times. They enable visual comparisons easily so that differences can be recognised quickly. The STEM case study in this chapter uses many (horizontal) bar graphs.

Microsoft Word and Excel offer a large range of charts that you can easily add to any document via the Insert → Chart menu.

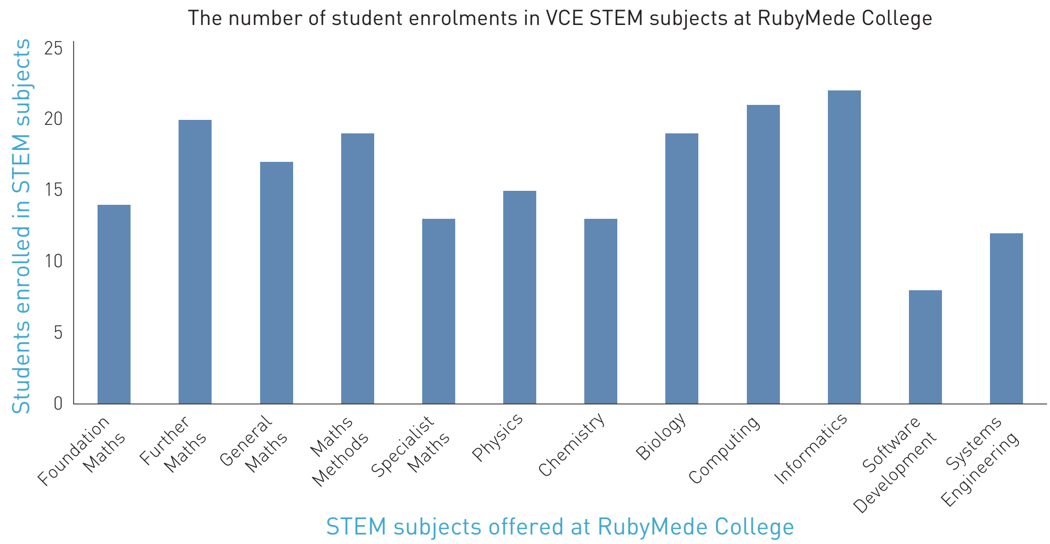



**FIGURE 2.11** An example of a column chart that depicts the number of student enrolments in VCE STEM subjects at RubyMede College

Choose a line graph when you need to display continuous data over time, set against a common time. It is useful for showing trends in data at equal intervals. If more than one line is shown, use colours to distinguish each line. The 'Pesticide Planet' infographic, (Figure 2.22, page 55) includes several line graphs, among other types of graphs.

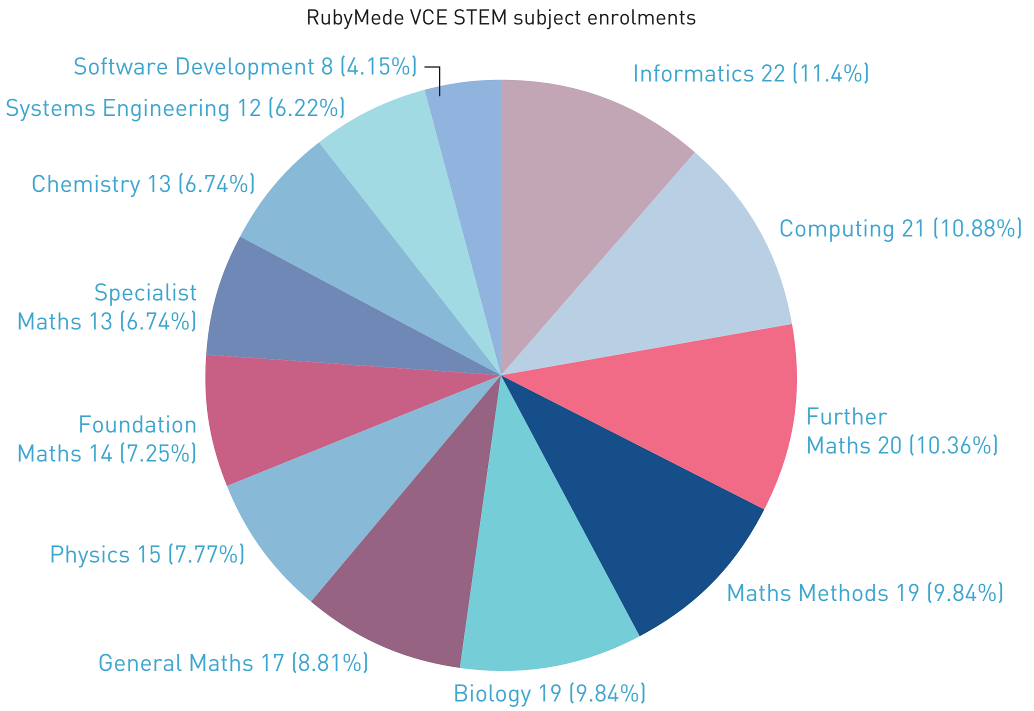



**FIGURE 2.12** This pie chart depicts the number of student enrolled in VCE STEM subjects at RubyMede College. Each segment of the pie chart represents the subject and the number of students studying each subject.

A pie graph is divided into 'slices' proportional to the percentage of the whole pie (Figure 2.12). Consider choosing a pie graph if you need to depict approximate proportional relationships (relative amounts) or compare part of a whole at a given point in time. The full circle represents 100 per cent. The angle of each 'slice' is found by multiplying its percentage value by 360°.

You should follow some simple rules with charts.

- They must have titles.
- The *x*-axis and the *y*-axis must be labelled.
- Use a key if more than one set of data is provided on the same graph.
- Include author identification and/or the source of the data, the date and a filename (if appropriate).
- Include the unit of measurement on the relevant axis.
- Label each segment of a pie chart.
- Arrange segments of pie chart (starting at 12 o'clock position) from largest to smallest.
- Consider including absolute figures as well as percentages.
- Choose colours that match the information being discussed.
- Use graphs to show trends or relationships between values on each axis.
- If possible, limit the number of items represented in a chart to five or six.

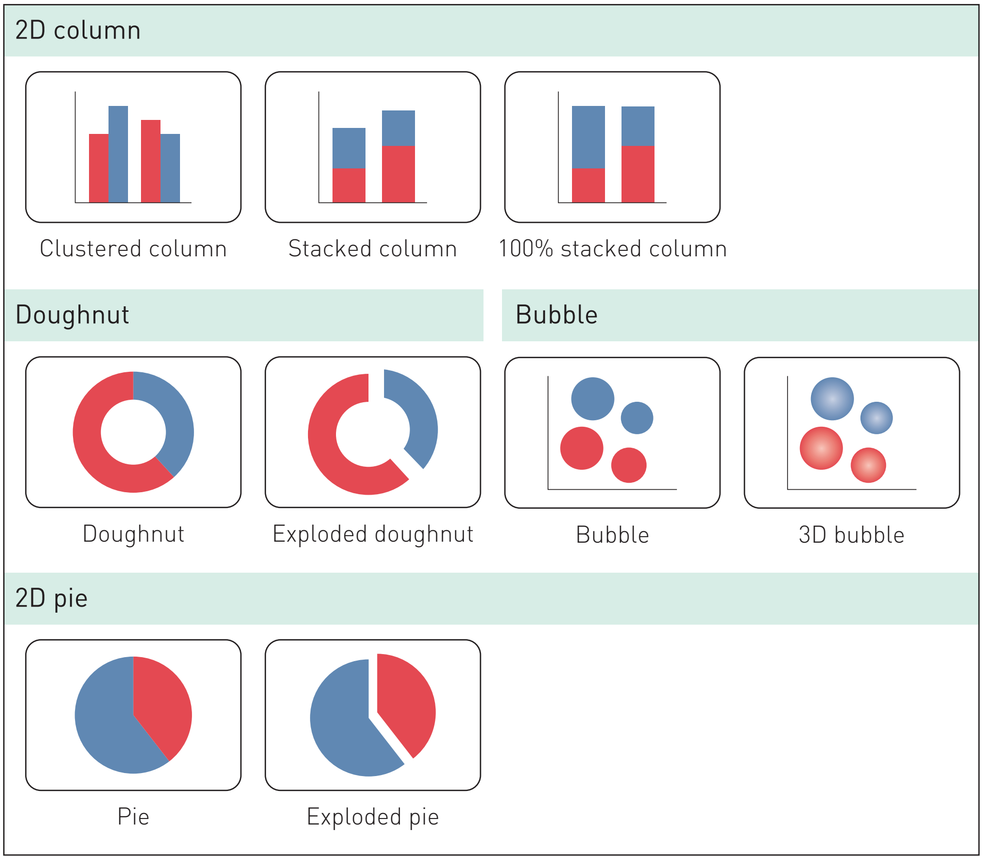



**FIGURE 2.13** Examples of charts used for graphic representation of data.

## Flowcharts

Flowcharts graphically represent the steps in a process or system. Boxes of data identify the steps to help the user understand what happens next. Flowcharts are used a great deal in information systems because they help explain very complex, technical processes. Many types of flowcharts exist, and some are more visual than others, but the fundamental step-by-step idea remains the same.

Flowcharts should generally be read from the top down or from the left to the right. They also often use lines and arrows to visually direct the user to the next step. In some cases, decision trees with yes/no options instruct the user where to go next in the flowchart.

Website site maps are also a type of flowchart.

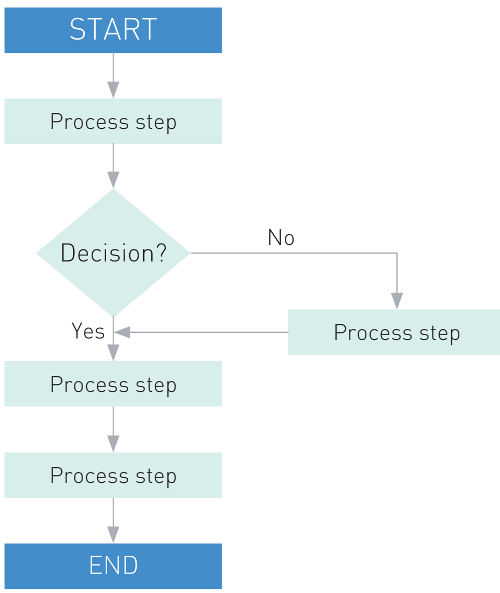



**FIGURE 2.14** An example of a flowchart with a decision tree

Lucidchart – free flowchart software

You will find it very useful to become familiar and proficient with flowcharts throughout your study of *Computing VCE*. They are a valuable tool for helping you visualise your solutions and work them out step-by-step.

## Diagrams

Diagrams present data or information in a visually clear, accessible way using formats and conventions such as colours, symbols, points, lines, shapes and explanatory drawings. They are usually two-dimensional geometric, but they can be three-dimensional. A diagram is usually a symbolic visual representation of what may be very complex data or information. Common

Blueprints are technical drawings or design plans.

Schematics are diagrams that represent parts of a system using graphic symbols instead of realistic images.

Orthographic drawings are drawings from a series of views and are designed to show every part of an object clearly. They are thought of as multiview drawings.

Axonometric drawings use lines that remain parallel and do not converge at any given point. They are sometimes called paraline drawings.

Isometric drawing is a technique where all lines remain parallel and length and width are drawn at 30°.

NelsonNet additional resource: Figure 2.15 Graph, p. 46

types of diagrams include blueprints, schematics and annotated diagrams. An infographic is an increasingly popular form of a diagram. A single diagram, especially an infographic, may include multiple diagrams within it.

## Images

Images may include illustrations and photos. Illustrations may be two-dimensional or three-dimensional drawings, drawn by hand using techniques such as orthographic, axonometric, isometric or perspective drawing or using software such as Adobe Illustrator. Illustrations may also be art, cartoons or caricatures, with varying levels of detail. What makes them different from other types of graphic representations in this context is that they (usually) are not representing data.

## Hierarchies

Hierarchies are a type of chart that usually depict the relationships and **hierarchy** between roles in an organisation, institution, project team, site map or process chart. While it is most common to use hierarchies to represent relationships between people, they do lend themselves to other uses. Family trees are another type of hierarchy. Figure 2.20 on page 52, which depicts the design principles, is also a hierarchy.

## Animations

An animation combines a series of images (either two-dimensional or three-dimensional) to create a sequence of moving images. Animations may include sound and some even offer a level of interactivity. You could use an animation to show the workings of part of a solution or

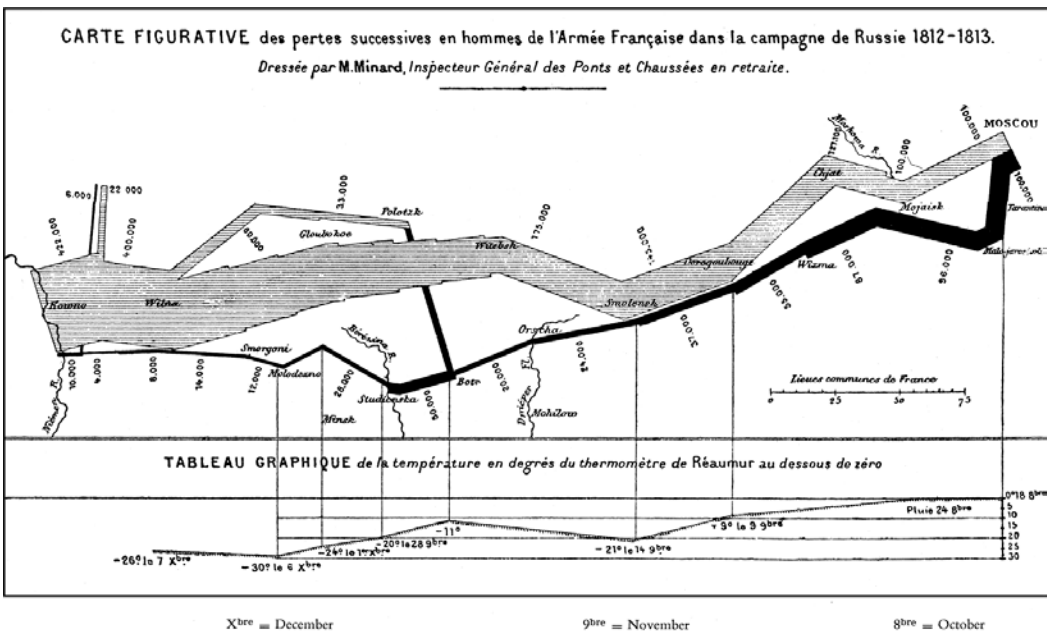



**FIGURE 2.15** Widely regarded as the best graph ever drawn, Charles Minard's visual representation of Napoleon's march to Moscow gives the user information on several levels at once: geographical, climatic and numerical. The top line represents the troops moving towards Moscow in 1812–1813. The figures on the side of the line show the dramatic fall in troop numbers, and the corresponding thinning of the line shows the fall visually. It can be seen that Napoleon lost large numbers of troops each time he crossed a river. The line at the bottom of the graph shows the temperature. As the temperature dropped, still more troops were lost. The black line shows the troops retreating. One can only speculate about how different history might have been if Napoleon had had Minard in his midst during the troop campaign.

perhaps to instruct on the functionality of your design. Animation may be used when printing is not suitable to communicate your message.

## Maps

A map represents an area of land or sea as a diagram, showing features such as roads, cities and other markers, such as peaks (mountains), deserts, and borders between states and countries. Another type of map you are likely to be familiar with is a transport map, which shows each individual route of a train or tram line as a single line, to provide a clear guide to destinations and a visual scale of distance between stations.

Signage and other wayfinding devices applied to maps create effective directional design. A map alone is just a map. Adding symbols and other conventions, such as arrows, lines and text, conveys a great deal more information.

## Timelines

Timelines show events, images or data in chronological order. A timeline may include both images and text. They are often used to graphically depict historical development over a period of time. You may find them in history and science texts, as well as newspapers, magazines and online. Timelines are often used in infographics to show comparisons or changes over time.

The 'Farewell To A Genius' infographic, Figure 2.33 on page 66, shows an example of a timeline in an infographic that includes both text and images. This infographic may appear to place textboxes haphazardly, but in order to fit the amount of detail in such a small space, each box is carefully placed, making it more like a jigsaw puzzle.

## Infographics

An infographic is a graphic solution that shows data and information using different elements that include:

- graphs
- pictures
- diagrams
- narrative
- timelines.

Infographics often communicate multiple findings for a topic. Infographics allow us to tell a more complete story of the data and are more engaging than most traditional ways of communicating data and information.

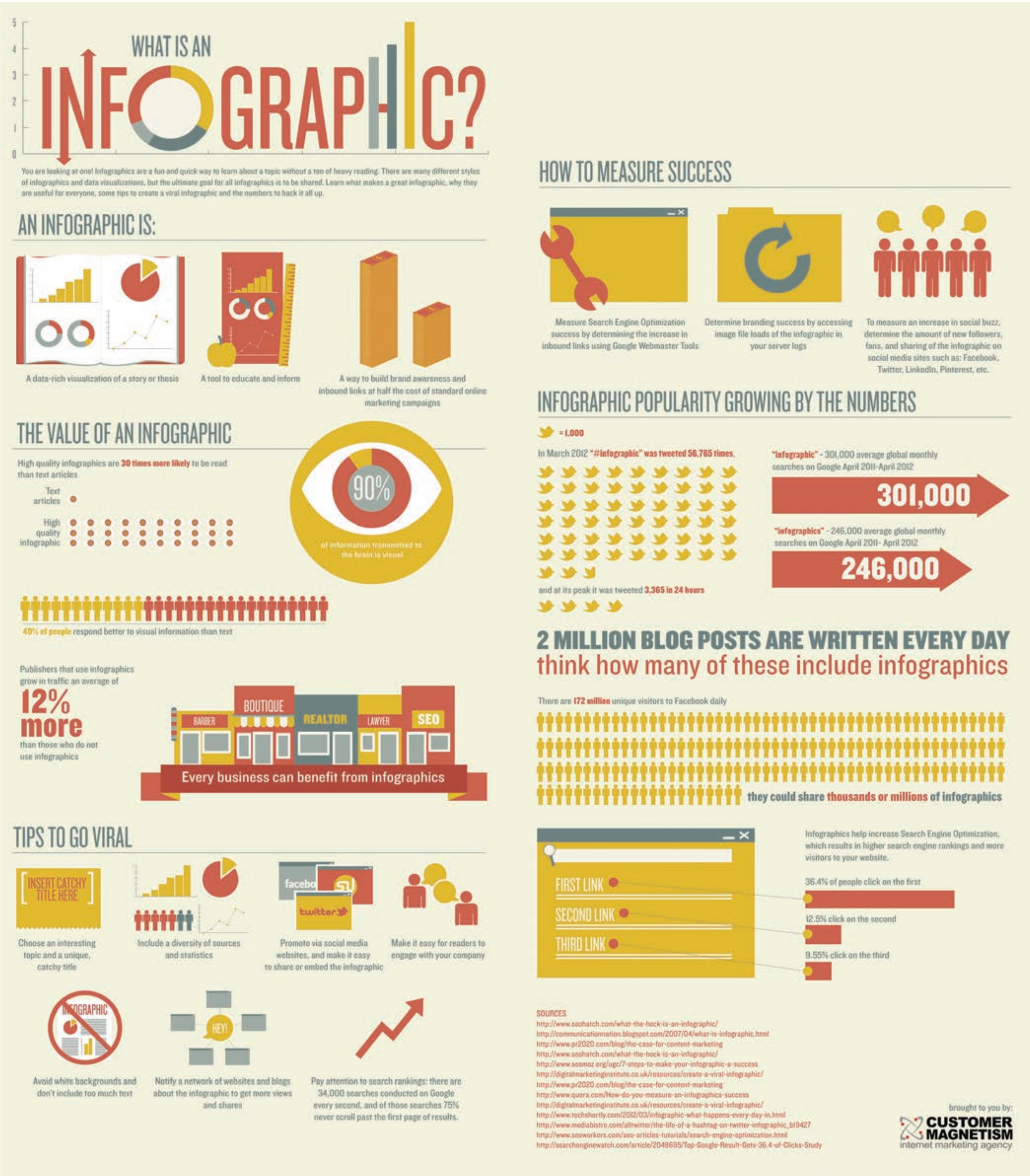
It is important to be creative when devising your infographic. An infographic is more than building a chart in a spreadsheet. Think of it as a creative poster that uses illustrations, icons, graphics and different fonts and colours to make a point. Pages 48–68 show examples of infographics that you may find useful as you prepare for your Outcome.

The steps to creating an infographic are as follows.

1. Conduct an investigation into an issue, practice or event.
2. Interpret the primary data.
3. Familiarise yourself with different ways to visualise data.
4. Mock up a design of the infographic.
5. Create the infographic.
6. Include references/citations/sources in the infographic.
7. Apply formats and conventions to the infographic.
8. Test and validate the infographic. You can follow the same process to create most graphic solutions.

Rather than writing the outcomes of research into written documents, the main points of research can be presented in a visual format. This can be more engaging for the reader.

The final product of Unit 1, Outcome 1 will likely be an infographic. Your infographic should be visually engaging, contain a subject matter that is appealing to the target audience, and be supported by other engaging content.




Customer Magnetism

**FIGURE 2.16** What is an infographic?

**THINK ABOUT COMPUTING 2.1**

Summarise what you think an infographic is, making reference to Figure 2.16.

NelsonNet additional resource: Figure 2.16 Infographic, p. 48

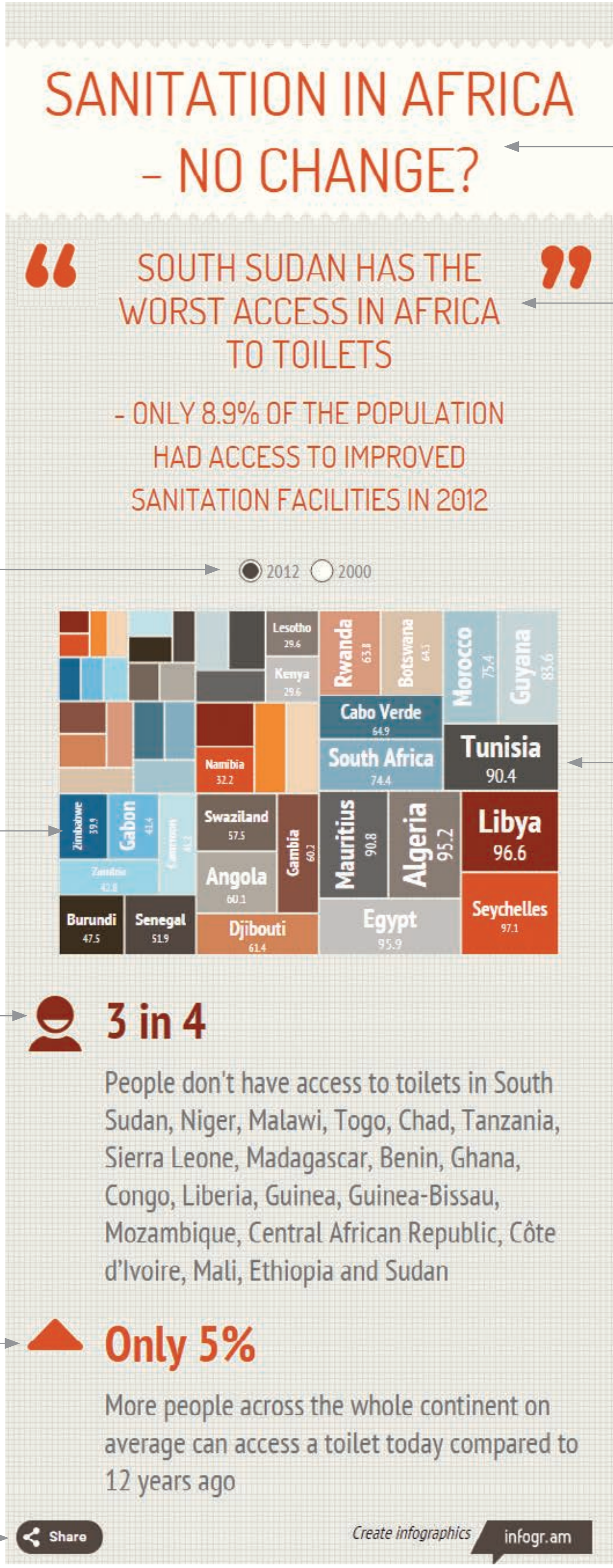





**FIGURE 2.17** A simple infographic on sanitation in Africa

The topic appears at the top

Shows the most important findings at the top in the largest fonts, with large quotation marks to emphasise that it is a quote

Provides two different time periods

NelsonNet additional resource: Figure 2.17 Infographic, p. 49

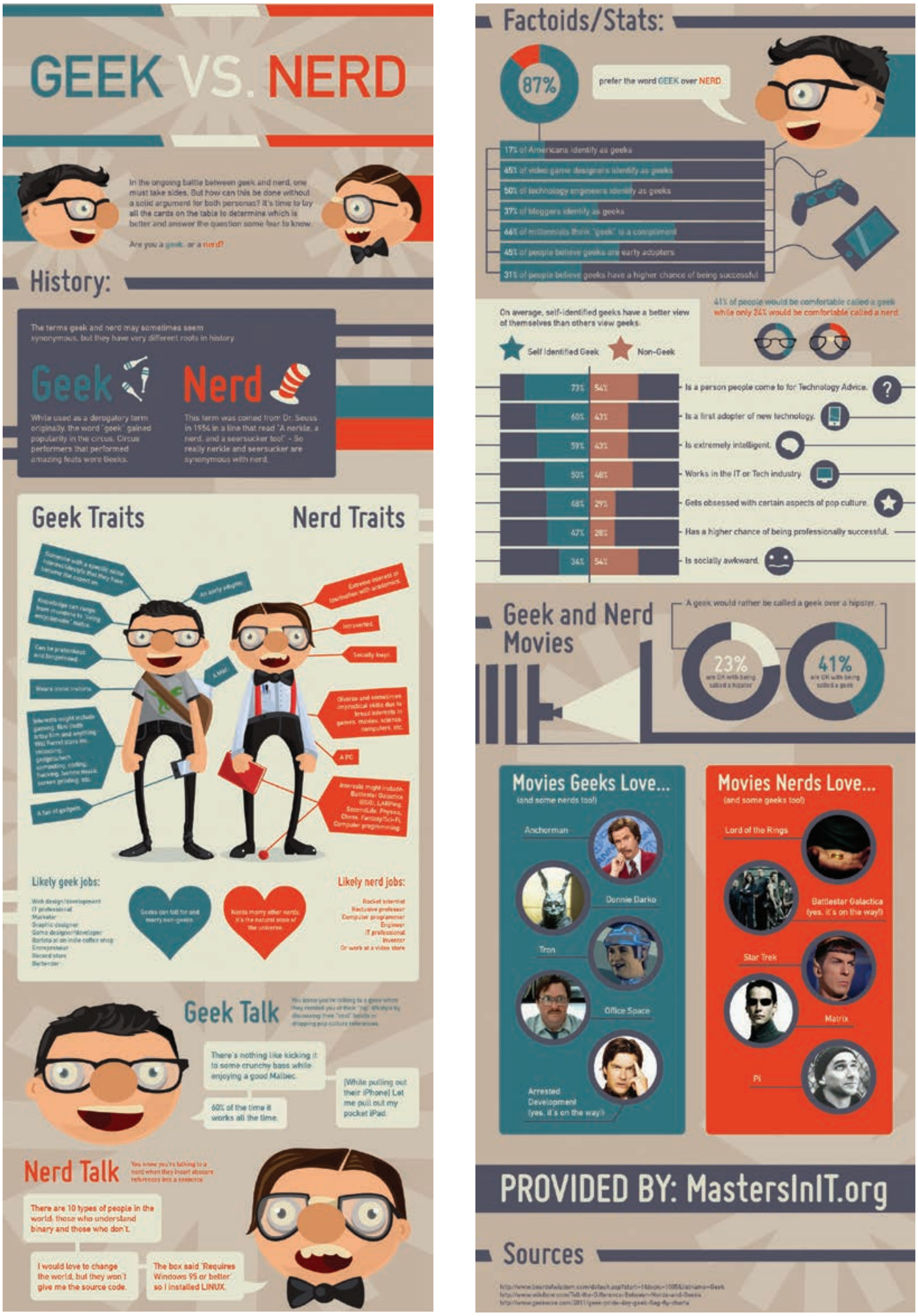
Shows the data charted in an unusual, interesting way that draws the user's eye; countries that are largest have improved access to sanitation; the smaller the country in the chart, the worse their access is

Uses a complementary colour palette of oranges and burnt reds with subtle hints of contrasting blues

Key findings are highlighted. Notice that these are the only two instances where text is bold.

Social media links are included

NelsonNet additional resource: Figure 2.18 Infographic, p. 50




Christian Behrens, The Data Visualisation Catalogue

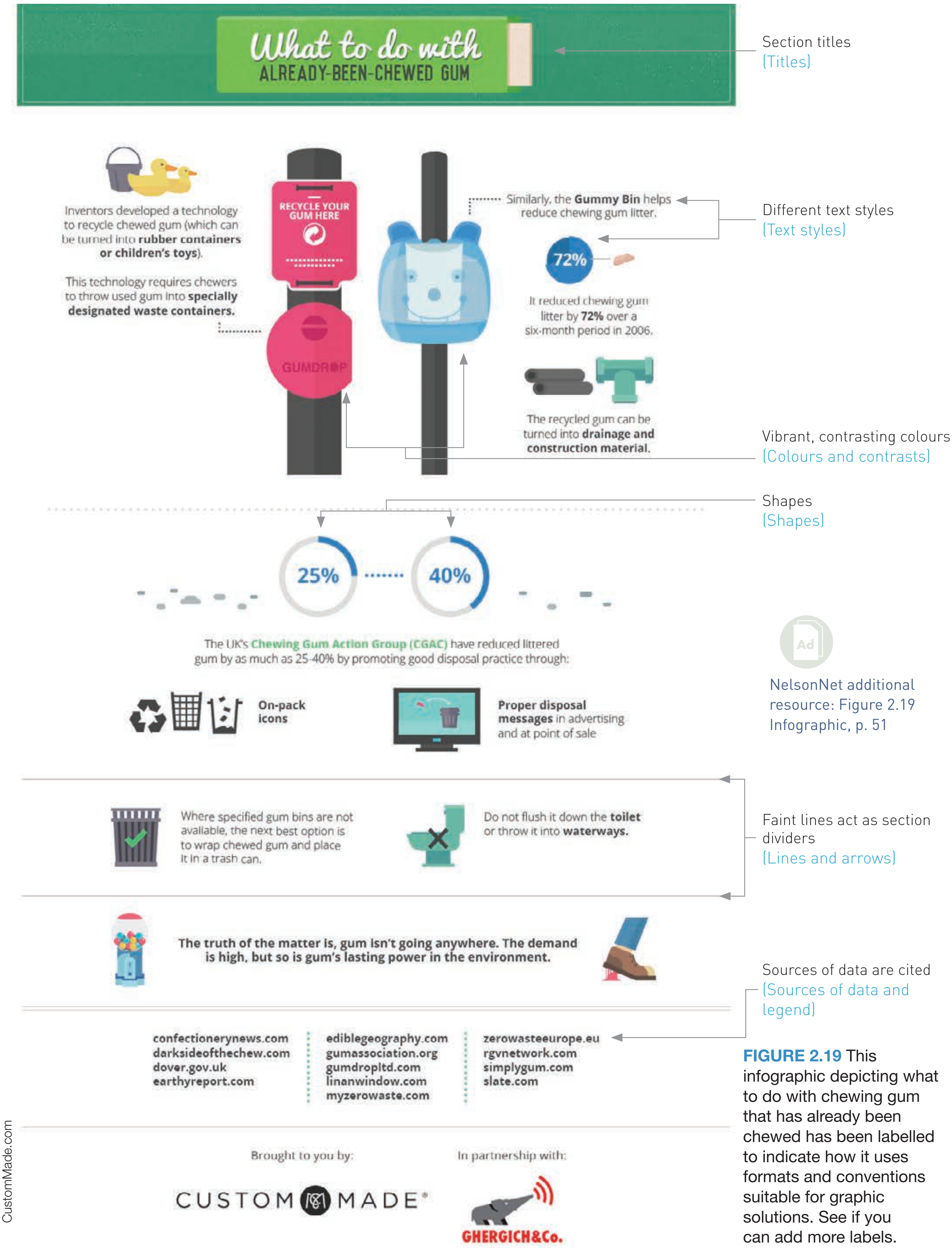
**FIGURE 2.18** Another example of an infographic

**THINK ABOUT COMPUTING 2.2**

1 Annotate Figure 2.18 to identify:

a the specific different types of charts and graphs used

b the general types of graphic solutions used.




CustomMade.com

NelsonNet additional resource: Figure 2.19 Infographic, p. 51

**FIGURE 2.19** This infographic depicting what to do with chewing gum that has already been chewed has been labelled to indicate how it uses formats and conventions suitable for graphic solutions. See if you can add more labels.

# Design principles for graphic solutions

Design principles are guidelines to help you enhance the appearance and functionality of solutions. Graphic solutions that are displayed onscreen need to be easily understood and accessed with minimal time and effort.

To communicate effectively, graphic solutions need to be clear and functional. You need to ensure that facts are obvious and your message is unmistakable. Your solution must be carefully designed, taking the design principles into account.

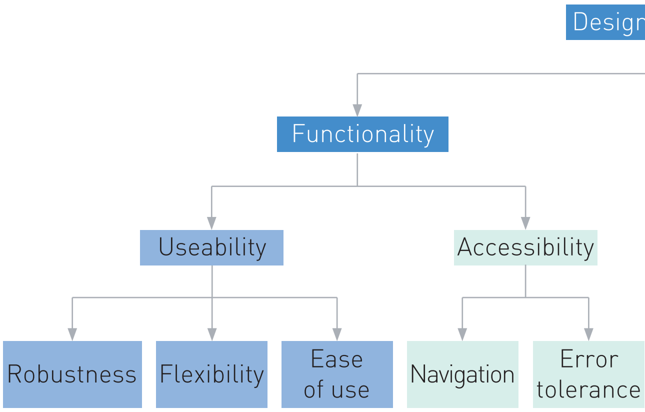



**FIGURE 2.20** Design principles are accepted characteristics that contribute to the functionality and appearance of solutions. For VCE Computing, the principles that relate to functionality are **useability**, **accessibility** and **appearance**.

The principles shown in Figure 2.20 are discussed in the following section, in terms of how they may apply to your solution.

## Functionality

### Useability

All graphic solutions that represent data need to be easy to use, flexible and robust. The user should be able to acquire the required information easily and efficiently. When designing your infographic for useability, consider the following.

- Can the user understand the graphic form and the information it conveys?
- Can the user quickly identify the purpose of the graphic form and interpret its critical data?
- Is the graphic form accurate and a true reflection of the data that has been analysed?
- Have you saved the final infographic in a lossless format to maximise legibility, but in a size that will be quick to load?
- Have you chosen sensible dimensions? For example, you may want to think carefully before designing an infographic that is very narrow, that is very long and requires a great deal of scrolling, or that is wider than most website body panes (around 800px).
- Have you chosen easily readable font sizes?
- Have you tested the infographic in multiple browsers, and also printed it out in colour and greyscale to check that it works?

### Accessibility

A user should be able to access meaning and relevant information from a graphic solution efficiently and easily. Users should not have to puzzle over the meaning or placement of text and symbols used.

To help users along, use simple and relevant labels and commonly understood symbols. For example, use $ to represent money.

When using your graphic solution, users should be able to navigate their way through text and images in a standard way – from top to bottom, or left to right. Use arrows if you literally want their eyes to move  a certain direction.

Do not make anything so small or hard to read that it goes unnoticed. Important facts should be treated with appropriate formats and conventions that highlight why they are crucial.

Essentially, make it easy for users to glean meaning immediately. When you are creating an infographic, it can never be *too* obvious.

# Appearance

## Alignment

Alignment refers to arranging text, images and objects vertically or horizontally in either straight lines or correct relative positions. When using word-processing software, you may have already used text alignment tools, which allow you to justify (align) your text to the left, right or centre of the page. Horizontal alignment can be either left, right, centre or full justified. Full justification refers to the text being aligned on both the left and right margins with spacing distributed evenly across the line to achieve this. Vertical alignment can be top, middle or bottom.

Using alignment cleverly gives your text, images and objects a sense of order and organisation that helps to communicate your message clearly. For example, putting something in the centre of the page vertically and horizontally suggests immediately that it is of central importance. Putting something in a small font size at the bottom right would seem to be of little importance.

Smart use of alignment also helps to imply relationships between different elements of your solution. You will find alignment tools in all graphics software packages.

When planning your solution, manage the elements of your infographic by drawing a visual 'grid' (Figure 2.21). This will help you to work out where you can place items in your infographic, how much space you have, and what kind of alignment works best for each element.

## Repetition

Repetition refers to the use of the same or similar visual elements repeatedly within a graphic solution. It is used to unify elements of a layout, and is achieved by repeating patterns, textures, fonts, colours and page elements. For example, a set of bullet points creates a sense of repetition that connects those points. On a graphic solution, repetition usually means that each section or module uses similar headings, colours, font styles or other visual cues so that it is easier for the user to understand the relationships between elements within the solution.

## Contrast

**Contrast** refers to the visual difference in colour or tone between objects (both text and images) in a graphic solution. Greater contrast will make objects appear to stand out more from one another. If there is not enough contrast between two objects, they may appear to blend into each other, making it difficult for the user to see each of them clearly. Contrast between the background of your graphic solution and text should make the information clearly visible and legible.

The use of white space can enhance contrast around objects within your graphic solution.

## Space

Space refers to the areas around and between objects – text and images. If your graphic solution is cluttered it may be difficult to follow. You may want to include lots of detailed information in

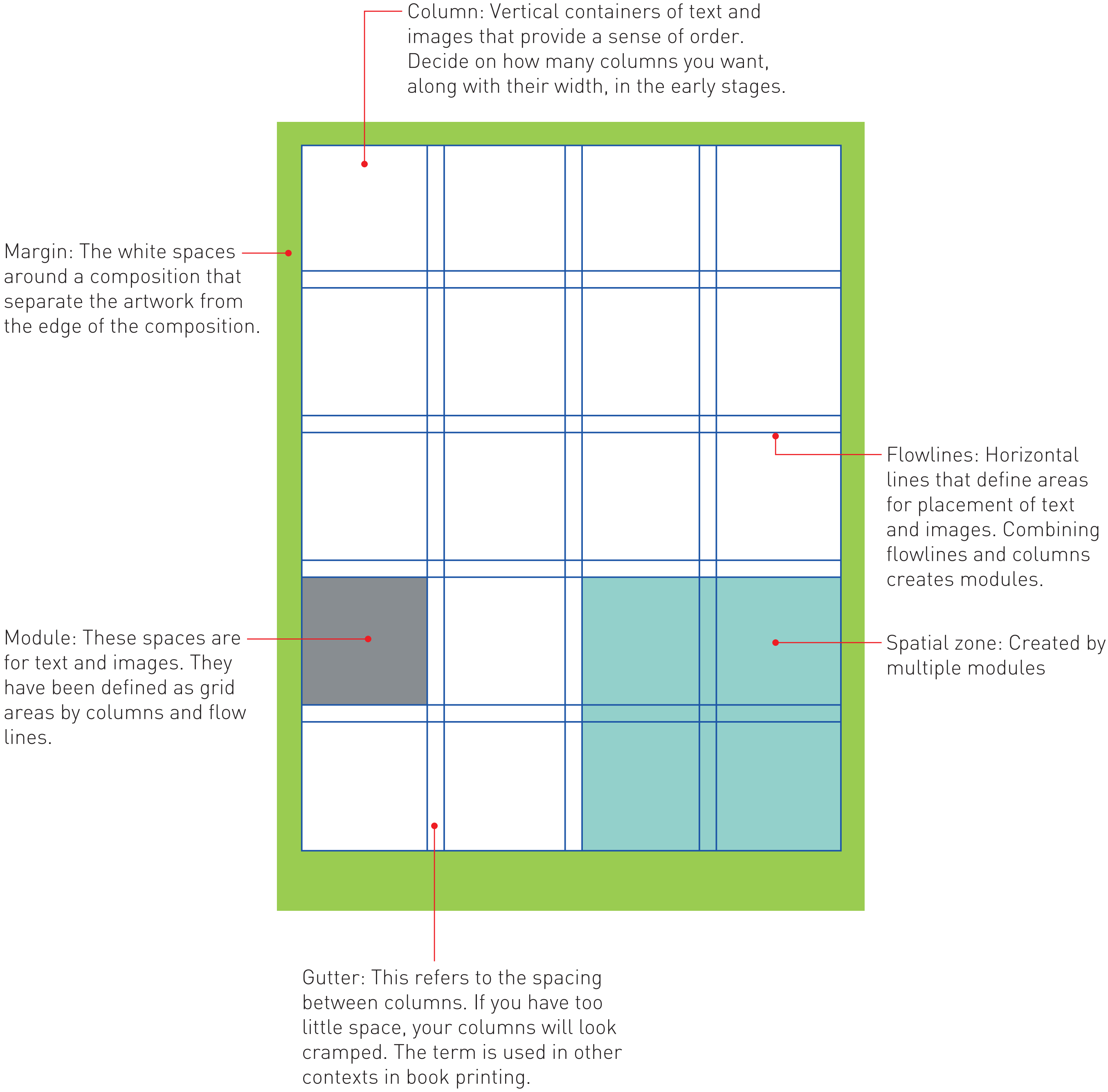


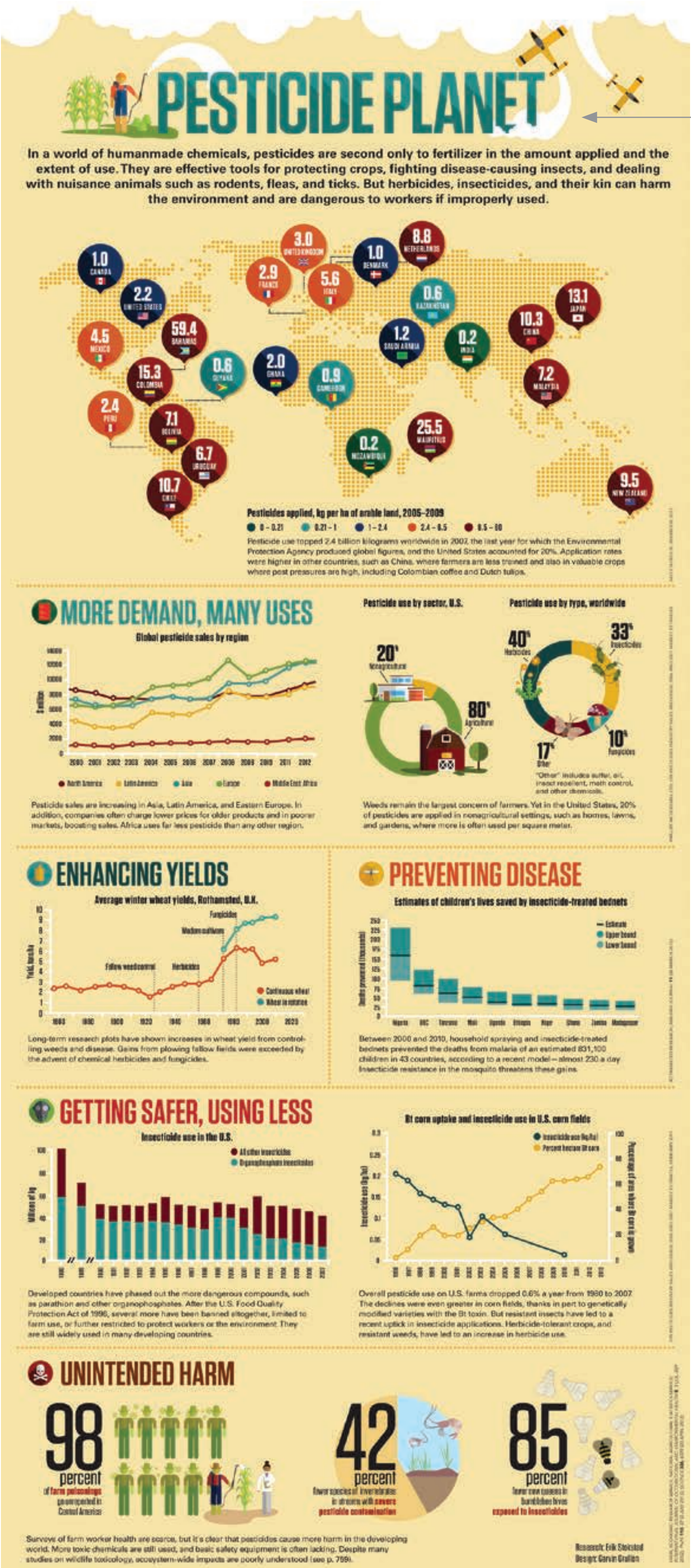

**FIGURE 2.21** The visual grid will not just help you with alignment – it also helps with balance, space and accessibility. A downloadable version of this grid is available on NelsonNet.

NelsonNet additional resource: Visual grid template

your graphic solution, but it is important to put as much space between objects as is necessary for them to be distinguished as separate and navigated through in the correct order. That means that if you arrange your space carefully and correctly, it will control user behaviour.

In theory it may sound very trying, but you are mostly going to be using areas of space that are only between a few millimetres and a few centimetres. A visual grid will be of use.

A large area of **white space** may be used to balance a section that contains an equally large area of text, because it will be of equal visual 'weight'. Working with space means also working with balance.




'Pesticide Planet' by G. Grullón/Science, Science 16 August 2013: Vol. 341 no. 6147 pp. 730-731 DOI: 10.1126/science.341.6147.730. Reprinted with permission from AAAS

**Succinctness**
This infographic tries to convey data and information about a specific topic and problem. It visually displays the research concisely without too much extra information.

**Orientation**
Orientation refers to the direction and aspect of elements within a graphic solution. When designing your graphic solution, you must consider all elements with regard to the visual hierarchy of various objects. It is important to keep in mind the aspect of each object in relation to other objects and to the graphic form overall. When deciding on the orientation of objects, you should consider the direction of data labels (particularly if there are too many to fit horizontally), the alignment of data labels and text, and whether the title will appear above or below the graphic form.

NelsonNet additional resource: Figure 2.20 Infographic, p. 55

**FIGURE 2.22** 'Pesticide Planet' is the title for an infographic created by http://www.sciencemag.org/.

**THINK ABOUT COMPUTING 2.3**

Annotate the Sanitation in Africa infographic, Figure 2.17 on page 49, to show how it applies the appearance design principles.

### Balance

A balanced solution will appear harmonious, and this creates visual appeal. Whether you understand or recognise it, you already like to see balanced designs. Do you ever straighten something that is crooked? Do you try to divide things into even pieces because somehow it just seems appropriate?

Unbalanced designs can lack the appropriate emphasis, can look untidy and they may end up discouraging users from viewing them.

In symmetrical balance, an object mirrors the elements on opposite sides of the visual axis, from one side to the other – you see the same amount of white space on the left side as on the right, for example. A person's left hand exactly mirrors their right hand.

Being balanced is not always about being symmetrical – using asymmetrical balance is also an option! This is characterised by an arrangement of elements that is not mirror or equal in appearance, but still uses the central visual axis.

Whether you experiment with asymmetrical balance or stick to symmetrical balance, both left-right balance and top-bottom balance are equally important, so use balance and alignment together when placing objects in your graphic solution.

## Formats and conventions

In addition to the basic design principles you should follow when creating your graphic solution, there are a number of useful formats and **conventions** suitable for graphic solutions, such as titles, text styles, shapes, lines and arrows, sources of data and legend, and colours and contrasts.

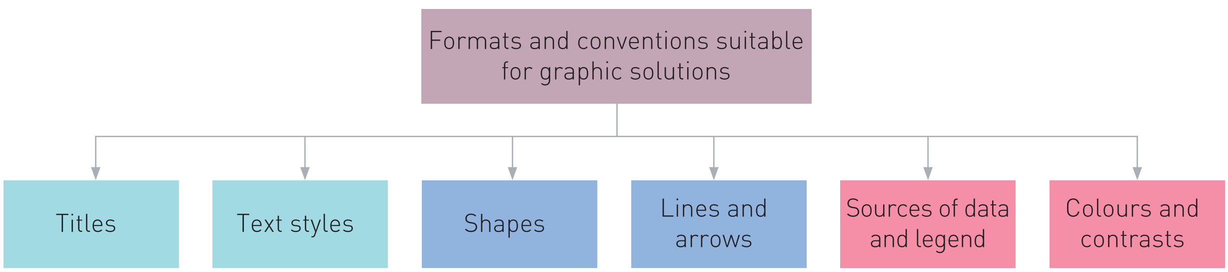



**FIGURE 2.23** Formats and conventions

### Titles

In the simplest of terms, adding a title to a document makes it a dominant element. Titles are generally styled as headings, with type that is bold and larger than the body text or subheadings. Titles make an impression. Titles should be concise, to-the-point and easy to say. Your title should be in larger text than the rest of your solution – perhaps at least 20pt if the body text is 10pt.

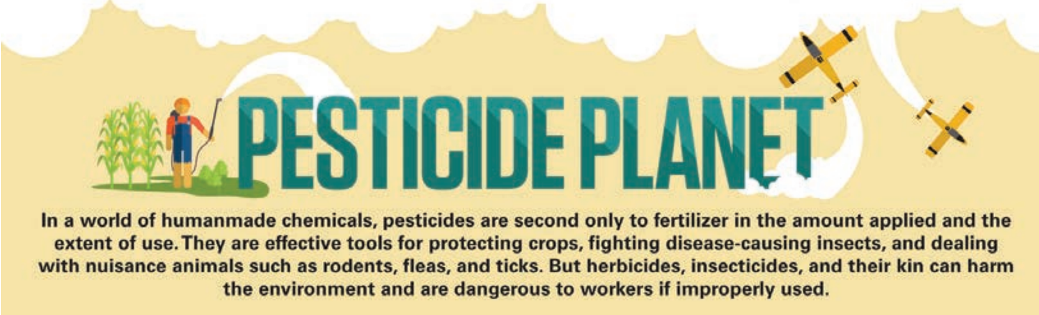





**FIGURE 2.24** 'Pesticide Planet' has a large, visually interesting title.

## Text styles

When we discuss text styles, we are essentially talking about fonts. A font is a typeface (such as Times New Roman, Arial or Calibri) plus its attributes (20pt, bold, red). You may already know a few standard, familiar typefaces, such as:

- Times New Roman, a serif typeface. Serif typefaces have tiny marks or 'tails' on the end of the horizontal and vertical strokes of each letter. Serifs are used in books for body text and especially for long passages of text.
- Arial, a sans serif typeface. Sans serifs do not have the serifs on the strokes of each letter. They work best for short paragraphs, large headings and online, but not for long passages of printed text.
- Courier New, a slab serif typeface, is often used in programming. Slab serifs are best used when the focus is on function and not appearance. Slab serif fonts ensure your characters are legible and unmistakable.

When you are choosing text styles for your graphic solution, keep things simple. Use a few well-chosen typefaces, perhaps three at most, and use bold, italic, colour and point size to set out heading levels and distinguish between different types of text.

There are other typeface styles, such as handwriting, script and decorative. You will know decorative fonts such as **Impact** because it is the typeface predominantly used in memes online. *Comic Sans*, a casual script or handwriting typeface, is also well known.

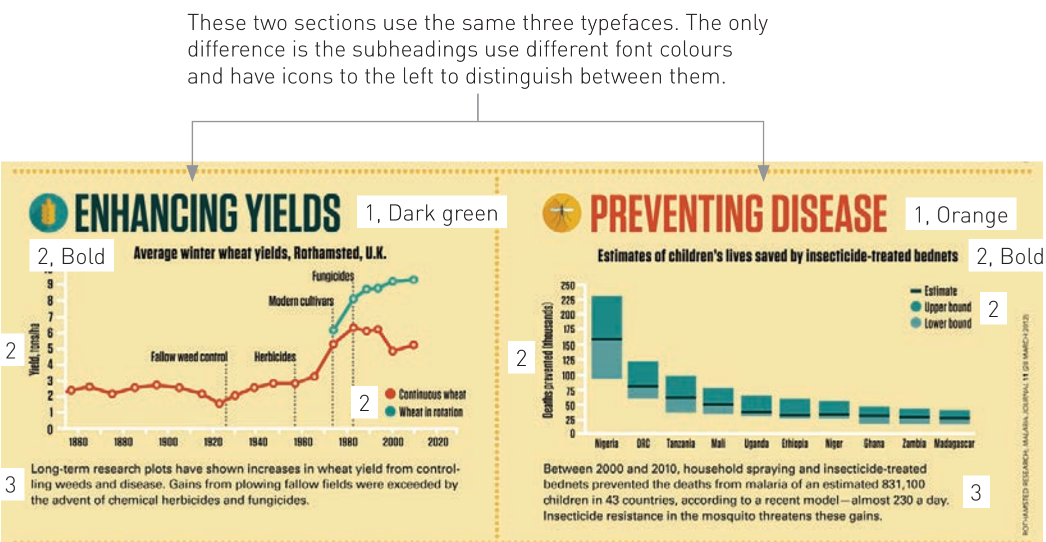



**FIGURE 2.25** Subtle changes make a difference in Pesticide Planet

Text styles will apply some contrast while promoting a streamlined, professional appearance. However, using many different typefaces in one space can be untidy and overwhelming.

Remember: less is still more – bigger is not always better. Really think about what needs to be emphasised the most and what needs to be highlighted. Not everything needs to be bold, italic and 40pt.

## Shapes

Using shapes in your solution can help to create patterns, contrast, hierarchies and backgrounds. You can use shapes as containers for sections of text in your graphic solution, and as dividers.

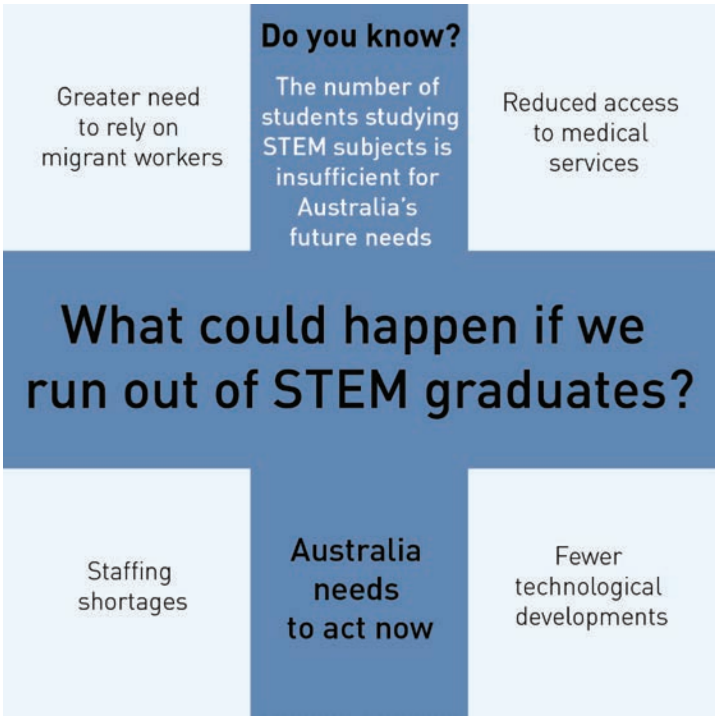



**FIGURE 2.26** The cross shape here acts as a divider and container

You do not have to stick to standard, two-dimensional geometric shapes such as squares, circles, rectangles and triangles. Other types of shapes, such as irregular, abstract and freeform shapes can evoke reactions in the user. You can also use shapes to develop logos, symbols and icons.

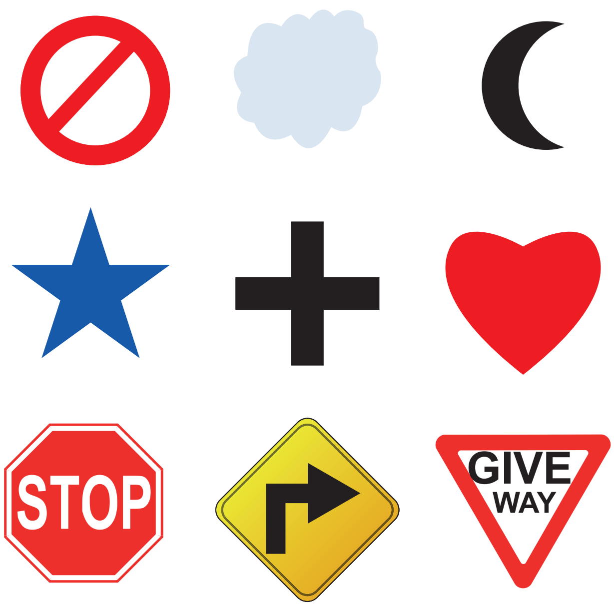



**FIGURE 2.27** These familiar shapes may not be what you immediately think of when shapes come to mind, but they may still evoke strong reactions that could make them powerful in your graphic solution.

**THINK ABOUT COMPUTING 2.4**

1. Make a list of what you immediately associate with each of the shapes in Figure 2.27.
2. Compare your list with another of your classmates. How much do they overlap?

## Lines and arrows

A line is a versatile visual element that uses only length and width. Lines can be:

| | |
|---|---|
| Solid | |
| Dashed | |
| Dotted | |
| Broken | |
| Double | |
| Thick | |
| Thin | |
| Curved | |
| Freeform | |

- Bold or thick lines work well for emphasis and for representing a structure within a space. The thicker the line, the more it will draw the eye to the space, but the more crowded and boxed in it will look, so use a thick line carefully.
- Light and fine lines can suggest technical details but also retain a sense of minimalism.

Line thicknesses you might use range from:

0.25pt
0.5pt
0.75pt
1pt
1.25pt
1.5pt
1.75pt
2pt

You can use lines in your graphic solution as borders or containers for sections of text or images.

The 'Pesticide Planet' infographic uses dotted lines as dividers, but also as a form of repetition from the maps at the top. By using lightly coloured lines that are similar to the background colour, and dots rather than solid lines, the infographic allows the user to read the infographic in the correct order and tell sections apart, but without a sense of crowding that solid or darker coloured lines could have created.


'Pesticide Planet' by G. Grullón/ Science, Science 16 August 2013: Vol. 341 no. 6147 pp. 730-731 DOI: 10.1126/science.341.6147.730. Reprinted with permission from AAAS

You can also use arrows as pointers in your graphic solutions. There are a variety of arrows and arrowheads to choose from:

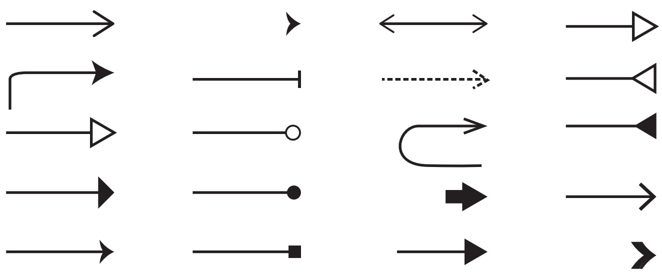


FIGURE 2.28 Popular arrows and arrowheads

Some arrows are sophisticated and elegant, while others are basic. The colour of your lines plus the colour of your arrow and choice of arrowhead can make a difference in the overall appearance of your diagrams.

## Sources of data and legend

If you are using data in your graphic solution you need to identify the source in an appropriate way. If you are designing an infographic for your solution you could include a list of all of your sources in the footer of the infographic, similar to 'What is an infographic?' on page 48.

SOURCES
http://www.seohatch.com/what-the-heck-is-an-infographic/
http://communicationnation.blogspot.com/2007/04/what-is-infographic.html
http://www.pr2020.com/blog/the-case-for-content-marketing
http://www.seohatch.com/what-the-heck-is-an-infographic/
http://www.seomoz.org/ugc/7-steps-to-make-your-infographic-a-success
http://digitalmarketinginstitute.co.uk/resources/create-a-viral-infographic/
http://www.pr2020.com/blog/the-case-for-content-marketing
http://www.quora.com/How-do-you-measure-an-infographics-success
http://digitalmarketinginstitute.co.uk/resources/create-a-viral-infographic/
http://www.techshortly.com/2012/03/infographic-what-happens-every-day-in.html
http://www.mediabistro.com/alltwitter/the-life-of-a-hashtag-on-twitter-infographic_b19427
http://www.seoworkers.com/seo-articles-tutorials/search-engine-optimization.html
http://searchenginewatch.com/article/2049695/Top-Google-Result-Gets-36.4-of-Clicks-Study

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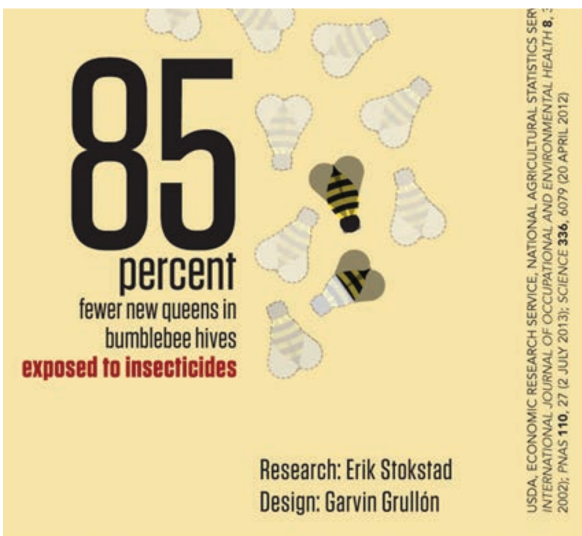
Alternatively, you could cite your source when it is used, similar to 'Pesticide Planet'. Note that 'Pesticide Planet' runs the source vertically up the side of the infographic:



9780170364744 

Citing information resources is a must when working with infographics because the data behind them is research-based. Citing sources also provides those who view the infographic the opportunity to further research the topic.

Make sure you cite all of your sources correctly. Include the name of the source, the author, the URL (if applicable), the page number, the date, the publisher and any other relevant information.

You should also make use of legends in your graphic solution when needed to identify the facts shown in charts or graphs clearly. In general, a legend or key explains the symbols used in a chart, diagram, map or table. In terms of your graphic solution, a legend will mostly be used as a patterned marker with blocks of colour that represent different groups of data in a chart.

'Pesticide Planet' includes multiple colour-coded legends – one for each 'module' that has a chart. The legends in 'Pesticide Planet' make it easy to understand what the data stands for and thus what each chart means, which is why legends are so useful. If you do not include a legend for a chart with a complex idea, the user may become confused about what is being shown on each axis and interpret your chart incorrectly. You can design them to take up very little space, as shown below.

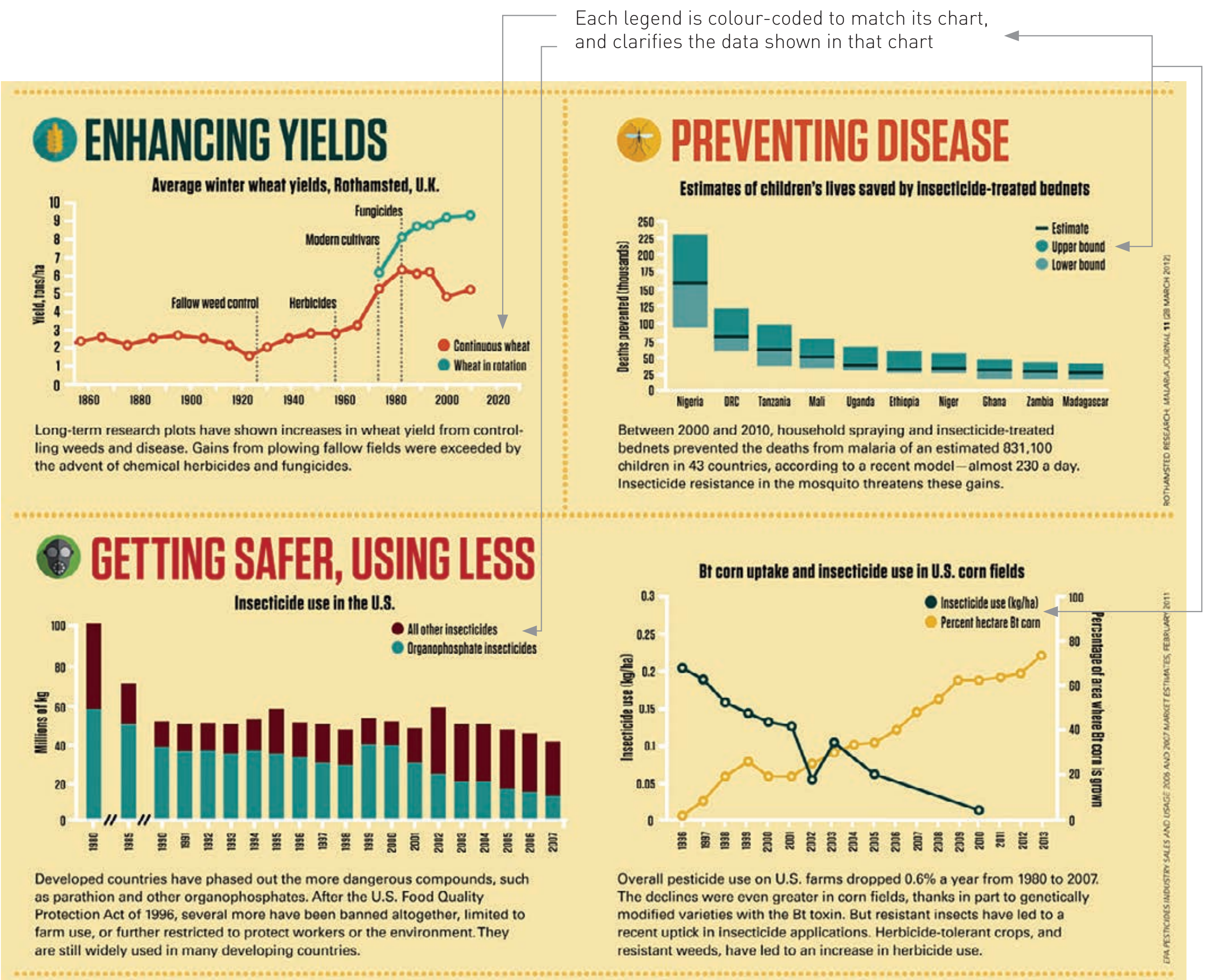



**FIGURE 2.29** Legends in 'Pesticide Planet'

'Pesticide Planet' by G. Grullón/Science, Science 16 August 2013: Vol. 341 no. 6147 pp. 730-731 DOI: 10.1126/science.341.6147.730. Reprinted with permission from AAAS

## Colours and contrasts

Colour should be used so that it makes the information clear, readable and attractive. The colours should emphasise important features, and a colour scheme should be used to ensure consistency. The following conventions for onscreen colour can be useful in determining colour schemes.

The most easily readable colours for text are black writing on a white background. Avoid using red and green together because people who are colourblind have difficulty distinguishing between them. Blue and brown together can also be difficult to read.

Light shades are best used for backgrounds. Avoid using yellow or other light colours for text on a white background.

Avoid using bright, neon or vivid colours, except where you wish to highlight an object or piece of information.

Limit the number of different colours used in your graphic solution.

As discussed on page 53, contrast refers to the visual difference in colour or tone between objects in a graphic solution. Greater contrast will make objects appear to stand out more from one another. If there is not enough contrast between two objects, they may appear to blend into each other, making it difficult for the user to see each of them clearly. Contrast between the background of the graphic representation and text should make the information clearly visible and legible. The use of white space can enhance the contrast around objects within the graphic representation.

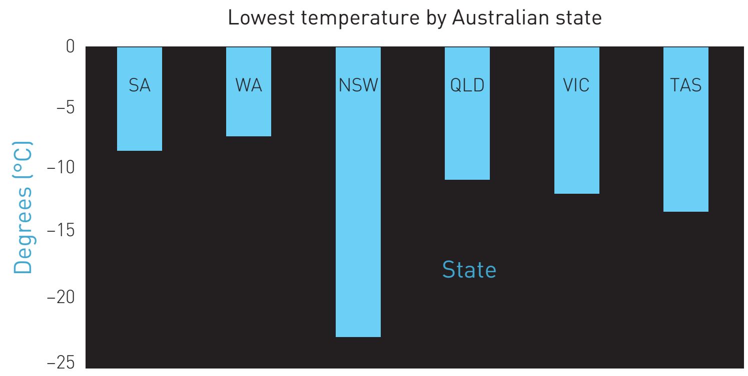



**FIGURE 2.29** This graph shows use of clear contrast.

### FORMATS AND CONVENTIONS

1 Identify the infographic in this chapter that you think has the most effective **title** and justify your choice.

2 a Identify the infographic in this chapter that you think uses **text styles** most effectively and justify your choice using examples.

  b Which, if any, of the infographics in this chapter could be improved by more effective use of text styles? Suggest how improvements could be achieved making reference to point sizes, typefaces, bold/italic, and so on.

3 a Identify the infographic in this chapter that you think uses **shapes** most effectively. Justify your choice using examples.

  b Which, if any, of the infographics in this chapter could improve upon their use of shapes? Justify your choice and suggest how to achieve this by hand drawing or mocking up the infographic with the new shapes that could be used.

4 Other than Pesticide Planet, identify the infographic in this chapter that you think uses lines and arrows most effectively. Justify your choice and outline the types of **lines and arrows** used, with reference to thicknesses and arrowheads.

5 Describe how the **sources of data and legend** shown in the different infographics in this chapter differ from the citation methods described in Chapter 1. Explain the correct way to cite your sources in your own work.

6 Identify the infographic in this chapter that you think uses **colours and contrasts** least effectively. Justify your choice and suggest ways to improve the colour palette.

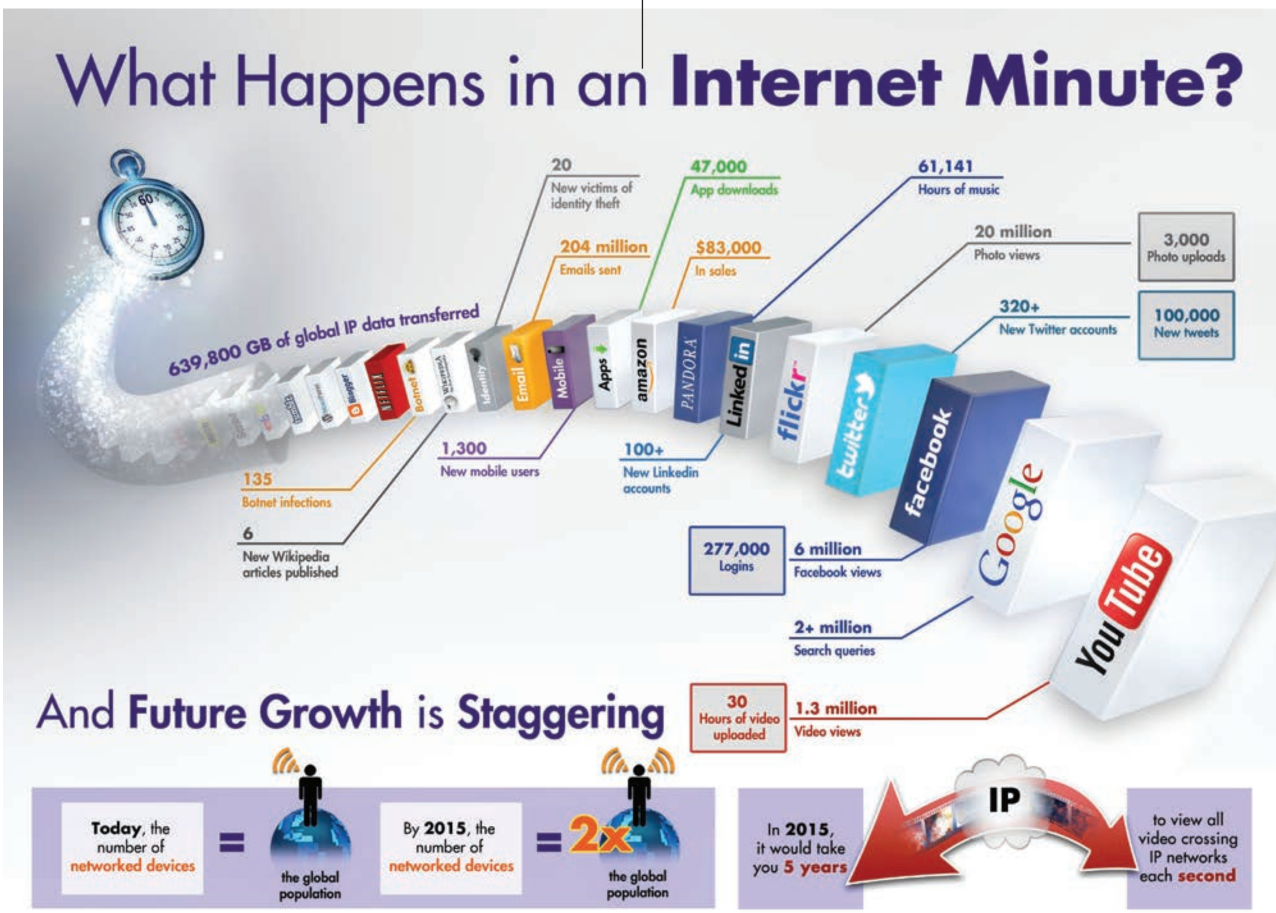
**THINK ABOUT COMPUTING 2.5**

Annotate 'What Happens in an Internet Minute' by identifying formats and conventions used. Identify one type of each of the following formats and conventions: titles, text styles, shapes, lines and arrows, and colours and contrasts.

**Visualisation**

Infographics should not be text-laden. Lengthy text can take longer to digest, while there is some immediacy with images. By using a variety of tools such as shapes, charts, icons and diagrams, you can can assist readers with visualising the data. Given that the purpose of an infographic is to provide information in a visual format, using visual cues will assist the reader with interpreting the infographic.

NelsonNet additional resource: Figure 2.31 Infographic, p. 63



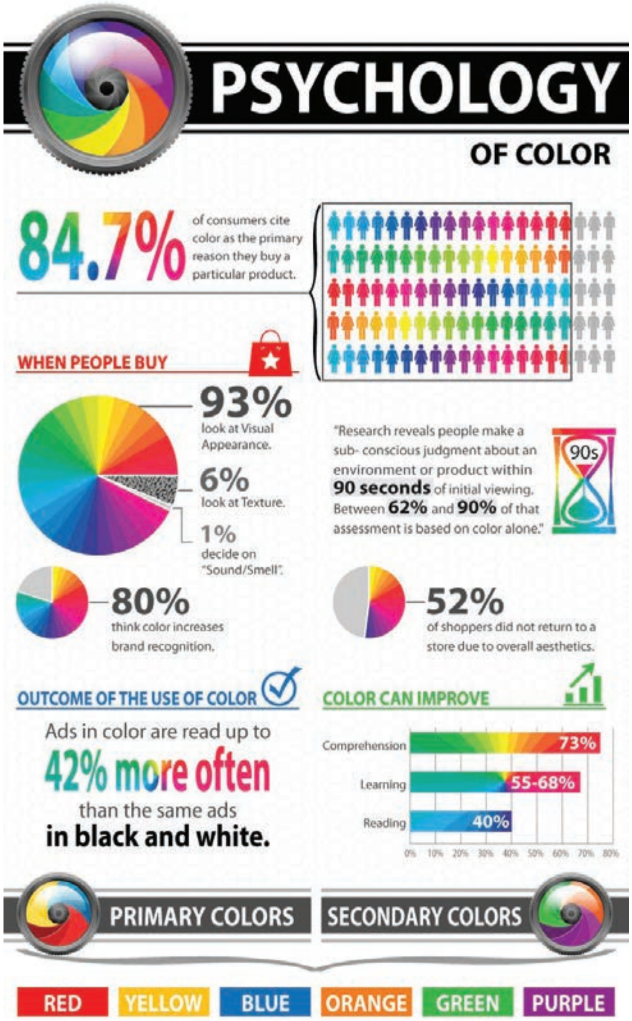

The Intel Free Press

FIGURE 2.31 A creatively drawn infographic using colour, shapes, icons, lines and arrows, graphics and illustrations, with minimal text.

**THINK ABOUT COMPUTING 2.6**

Annotate two of the psychology of colour infographics: one for design principles (discussed in Figure 2.20), and one for formats and conventions (discussed in Figure 2.23).

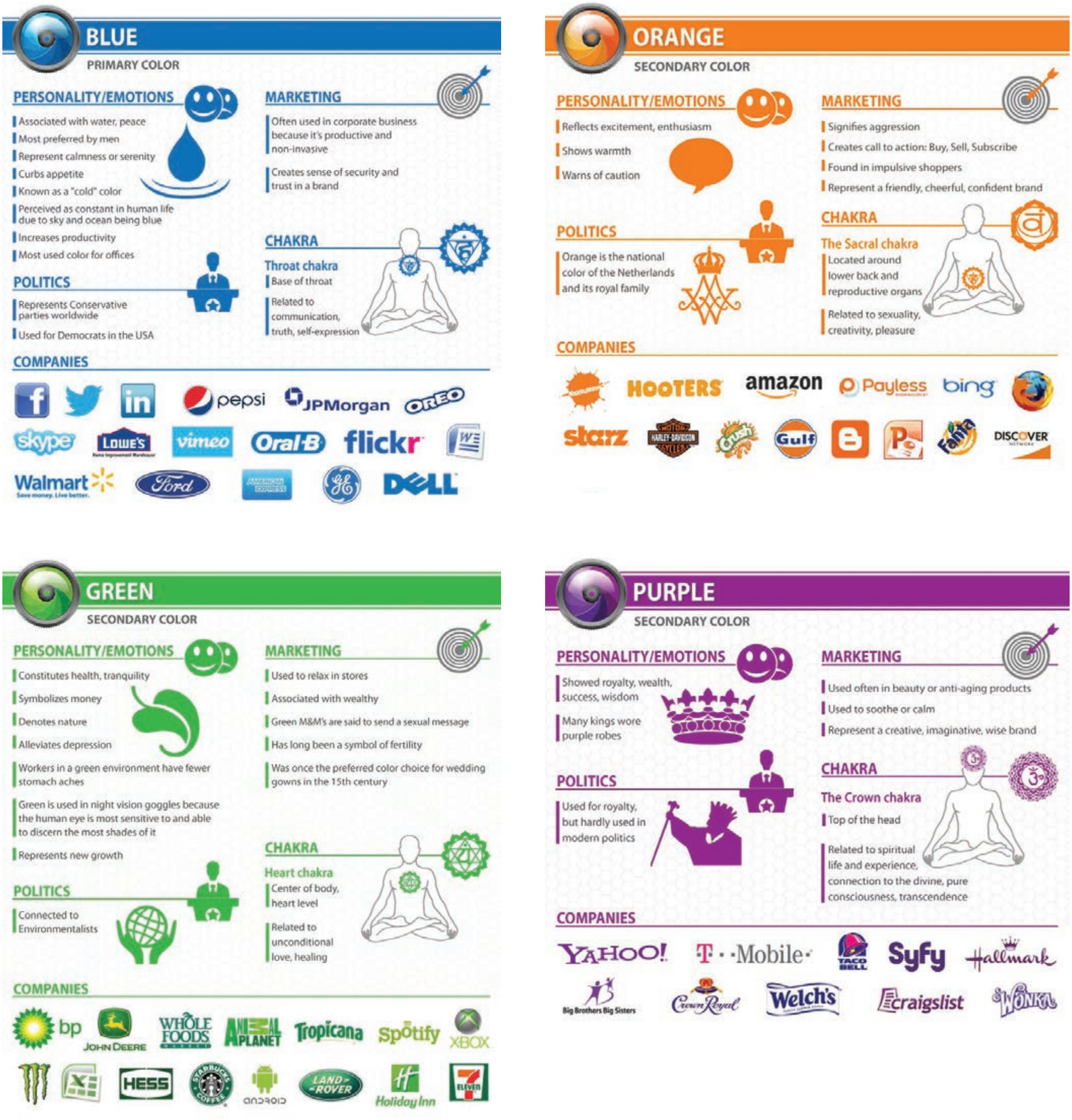
NelsonNet additional resource: Figure 2.32 Infographic, pp. 64–5





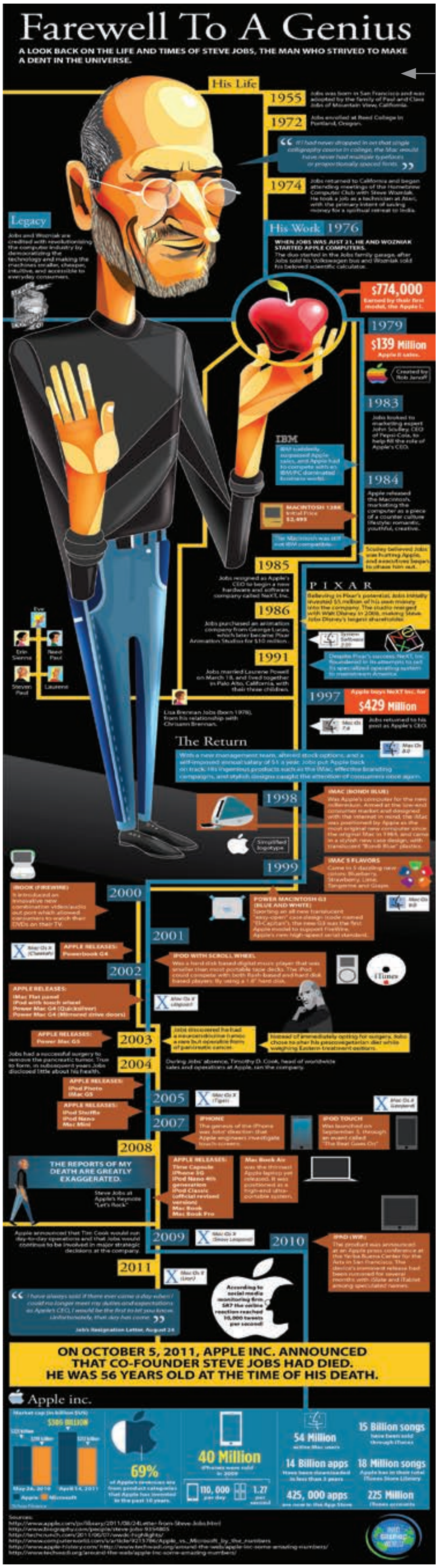
WebpageFX

**FIGURE 2.32** The psychology of colour




WebpageFX

**FIGURE 2.32** *Continues*




Info Graphic World

**FIGURE 2.33** Sources are listed at the bottom of the infographic, making them unreadable in printed form.

### Proportion

A hierarchy is an arrangement of items in which each is ranked above, below or at the same level as another to show their importance. Proportion refers to the visual hierarchy of objects within a graphic representation. The proportions (or relative sizing) of objects affect the visual hierarchy of the graphic solution. This infographic does not function unless it is viewed entirely on-screen and can be zoomed in to 100% because of its unusual proportions.

# Design tools

Design tools are used to represent the functionality and appearance of graphic solutions; normally, the solution is first sketched on paper. Several design tools can be used to represent the design of graphic solutions; however, **annotated diagrams** are the most apt for planning a solution and presenting it.

Software such as spreadsheets can assist with the manipulation of data to develop graphs and charts. Spreadsheets include functions that enable users to work quickly and with less effort, thereby minimising cost.

Spreadsheet functions and design capabilities are discussed on page 31.

A wide range of design tools can be used to design the appearance of a graphic solution. They include:

- **input–process–output (IPO) charts**
- annotated diagrams or mock ups.

## IPO chart

An IPO chart (Table 2.9) is used during the design stage to clearly identify the solution's input and output, and the processing steps required to transform the data into information. By completing an IPO chart, the developer gets a sense of how much formula development work might occur during the manipulation stage of the project. An IPO chart can be used to show how data is processed into meaningful information. An IPO chart, also called a 'defining diagram', identifies what data is required for the solution (input), what information the solution needs to produce (output), and the processing manipulation activities required to transform the data into information, or the function of the solution. In the case of creating a graphical solution, the input requires an understanding of what data is needed and where it is coming from, the process focuses on the functionality of the solution and the output refers to the graphical solution that is being created.

NelsonNet additional resource: Figure 2.33 Infographic, p. 66

**TABLE 2.9** An example of an IPO chart for investigation into whether the number of students undertaking STEM subjects is sufficient for Australia's future needs.

| Input (data) | Processing (calculations) | Output (information) |
|---|---|---|
| Selection of year level of participant (i.e. Year 11 or Year 12) | Tally the results in each category | Aggregate total of each category |
| Selection of STEM subject studied (ie Foundation Maths, Further Maths etc) | Tally the results in each category | Aggregate total of each category |
| Identification of factors to experiencing success STEM is selected | Tally the results in each category | Aggregate total of each category |
| Identification of influence on decision to pursue STEM subjects | Tally the results in each category | Aggregate total of each category |
| Selection of reasons for pursuing a STEM career | Tally the results in each category | Aggregate total of each category |

## Annotated diagrams and mock ups

Annotated diagrams provide a visual depiction of how graphic solutions should look (Figure 2.34).

The designs indicate features such as differences in font size, colour and positioning of objects. The placement of objects must be planned so that a balanced, visually appealing and clear effect is attained.

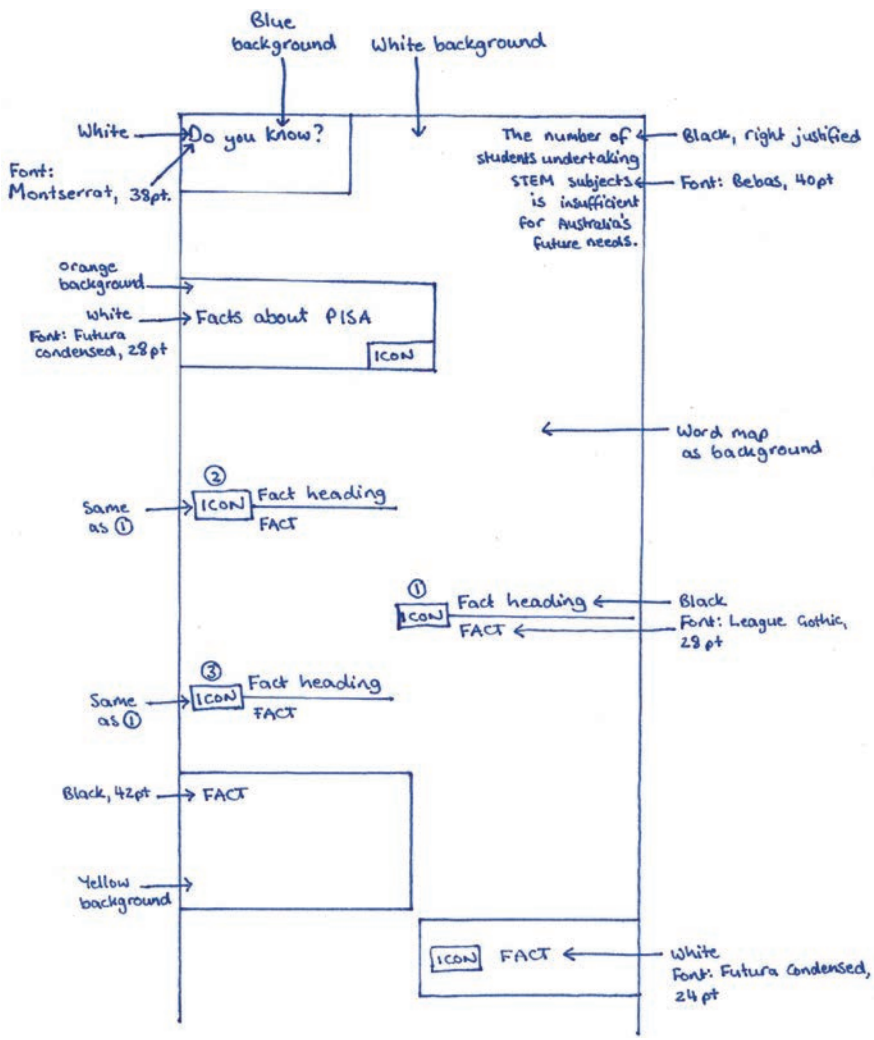



**FIGURE 2.34** An example of an annotated diagram for the STEM infographic

**THINK ABOUT COMPUTING 2.7**

1. Hand draw one of the infographics from this chapter as an annotated diagram similar to Figure 2.34. (You will not be able to identify specific typefaces when you do this.)
2. Hand draw Figure 2.21 from page 54. Try to use it to identify modules, flowlines, columns and gutters in the infographic you have hand drawn.
3. Label the columns, gutters, margins and flowlines on the hand drawn infographic.

The annotated diagram should clearly indicate:

- the shape of graphic solutions
- titles and layout of the diagram
- formats and conventions that are used in graphic solutions.

Before using an annotated diagram, you should consider the data set that will be used as the basis of the graphic solution. The amount and type of data, and purpose for developing a graphic solution of the data will help you decide on the type of graphic solution to create.

# Types of tests

It is important to check that what you are trying to produce meets the specified need and fulfils the specified purpose. The **effectiveness** of a solution is determined by its quality. A solution is effective if it is complete, readable, attractive, clear, accurate, accessible, timely, relevant and usable; and if it communicates the message. Each of these attributes needs to be tested once the solution has been built.

## Validation versus testing

Validation is involved with input, while testing is concerned with the solution itself, or output. **Testing** can, however, also involve ensuring that **electronic validation** works correctly. In the design stage you need to plan the testing that you will conduct after the development stage. Therefore, after the designs for the graphical solution have been created, we make the test plan or test table. Testing and validation serve different purposes. Testing is performed to ensure that processes, functions and formulas in a solution work as expected. Validation checks that input data is appropriate and reasonable.

## Completeness testing

A solution is considered incomplete if the intended user has to find additional information. A graphic solution that does not provide sufficient information will not fulfil its purpose. To check the completeness of a graphic representation, the developer should consider the following.

- Does the graphic representation provide the information required?
- Is the graphic representation clearly and accurately labelled?
- Will the intended users easily find what they need?

## Reliability testing

The digital revolution has opened up limitless ways in which information can be communicated, and access to this information is becoming easier and cheaper. But is all of the information reliable? For many different reasons, the data and information presented to us may be untrustworthy. To determine the reliability of data, the reliability of the source should be checked. One way in which the information given in a solution can be verified is to confirm the information from more than one source. Unreliable graphic solutions can cause confusion and information about a particular topic.

## Presentation testing

During the design phase of the problem-solving methodology a decision must be made on the appropriate format of the solution; for example, how a solution should be communicated. It is important to consider its overall look and format. The solution must be attractive and clear. One of the most important considerations should be the intended audience and intended purpose.

Some of the formats and conventions suitable for a graphic solution that can be tested are:

- appropriate use of white space and fonts
- the use of consistent font styles and sizes
- readability – that the information presented is easy to read and can be understood by the intended audience
- consistent and appropriate use of colour and contrast
- careful choice of background colours (generally they should be white or grey)
- consistent use of a colour scheme (perhaps matching the corporate colours or image of the client)
- easy-to-read charts and labels
- adherence to the formats and conventions discussed earlier in the chapter.

No matter what format is chosen, the presentation of the solution can be a difficult attribute to test. What looks good to one person may appear ugly to someone else.

## Functionality testing

The functionality of a solution relates to its ability to perform tasks and functions. If a solution is deemed functional, it will provide accurate output that is reliable.

When testing the function of a graphic solution, it is prudent to test that the representation accurately depicts the data as it was meant to. A useful way to organise this testing is to develop a test plan.

A test plan is a method for recording the tests to be executed and the results of the tests. Usually, it includes the type of test, what test data will be used, what results are expected and the end results (Table 2.10).

When constructing your test table, take your time. Complete it while developing your solution, using any mistakes you make as a basis for good testing.

**TABLE 2.10** A test table

| Feature tested | Test/sample data | Expected result and why | Actual result |
|---|---|---|---|
| | | | |
| | | | |
| | | | |

## Relevance testing

Relevance describes how applicable a solution is to its intended purpose and its intended audience. A solution that lacks relevance can be misleading and uninteresting. A question to consider in checking the relevance of a solution is: 'Does the infographic match the user's search for information?'

## Communication of message

All of the required information presented in a solution must be clear and obvious. For instance, a graphic representation that is meant to show the unemployment rates in Australia over the last ten years must convey the trend and the figures plainly, without the user getting lost among other insignificant or irrelevant information.

## Questions to ask

To test the quality of onscreen information that is represented in graphic form specifically, ask the following questions.

- Does the graphic representation depict the information required and fulfil its intended purpose?
- Is the overall look and tone of the graphic representation appropriate to its intended audience?
- Is the graphic representation accurate? That is, has the data source been validated and verified?
- Is the type of graphic representation the most appropriate type for the data?
- Is there anything that is misleading, confusing or unclear?
- Are the axes correct?
- Are there any unnecessary elements or information in the graphic representation?
- Is the numerical scale of the value axis identified (for example, thousands or millions)?
- If the chart uses two value axes, can the audience easily identify the appropriate axis for each series?
- If more than one chart is being developed for the same solution, are the charts consistently formatted and presented?
- Is all of the text readable?
- Can any of the information presented be further summarised?
- Are font styles, sizes and colours consistent?
- Is all text spelled correctly?

# Validation

To make the solution accurate and reasonable, all data that is used should be validated. This means that the original data should be manually checked for illegal data types, for reasonableness, for correct spelling, to ensure that data fall within a correct 'range' or that any codes that are used are consistent (follow similar style) and reasonable (similar codes relate to similar products). Although **validation** is actually used when entering data during the development stage, it needs to be planned for in the design stage.

It is easy for data entry errors to occur during the input phase, particularly if a large amount of data is involved. Data should therefore always be validated before any processing occurs.

There are two types of **validation**: manual and **electronic validation**.

**Manual validation** occurs when the data entered are checked for accuracy by a person rather than by a machine. Proofreading is one manual validation technique. When you proofread data, you look for transcription errors. The data entered should be compared with the source document to ensure that they match. Any differences observed must be followed up.

Data may be validated by computer if a validation function is contained in the software or built into the solution to a problem. Electronic validation techniques, sometimes called machine-validation techniques, ensure the accuracy of data and are built into software, such as spell checkers. Types of electronic validation include range checking, existence checking and data type checking.

# Manipulating data to create solutions

The development stage of a problem-solving methodology involves using the appropriate software to create the solution. This is the stage at which the data (in this case, numbers, text and audio data from interviews) becomes information. Manipulation occurs when the data is transformed into information; that is, it is the process of making sense of the data. Before computers existed, manipulation took place by hand and was subject to human error and interpretation. With the aid of computers, however, data manipulation now requires far less effort. The nature of the manipulation usually depends on the software being used to create the infographic.

## CASE STUDY THE NUMBER OF STUDENTS UNDERTAKING STEM SUBJECTS IS INSUFFICIENT FOR AUSTRALIA'S FUTURE NEEDS

Questionnaires are often left open for a finite amount of time to ensure that as many participants have the opportunity to respond. Once the questionnaire has closed, data can then be manipulated to assist with the development of the solution. Software packages such as Opinio (online survey) can assist with filtering data to create totals of categories found in the survey. For example, you may want to find out the number of Year 12 students studying Informatics. To do this, you need to filter the remaining data to ensure that you receive the data that you are after. In this case study, there were 10 students who satisfied this criterion. The software was able to make a report on those 10 students, exploring the other STEM subjects they were studying as well as Informatics (see Figure 2.35). Various reports need to be made to assist with data interpretation so that the research question is being answered thoroughly. Various data sources such as the PISA and TIMSS results are also referenced to provide supplementary data to help answer the research question. Once all the data has been gathered, the mock-ups or annotated diagram of the infographic needs to be drawn (Figure 2.34).

As there is no prescribed software in Outcome 1, students can use a variety of software to create their infographic such as a spreadsheet, a word cloud generator, illustrating software, or an online infographic software generator.

Software that will be used to assist with the development of the infographic needs to be selected such as Excel and Piktochart. These packages have been selected to assist with the development of the infographic (Figure 2.36). The infographic needs to be put together in a creative and logical way by starting with one section at a time. The first section looks at the PISA results (Figure 2.37) and provides some background information about the results and Australia's placement in mathematics. The next section focuses on the questionnaire results and is creatively displayed in a Venn diagram (Figure 2.36). The other sections of the infographic needs to be developed and then tested to ensure that the infographic is complete and answers the question.

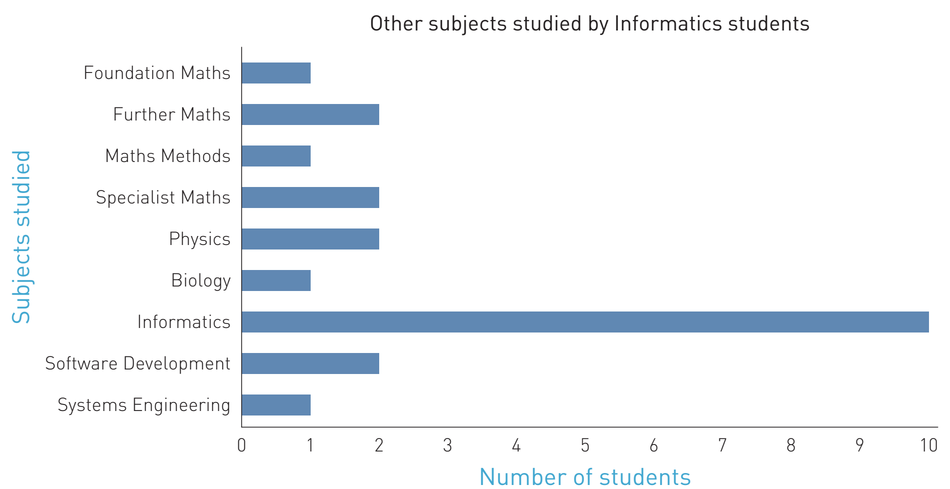



**FIGURE 2.35** Data has been filtered to only include the Year 12 students who are studying Informatics; this report wanted to see what other subjects those students were studying.

**TABLE 2.11** Frequency table

| Choices | Absolute frequency | Relative frequency by choice (%) | Relative frequency (%) | Adjusted relative frequency (%) |
|---|---|---|---|---|
| Foundation Maths | 1 | 4.55 | 10 | 10 |
| Further Maths | 2 | 9.09 | 20 | 20 |
| Maths Methods | 1 | 4.55 | 10 | 10 |
| Specialist Maths | 2 | 9.09 | 20 | 20 |
| Physics | 2 | 9.09 | 20 | 20 |
| Biology | 1 | 4.55 | 10 | 10 |
| Informatics | 10 | 45.45 | 100 | 100 |
| Software Development | 2 | 9.09 | 20 | 20 |
| Systems Engineering | 1 | 4.55 | 10 | 10 |
| Sum: | 22 | 100 | – | – |
| Not answered: | 0 | – | 0% | – |
| **Total answered: 10** | | | | |

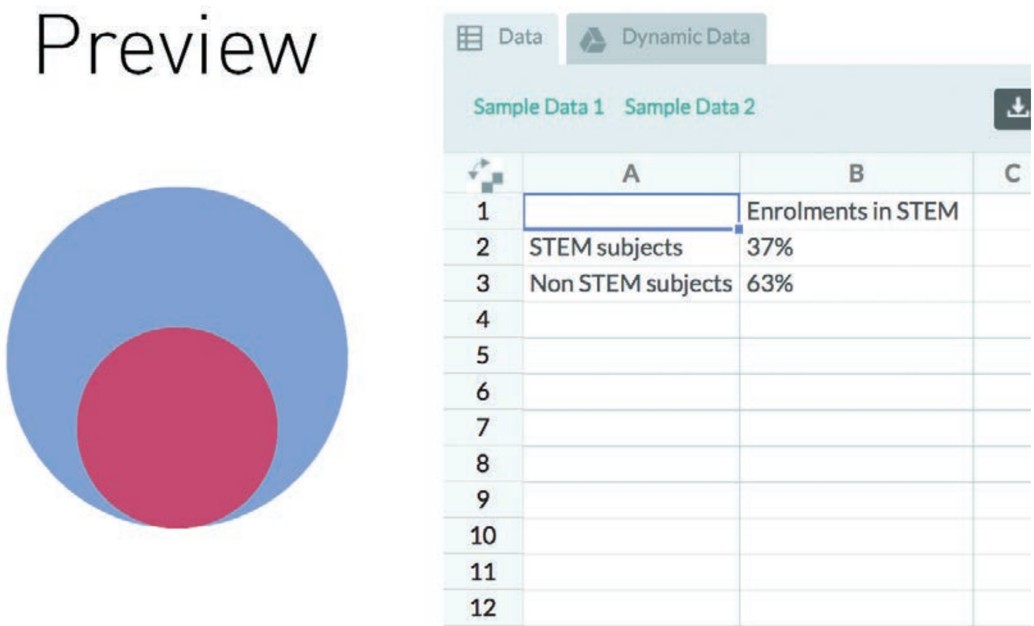
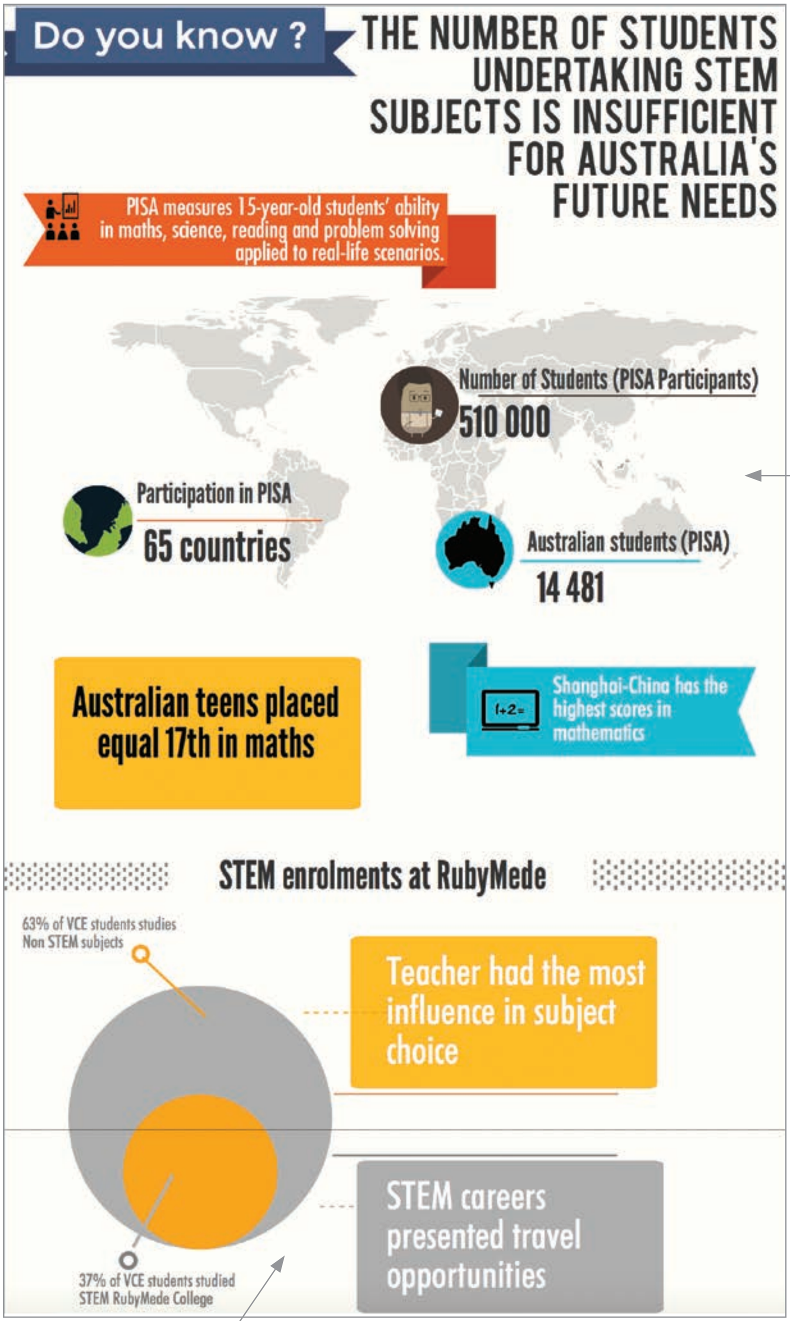



**FIGURE 2.36** The creation of a simple Venn diagram using Piktochart




The first section of this infographic looks at the PISA results and provides some background information about the results and Australia's placement in mathematics.

STEM enrolments at RubyMede data derived from the questionnaire and data from the school.

TIMSS and PIRLS International Study Center (2011) TIMSS 2011 International Results in Mathematics. In *IEA's Trends in International Mathematics and Science Study*, Boston College.
OECD (2012), What 15-year-olds know and what they can do with what they know. *In PISA 2012 Results in Focus*.

**FIGURE 2.37** A section of the completed STEM infographic used to inform the public that there are too few students undertaking STEM subjects

## ESSENTIAL TERMS

**alignment** refers to text: can be left, right, centre or full. Full alignment, which is also known as full justification, refers to text being aligned on the left margin of a column and spaced appropriately so that the last letter in a word on the same line is aligned with the right margin.

**annotated diagrams** a visual depiction of how a graphic representations should look; designs indicate features such as differences in font size, colour and positioning of objects; the placement of objects must be planned so that a balanced, visually appealing and clear effect is attained

**clarity** how clearly the information in the graphic representation is presented and how well a user can differentiate between objects in the graphic form

**contrast** the visual difference in colour or tone between elements on a screen; there should be sufficient contrast between background and text or other page elements to make the information plainly readable

**conventions** standards that have been developed to determine the presentation of documents and other output produced using information systems; rarely static, they change over time as changes in technology and business occur; a convention is first decided on and adopted

**effectiveness** the measure of how well a solution works and the extent to which it fulfils its purpose; measures of an effective solution include completeness, readability, attractiveness, clarity, accuracy, accessibility, timeliness, communication of message, relevance and reliability

**electronic validation** techniques, sometimes called machine-validation techniques, that ensure the accuracy of data are built into software such as spell checkers

**graphic representation** a pictorial diagram that shows the interdependencies between variables; common types derived from numerical data are column charts, line charts, pie graphs, bar charts, area charts, scatter diagrams and bubble charts

**graphic solutions** pictorial diagrams that show interdependencies between variables.

**hierarchy** an arrangement of items in which each is ranked above, below or at the same level as another to show their importance

**infographic** a graphic representation of data and information using different elements

**IPO chart** (input–process–output) a defining diagram that shows how data is processed into meaningful information; it identifies what data is required for the solution (input), what information the solution needs to produce (output), and the processing steps required to transform the data into information, or the function of the solution

**macro** an automated series of tasks. In spreadsheet programs such as Microsoft Excel, you can create macros by using the macro recorder. Macros are used to automate series of tasks that are performed frequently. Macros can be run directly from a key combination or from a button added to the user interface

**manual validation** entails the data entered being checked for accuracy by a person rather than by a machine

**orientation** the direction and aspect of elements within a graphic representation

**problem-solving methodology** a structured approach to creating a solution; the method applicable to our course comprises the following steps: analysis, design, develop and evaluate

**proportion** the visual hierarchy (relative sizes) of objects within a graphic representation

**spreadsheet functions** include performing mathematical and logical functions, producing various sorts of graphs and charts, inserting labels, headers footers, notes and comments

**testing** a step in which the solution created is checked for accuracy

**useability** the ease of use of the graphic solution; all spreadsheet solutions, including graphic representations of numerical data, need to be user-friendly; the user should be able to access the required information with ease and efficiency

**validation** a step in which the data that has been entered is checked for accuracy

**variable** in programming, a key word, phrase or symbol that represents a value that may change

**white space** a section of a graphic representation that is empty of any colour or object that is used to create a clean, uncluttered look and is not considered wasted space by designers

## IMPORTANT FACTS

1 Spreadsheet functions enable the user to format data, calculate simple and complex mathematical calculations, and produce different charts and graphs.
2 We inform when we provide information or tell facts, such as reporting on a current issue. We persuade when we influence a decision or action, or change a person's opinion. We educate when we teach and provide knowledge and skills through a learning process.
3 Colour should be used so that it makes the information clear, readable and attractive. The colours should emphasise important features, and a colour scheme should be used to ensure consistency.
4 Clarity is important for onscreen products. All elements on the screen should able to be seen clearly in order to convey the message effectively to the user.
5 Consistency of navigation links, colour schemes and other repeatable features allows users to navigate an onscreen product comfortably with minimal confusion.
6 Colours selected should make an onscreen product readable and attractive.
7 There are a set of formats and conventions to use when producing a graphic solution, including appropriate labelling to ensure that the information communicated is clear and concise.
8 A user should be able to efficiently and easily attain meaning and relevant information from an onscreen graphic representation.
9 When testing a solution, the following areas can be tested for appropriateness: functionality, presentation, usability, accessibility and appropriateness of communication.
10 It is important to test what you are trying to produce meets the specified need and fulfils the specified purpose.

# TEST YOUR KNOWLEDGE

Review quiz

## PURPOSE OF GRAPHIC SOLUTIONS

1 What is a graphic representation?
2 Find three different types of graphic representations suitable for educating, persuading and informing audiences.
3 Describe the context of each of these three graphic representations and how they could best be used.

## DESIGN PRINCIPLES FOR GRAPHIC SOLUTIONS

4 Select one of the infographics from Question 2 and comment on the data that is displayed in terms of the clarity of the message and the evidence provided to support the case.
5 What is the difference between a format and a convention?
6 List five conventions that are used in graphic representations.
7 Describe the types of data you would include in an infographic.
8 How would you test an infographic?
9 List five different software packages that could be used to create an infographic.

## DESIGN TOOLS

10 What is a data set?
11 What does the acronym IPO stand for? Explain what each component means.
12 What is usually depicted in an annotated diagram?

## TYPES OF TESTS

13 Why is testing undertaken?
14 What should be considered when undertaking completeness testing?
15 What is one result of an unreliable graphic solution?
16 What do you need to ensure by undertaking relevance testing?

## VALIDATION

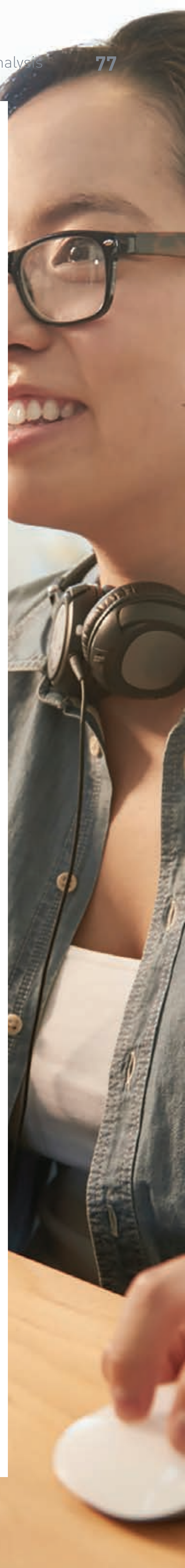
17 What is validation? Identify two ways to perform validation.

# APPLY YOUR KNOWLEDGE

Using the 'Infographic: The global impact of wireless internet connectivity' weblink, answer the following questions.

Infographic: The global impact of wireless internet connectivity

1. Focusing on the infographic on the page, rather than the introductory article at the beginning, describe the data displayed in the infographic.
2. List 10 of the subsections shown in the infographic.
3. For each of the subsections listed in Question 2, describe how the data is represented and summarise the findings.
4. What is the 'INTERNET OF THINGS (IOT)'?
5. Provide two additional examples of the IOT, other than the ones listed in the infographic.
6. Using the infographic as a source, explain whether you believe that wireless is more than a luxury, and why, in 500 words.



# PREPARING FOR UNIT 1 OUTCOME 1

## Acquire, secure and interpret data, and design and develop a graphic solution that communicates the findings of an investigation

In Unit 1, Outcome 1, you are required to conduct an investigation into an issue, practice or event through the systematic collection, interpretation and manipulation of primary data and then create a graphic solution, such as an infographic, that represents your findings.

## OUTCOME MILESTONES

1. Identify a topic to investigate.
2. Identify the types of data that will be gathered.
3. Decide which data-gathering methods and techniques to use.
4. Identify, legally and ethically acquire, and reference data and information from primary sources.
5. Identify the techniques to minimise risks to the security and privacy of data and information.
6. Interpret selected data, identifying relationships and patterns.
7. Select and apply appropriate design tools to represent the functionality and appearance of graphic solutions for particular purposes.

## STEPS TO FOLLOW

1. Choose a topic to investigate. Topics could be as diverse as social networking, shopping habits or public transport usage.
2. Decide on an aspect of the topic to investigate in detail. For example, the social networking habits of different age groups, shopping preferences of a particular sex and age group, or monitoring public transport usage of a specific group of people.
3. Identify the type of data you will collect.
4. Based on the type of data that will be collected, identify the data-collection method you will use in the research (for example, observation, questionnaires/surveys, interviews or focus groups).
5. Create content for data gathering.
6. Create the participation information statement.
7. Create consent forms.
8. Identify risks to the privacy of participants and security of data and have strategies in place to minimise them.
9. Once permission has been granted from participants, collect the data.
10. Once data has been collected, it needs to be analysed. Identify any patterns, look for meaning in the data and then draw your conclusions.

11 From the interpreted data, you will need to create a graphic solution for the purpose of informing, educating or persuading an audience.

12 Use software, and select and apply functions, formats, conventions, data validation and testing techniques to manipulate data and create graphic solutions efficiently. Note: no restrictions are placed on the software tools used to create your solution.