Level

F	1	**2**	**3**	**4**	5	6	B6

Measurement in science

Strand
Science and Society

Key concept
Science as a 'way of knowing' is shaped by the ways that humans construct their understandings.

Purpose

Activities in this module are designed to help students understand that people observe and explain phenomena in different ways for different purposes, and to help students develop an awareness of the tools scientists use. Students have opportunities to:

- collect information (data) from a range of sources;
- look for patterns and meanings in the data collected;
- use tables and graphs to communicate collected data to other people;
- identify what piece of measuring equipment to use to create specific types of data;
- infer and interpret from data;
- compare the accuracy and relevance of the data produced.

Overview of activities

The following table shows the activities in this module and the way in which these are organised in **introductory**, **developmental** and **culminating** phases.

Introductory ►	Developmental ►	Culminating
Measuring in everyday life	What to use when	Making your own measuring instrument
Is a horse big?	My container is bigger than yours	
	Running on time	
	Maintaining scientific instruments	
	What is the weather like today, tomorrow and the day after?	
	The accuracy of graphs and tables	

QUEENSLAND SCHOOL CURRICULUM COUNCIL

Core learning outcomes

This module focuses on the following core learning outcomes from the Years 1 to 10 Science Syllabus:

Science and Society

2.2 Students identify some ways scientists think and work.

3.2 Students recognise the need for quantitative data when describing natural phenomena.

4.2 Students use the elements of a fair test when considering the design of their investigations.

Core content

This module incorporates the following core content from the syllabus:

Science and Society

Use of tools to assist observation

- accuracy
- measurement
- appropriateness
- aberrations

Investigations

- controlled — fair testing
- different ways of collecting evidence provide different information

Ways scientists think and work

- different ways of collecting information

Assessment strategy

Suggestions for gathering information about student learning are provided in each of the activities in this module. Once sufficient information has been collected, judgments can be made about students' demonstrations of outcomes. Typical demonstrations of this module's intended outcomes are provided here to indicate the pattern of behaviour to look for when making judgments.

Science and Society

2.2 Students identify some ways scientists think and work.

Students may:

- recognise that scientists in different situations use different tools;
- generalise that there may be similarities in the ways that scientists work;
- identify ways of working scientifically.

Science and Society

3.2 Students recognise the need for quantitative data when describing natural phenomena.

Students may:

- perform experiments that explore natural phenomena;
- collect data from experiments and represent the data in appropriate tables or graphs or both;
- use appropriate equipment to measure particular data and explain why that piece of equipment was used;
- ask pertinent questions about the data they have collected and present that data appropriately.

Science and Society

4.2 Students use the elements of a fair test when considering the design of their investigations.

Students may:

- draw the conclusion that using quantitative data can contribute to the fairness of a test.

Background information

Current scientific conceptions

Quantitative and qualitative data are forms of information that differ in their degree of precision of measurement. Qualitative data are descriptive. When people talk about contexts, situations, events, conditions and interactions, they may use words — hot, heavy, tall, fun, cool, wild — that do not have a precise meaning or value. For example, 'the tree is very tall' and 'the water is cold' are qualitative descriptions. The standards of measurement that people use for such descriptions are often subjective and relative to a personal reference; therefore, qualitative data lack the precision of quantitative data and often mean different things to different people. Qualitative data can be gathered from observations, interviews, documents, books and videotapes.

Quantitative data are numerical data gathered through standards-based measurements or generated using statistical procedures. The information and results from these procedures are given in units that are understood and agreed around the world. For example, 'the tree is 100 m tall' and 'the water temperature was 3ºC' are quantitative, standards-based statements that give the numeric value and the units of what they are measuring.

Quantitative data are obtained by using a scientific approach towards a problem and experimenting to produce the data. The main strengths of the scientific approach are its **precision** through reliable measurement and its **control** through the design of task and sampling methods. These data can be represented in tabular or graphical forms that allow for manipulation and analysis. Replication of experiments enables data from different trials to be compared. Control of equipment and conditions is vital in experimental work; otherwise the results may not be valid or reliable.

Students' prior understandings

Students' prior understandings may differ from current scientific conceptions in a range of ways.

Some students may not be familiar with equipment that is used for measuring and some may not have heard the term 'data' before. Other students may have had prior experience with using measuring instruments.

Teachers can build on students' understandings by providing opportunities for them to:

- discuss situations where measuring instruments are used;
- investigate certain situations and decide which measuring instrument would be appropriate in that situation.

Terminology

Terms associated with the use of scientific tools, data collection and analysis are essential to the activities in this module — for example:

balance	graph	microscope	telescope
beaker	height	numerical	thermometer
binoculars	length	qualitative	time
breadth	magnifying glass	quantitative	trundle wheel
cylinder	measuring jug	table	width
data			

Students may already be familiar with some of these terms and understand their meanings and use in scientific contexts. If so, the activities in this module will provide opportunities for them to evaluate current usage. If not, these activities will provide opportunities for students to develop their understandings.

School authority policies

Teachers need to be aware of and observe school authority policies that may be relevant to this module.

Safety policies are of particular relevance to the activities that follow. It is essential that demonstrations and student activities are conducted according to procedures developed through appropriate risk assessments at the school.

In this module, teachers need to consider safety issues relating to students using hot water.

Support materials and references

Australian Bureau of Statistics. Available URL: http://www.abs.gov.au/ (accessed November 2000).

National Standards Commission 1996, *Measurement in Sport*, North Ryde, NSW.

Project Atmosphere Australia On-line. Available URL: http://www.schools.ash.org.au/paa/paa.htm (accessed November 2000).

VanCleave, J. 1995, *Janice VanCleave's Weather*, John Wiley & Sons, New York.

Watson, G. 1996, *Science Works*, Oxford University Press, Melbourne.

ACTIVITY

Measuring in everyday life

Introductory

Focus

This activity provides opportunities for students to clarify their ideas about measuring and measuring instruments.

Students prepare and draw a concept map.

Materials

For each group:

- butcher's paper
- pens
- overhead transparencies

Teaching considerations

Students work in small groups to develop and draw a concept map. The final concept map can be presented on an overhead transparency or on butcher's paper. Teacher input may be required during the activity although the focus should be on the students' own ideas. Maps can be displayed in the classroom.

Resource Sheet 1

Teachers may refer to Resource Sheet 1, 'Concept map' in this module, or to the initial in-service materials (p. 38) for guidance with concept mapping.

Preparation

Teachers may find it necessary to model the process of concept mapping for some students.

Working scientifically

Time: 20 minutes

Applying ideas and concepts
Assessing and reassessing
Examining and evaluating
Making links
Clarifying ideas and concepts
Creating diagrams
Discussing thinking
Explaining ideas and decisions
Relating

▶ As a class, students discuss the word 'measure' and suggest where and when measurement is used. In groups of two or three, students write the word 'measuring' in the middle of a piece of butcher's paper or an overhead transparency. They circle the word. Students add words which describe in general terms the amounts or quantities to be measured — for example, length, mass, volume. Instruments used to do this type of measuring are then linked to these terms. Other words that students associate with measuring could also be added.

▶ Groups display their concept maps and explain their ideas to the rest of the class.

Gathering information about student learning

Sources of information could include:

- students' contributions to discussions;
- students' completed concept maps.

ACTIVITY

Is a horse big?

Introductory

Focus

This activity provides opportunities for students to clarify their ideas about terms that describe quantitative and qualitative properties of objects and materials.

Students identify and group quantitative measurements and qualitative descriptions.

Materials

For each group:

- butcher's paper and pens
- 3 buckets or large ice-cream containers
- hot water, tap water and ice cubes
- a small object such as a cricket ball
- kitchen scales

Teaching considerations

Public figures or people prominent in the community and well known to all students could be used instead of family members in the first part of the activity.

Comparing the temperature of water could be done outside. If there is no access to hot water it could also be completed as a class exercise rather than as a small group activity.

Safety
Inform students about safe practices when working in wet areas and with hot water.

Working scientifically

Time: 30 minutes

Engaging with problems
Exploring phenomena
Measuring
Playing
Seeking reasons
Generalising
Judging credibility
Discussing thinking

▶ Students consider the meaning of the terms 'qualitative' and 'quantitative'. Questions to guide thinking could include:

- What smaller familiar words can you see within the words 'quantitative' and 'qualitative'? (quantity, quality)
- What descriptive words do you associate with the word 'quantity'?
- What descriptive words do you associate with the word 'quality'?

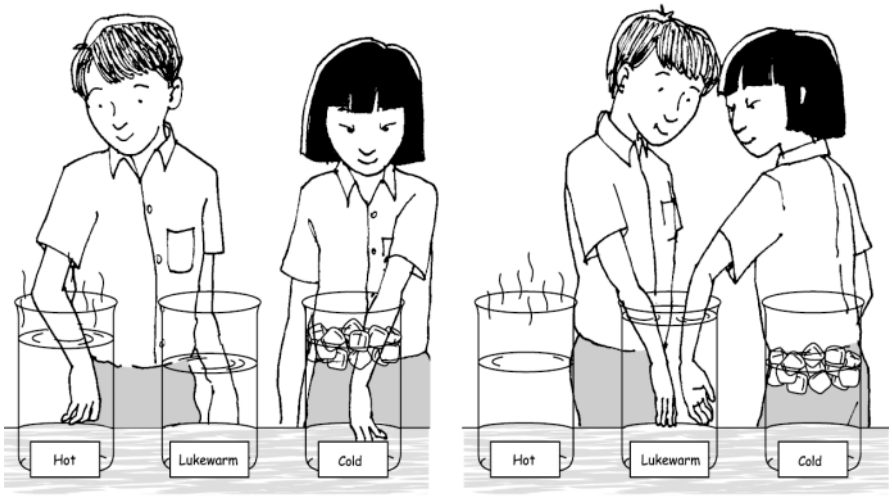
Questions which could assist reflection of instances of qualitative descriptions include:

- Is your parent or carer 'old'?
- Is your grandparent 'old'?
- Compared to the age of your grandparent, can your parent or carer still be described as 'old'?
- Is a horse a 'large animal'?
- Is an elephant a 'large animal'?

- Compared to the size of an elephant, can a horse still be described as a 'large animal'?
- Many recipes list the juice of half a lemon. How much is the juice of half a lemon?
  - Is this a consistent amount?
  - Does the precise quantity matter in a recipe?
  - What are the difficulties that could arise as a result of such an imprecise measurement?

▶ Students reflect on their understanding of the terms 'hot', 'warm' and 'cold'. Working in groups of three or four, they position three buckets (or ice-cream containers) on a table or on the floor. One bucket contains hot water (not hot enough to scald). The second bucket contains lukewarm water. The third bucket contains cold water. If necessary, use ice cubes to make the water distinctly cold.

▶ One student from the group puts one hand in the hot water. Another student puts one hand in the cold water. In turn, students describe the temperature of the water in which their hands are immersed. The other students in the group record their descriptions. Both students then put their hands in the lukewarm water (see illustration). Once again they describe the temperature of the water and their descriptions are recorded.



Testing the temperature of water

▶ As a class, students discuss the group responses. Questions to guide discussion could include:

- Did all students describe the hot (or cold) water in the same way?
- Did all students describe the lukewarm water in the same way?
- Why did one student say the water was cold when the other student said the same water was warm?
- What influence does previous experience have on the answers that were given in this situation?
- Suggest other situations where previous experience might influence your response?

- Were the descriptions of water temperature quantitative or qualitative?
- What instrument could have been used to get a quantitative measurement of water temperature?

▶ Students estimate the weight of an object using their hands and then weigh the object using kitchen scales. They discuss their results. Questions to guide discussion could include:

- Why were the estimates different?
- What difficulties might arise as a result of estimating rather than using precise measurements? Where might these difficulties become important? (for example, when dispensing medicines)

▶ Students prepare a table with two columns like the one shown below. In groups, students brainstorm words describing quantities or amounts. When the brainstorming is completed students sort their lists of words into the appropriate column of the table.

Word list

Qualitative (not precise)	Quantitative (precise)
Old	1 kilogram
Young	1 gram
Big	1000 litres
Small	10 metres
A pinch	22°C
Heavy	170 cm
Light	100 kJ
The juice of a lemon	
A couple	
A few	
Several	

Additional learning

▶ Students could conduct a survey examining people's interpretation of the qualitative terms listed in the table.

Gathering information about student learning

Sources of information could include:

- students' contributions to discussions;
- students' lists of words.

ACTIVITY

What to use when

Developmental

Focus

This activity provides opportunities for students to investigate the appropriate use of measuring instruments.

Materials

For each student:

- Resource Sheet 2, 'What to use when'

For the class:

- a range of instruments used for measuring distance or volume depending on the investigation devised by students
- bucket
- 1 L jug

Teaching considerations

Using Resource Sheet 2, students consider situations where measuring instruments could be used. A picture showing each of the situations described would assist some students to develop their writing and reading. Suggested answers for Resource Sheet 2 are shown below.

Situation	Measuring instrument that could be used
Watering a pot plant inside the house	Watering can
Measuring an exact amount of water	Measuring jug
Finding the mass of a rock	Scales (Capacity depends on the size of the rock.)
Finding the mass of a person	Scales
Measuring the temperature of water	Thermometer
Measuring a person's temperature	Thermometer
Measuring the length of a rectangular box	A ruler or tape measure
Measuring the length of a beetle	A ruler
Measures angles in the field	Inclinometer
Measures time taken to obtain a soft boiled egg	Egg timer
Measures speed of a vehicle	Radar gun
Measures angles in degrees	Protractor
Measures width of an object	Callipers
Measures blood pressure	Sphygmomanometer
Instrument attached to motor vehicle to indicate the rate of travel	Speedometer
Measures the number of revolutions per minute made by a revolving shaft, as in a car	Tachometer
Measures the electrical activity of the heart	Electrocardiograph

Working scientifically

Time: 40 minutes

Designing and performing investigations
Exploring phenomena
Measuring
Analysing
Suggesting
Creating presentations
Creating tables and graphs
Discussing thinking

Resource Sheet 2

▶ Working individually, students complete Resource Sheet 2, 'What to use when', using their own knowledge and reference material. They share their responses with the rest of the class and discuss the need for specialised measuring instruments in some situations.

▶ Students are given a 1 L jug to which 50 mL of water has been added. They discuss whether or not the jug is appropriate for measuring this amount of water. They suggest alternative measuring instruments that might be more suitable. They test their suggestions and then decide which is the most appropriate instrument to use with this volume and record their decisions.

▶ Students design and perform investigations into the amount of error that can be introduced into a measurement by using inappropriate measuring instruments. Suggestions for investigations could include:

- measuring 2 L of water using:
  - 2 L measuring cylinder or flask;
  - 1 L measuring cylinder or flask;
  - 500 mL measuring cylinder or flask;
  - a medicine measuring glass (these have about 40 mL capacity);
  - measuring cups;
  - spoons;
- measuring a distance of 15–20 m using:
  - a trundle wheel;
  - 100 m tape;
  - 1 m tape;
  - 40 cm ruler;
  - 15 cm ruler.

▶ Students record and analyse the results they obtained with each of the different measuring instruments, then prepare a presentation to share their findings with the rest of the class.

▶ As a class, students discuss the value of using measuring instruments appropriate to the task.

Gathering information about student learning

Sources of information could include:

- students' responses to questions on Resource Sheet 2;
- students' contributions to discussions;
- students' design and performance of the investigation, and recording and analysis of results;
- students' presentations to the class.

ACTIVITY

My container is bigger than yours

Developmental

Focus

This activity provides opportunities for students to compare ways of measuring the volume of containers of different shapes and sizes.

Materials

- several containers of different shapes
- water
- graduated beaker or measuring cylinder with a capacity greater than that of the containers to be tested
- beam balance
- kitchen scales

Teaching considerations

Preparation

A variety of different and unusually shaped containers is required — for example, novelty soft drink bottles, lolly jars, flower vases, sauce bottles or containers for cosmetics.

Measuring volume

Volume can be measured by filling the container under test with water and then emptying it into a measuring cylinder. An alternative approach is to find the mass of the container before and after it has been filled with water. One millilitre of water can be assumed to have a mass of one gram.

Working scientifically

Time: 40 minutes

Clarifying and challenging
Engaging with problems
Exploring phenomena
Making plans
Predicting
Examining and evaluating
Making comparisons
Discussing thinking

▶ Students discuss the shapes and sizes of a variety of differently shaped containers. They decide which container has the largest volume and which the smallest. The remaining containers could be placed in order between these two.

▶ Working in pairs students select a container, plan how to measure its volume and carry out their plan. Students discuss how successful their plan was and how they would modify their method to improve the accuracy of their measurement. Discussion questions could include:

- How do you decide when the container is full?
- Where in the process could errors in the measurement be made?

▶ Students share their results with the rest of the class and the initial predictions made by the class are compared with these results.

The class discusses the results from all groups. Points for discussion could include:

- sources of error that could mean that the results between groups should not be compared;
- the accuracy of using volume or mass of water as the basis of comparison;
- other situations where unusual shapes make measurement difficult.

Gathering information about student learning

Sources of information could include:

- students' participation in planning the method to work out the volume of the container;
- students' measurements of the volume of the containers;
- students' discussion and explanation of how to improve the method;
- students' participation in group work.

ACTIVITY

Running on time

Developmental

Focus

This activity provides opportunities for students to compare precision and accuracy in measurement.

Materials

For each group:

- 3 stop watches measuring to tenths or hundredths of a second
- watch or clock with second hand
- watch or clock without a second hand but showing minutes

Teaching considerations

In everyday speech the terms 'precision' and 'accuracy' are often inappropriately used interchangeably. They are actually different aspects of measurement. An accurate measurement is one free from error. Precise measurements are exact. The precision of measurement depends on how exact the measurement can be and that depends, in turn, on the coarseness or fineness of the scale being used on the measuring instrument. For example, a scale using 1 mL divisions is finer and will allow more precise measurement than a scale with divisions of 5 mL or 10 mL.

The number of different groups that can engage in this activity at the same time depends on the availability of stop watches and other watches or clocks. In this activity students time how long it takes to run a fixed distance. Any activity where time to complete a set task can be recorded could be substituted for running.

Safety

This activity involves students in physical exertion. Identify students with health considerations that need to be taken into account.

Working scientifically

Time: 30 minutes

Engaging with problems
Looking for patterns and meanings
Making and judging observations
Measuring
Seeking reasons
Interpreting data
Making comparisons
Discussing thinking

▶ Students discuss their understanding of accurate measurement and what influences the accuracy of measurement. They discuss the difference between accuracy and precision and record their ideas.

▶ In groups students explore precision of measurement by using watches with different scales of measurement to time a student running 50 metres (or another task that takes about 30 seconds). They record their results and discuss the differences they identified. Questions to guide discussion could include:

- From which watch were you able to get the most exact, specific or precise information about the time it took the student to run 50 metres?
- From which watch was the information least exact, specific or precise?
- What was different about the watches that influenced the information they provided?
- What other factors could have influenced the difference in the times recorded?

► Students explore accuracy of measurement by having three students, each with a stop watch, measure and record the time it takes another student to run 50 metres. They compare the three measurements for the same event. Questions to guide discussion could include:

- What reasons could there be for any differences in the times recorded?
- What could be done to increase the accuracy of measurement in this situation?

► Students clarify their thinking about precision and accuracy. They reflect on the statements made at the beginning of the activity and identify any changes to their thinking resulting from the activity and subsequent discussion. The statements are changed to reflect new understandings.

Additional learning

► Students could compare precision and accuracy in measurement of mass using electronic and pan balances.

Gathering information about student learning

Sources of information could include:

- students' contributions to discussions;
- students' statements about precision and accuracy.

ACTIVITY

Maintaining scientific instruments

Developmental

Focus

This activity provides opportunities for students to examine tools used by scientists and to recognise the importance of maintaining these instruments.

Materials

For each student:

- Resource Sheet 3, 'The tools of science'
- Resource Sheet 4, 'Tools'

For the class:

- a range of poorly maintained measuring instruments:
  - rulers with scale rubbed off, ends broken, edge damaged;
  - hand lenses, magnifying glasses, telescopes or microscopes with dirty or scratched lenses;
  - beaker or measuring jug with scale removed.

Working scientifically

Time: 30 minutes

Formulating and elaborating ideas
Making links
Suggesting
Discussing thinking
Explaining ideas and decisions
Using scientific terminology

▶ The teacher guides a discussion on the importance of maintaining equipment, machines, instruments and implements, be they for sport, gardening or any other purpose, and collates a list of ideas developed by students. The teacher guides the discussion towards tools used by scientists and emphasises the importance of maintenance and how this might affect:

- the ability to make observations;
- the collection of precise information (using language such as 'minimising sources of error');
- the need to use the equipment repeatedly (multiple trials are needed to justify any conclusions or judgments that are made as a result of the investigation using that equipment).

▶ Students discuss the consequences for science investigations of lack of maintenance of tools and equipment. They use well-maintained and poorly maintained instruments to make observations or measurements and compare the precision of the observations they make.

Resource Sheets 3, 4

▶ Students cut out the pictures of instruments from Resource Sheet 4, 'Tools', and identify the matching name and use of the instrument on Resource Sheet 3, 'The tools of science'.

▶ Students make notes on:

- how each instrument is cared for;
- how lack of maintenance might affect the qualitative and quantitative data collected;
- the effect on interpretation and subsequent understandings of inaccuracies that might arise.

▶ Students paste each illustration in the appropriate place on Resource Sheet 3 as a flap that can be lifted to expose the text beneath.

▶ Students suggest ways in which particular tools and equipment should be maintained and discuss ways of ensuring that the tools and equipment they have in the classroom are looked after correctly.

Gathering information about student learning

Sources of information could include:

- students' responses during discussion;
- students' completion of Resource Sheet 3, 'The tools of science'.

ACTIVITY

What is the weather like today, tomorrow and the day after?

Developmental

Focus

This activity provides opportunities for students to collect quantitative data used to measure natural phenomena.

Students use measuring instruments to record information about weather.

Materials

For the class:

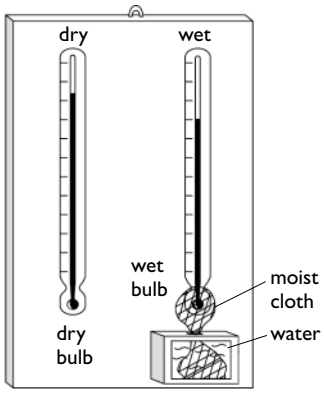
- thermometer
- hygrometer (wet and dry bulb thermometer)
- humidity chart
- barometer
- anemometer
- rainfall gauge

Teaching considerations

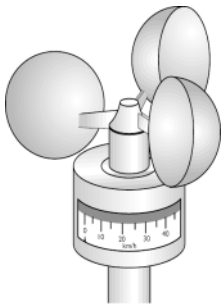
Students work as a class to collect weather data in their local area.

Background

The **hygrometer** (wet and dry bulb thermometer) measures relative humidity, which is the amount of water vapour in the air relative to the maximum amount of water vapour that could be in the air at that temperature. The reading on the scale of the wet bulb thermometer reflects the cooling capacity of the air, since the rate of evaporation of moisture from the damp cloth surrounding the bulb depends on the amount of water vapour in the air. The difference between the readings on the two thermometers can be used to determine the relative humidity by reading from a table of humidity values.

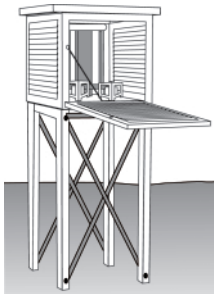


An **anemometer** is an instrument used for recording the wind speed.



A **barometer** measures atmospheric pressure. Most changes in the weather are accompanied by changes in atmospheric pressure, so a barometer can be used to indicate weather changes.

Many schools have a **Stevenson screen**. These are standard box-like shelters in which thermometers can be placed. The screen ensures that air can move freely around the thermometers while they are shielded from direct rays from the sun or re-radiation from the ground and nearby objects.



Newspapers present weather information graphically and could be used to guide students when they are presenting their data.

Ensure students understand that collecting data accurately enables comparisons of data to be made both over time and throughout the world.

Students can participate in an Internet weather exchange by linking up to the Project Atmosphere Australia On-line weather data exchange program (http://www.schools.ash.org.au/paa/paa.htm). This program is carried out mainly by schools in Australia comparing weather conditions in their local area to those of other schools. Schools from all over the world are becoming involved in the exchange of weather data.

Linkage

This activity could be linked with core learning outcome 4.1 in the strand Earth and Beyond: 'Students recognise and analyse some interactions (including the weather) between systems of Earth and beyond'.

Working scientifically

Time: 30 minutes, then 10 minutes every day

Collecting information
Looking for patterns and meanings
Measuring
Formulating and elaborating ideas
Creating presentations
Creating tables and graphs

▶ Students list terms they associate with weather. They group the terms as qualitative or quantitative.

▶ Students find out what measurements are used in weather forecasting and decide upon the instruments they would need to do their own investigations. They discuss the information to be collected, how it will be collected and ways in which it will be recorded.

▶ Students measure and record the weather for one week using the available measuring instruments. They discuss the most appropriate way of presenting their data and create a presentation.

▶ Each group of students concentrates on one particular measuring instrument. They explain the workings of the instrument, present the data collected and describe how data of this type contributes to weather forecasting.

▶ Students suggest why it is important that we have accurate measurements and recordings of weather patterns and discuss each other's ideas.

Gathering information about student learning

Sources of information could include:

- students' measuring and recording of weather data;
- students' presentations;
- students' contributions to discussions.

ACTIVITY

The accuracy of graphs and tables

Developmental

Focus

This activity provides opportunities for students to draw graphs and tables to represent data and to recognise effects of presenting data in different ways.

Materials

For each student:

- graph paper
- Resource Sheet 5, 'Temperature recordings over a ten-day period'

Teaching considerations

Teachers may obtain sets of data on the Internet from sources such as the Australian Bureau of Statistics (http://www.abs.gov.au/).

Working scientifically

Time: 60 minutes

Engaging with problems
Looking for patterns and meanings
Analysing
Interpreting data
Making comparisons
Creating tables and graphs
Explaining ideas and decisions

▶ Students are shown different types of graphs — line, bar or column, pie and pictograph. As a class they discuss the different types of graphs, instances when each particular graph should be used and why they are used for specific purposes.

▶ Students collect examples of graphs in the popular press and discuss the type of graph used, the information it presents and the benefits of using a graph in this situation. They select one of the graphs and record their ideas on its use.

▶ Students use the data from the activity 'What is the weather like today, tomorrow and the day after?' (p. 18). They create a table and present the information as a line graph, a pie graph and in another format of their choice. (Data from Resource Sheet 5, 'Temperature recordings over a ten-day period', or from another experiment performed by students, could be used as an alternative.)

Resource Sheet 5

▶ Students compare each other's graphs and discuss the differences between them. Guides to discussion could include:

- How does the shape of everyone's line graph compare?
- How can the shape of a graph be changed?
- What makes a graph easy to use?
- Which graph is easiest to read?
- Comment on the usefulness of presenting this type of data on a pie graph.
- On which of the graphs has quantitative data been changed into qualitative data?
  - Is this a useful change?
  - If so, why; if no, why not?

▶ Students examine different sets of data obtained by the teacher, transfer one set onto a table and then graph the data appropriately.

Gathering information about student learning

Sources of information could include:

- students' explanations of their ideas about the usefulness of different types of graphs;
- students' tables and graphical interpretations of statistical information.

ACTIVITY

Making your own measuring instrument

Culminating

Focus

This activity provides opportunities for students to design their own measuring instrument and to gather data with it.

Materials

Choice of materials will depend upon student designs.

Teaching considerations

This activity asks students to design their own measuring instrument. Alternatively, students could repeat the activity 'What is the weather like today, tomorrow and the day after?' (p. 18) using instruments of their own construction. The text *Janice VanCleave's Weather* could be helpful when seeking guidance on construction of weather instruments (see 'Support materials and references', p. 5).

Preparation

Students could be referred to the activity 'What to use when' (p. 10) for a discussion of the appropriate use of measuring instruments.

Working scientifically

Time: 90 minutes

Designing and performing investigations
Making plans
Selecting and justifying
Reflecting and considering
Supporting decisions
Examining and evaluating

▶ Students discuss their ideas of 'appropriate' when referring to measuring instruments. They decide on criteria that could be used to determine whether or not a particular instrument was appropriate in a given situation.

▶ Students discuss situations where measurement using familiar instruments can be difficult — diameter of a ball, volume of a rock, size of an ant. They design and construct their own measuring instruments to use in situations of their choice. Students test their instruments and make improvements to them.

▶ Students present talks on their instruments and explain why they think they are useful. Students might consider:

- how their instruments are different from other instruments that are currently in use;
- where their instruments could be used;
- why their instruments are good for making that sort of measurement;
- whether evaluation of their instruments satisfies the criteria established by the class;
- how and where the information gathered using their instruments could be used by the community or by scientists.

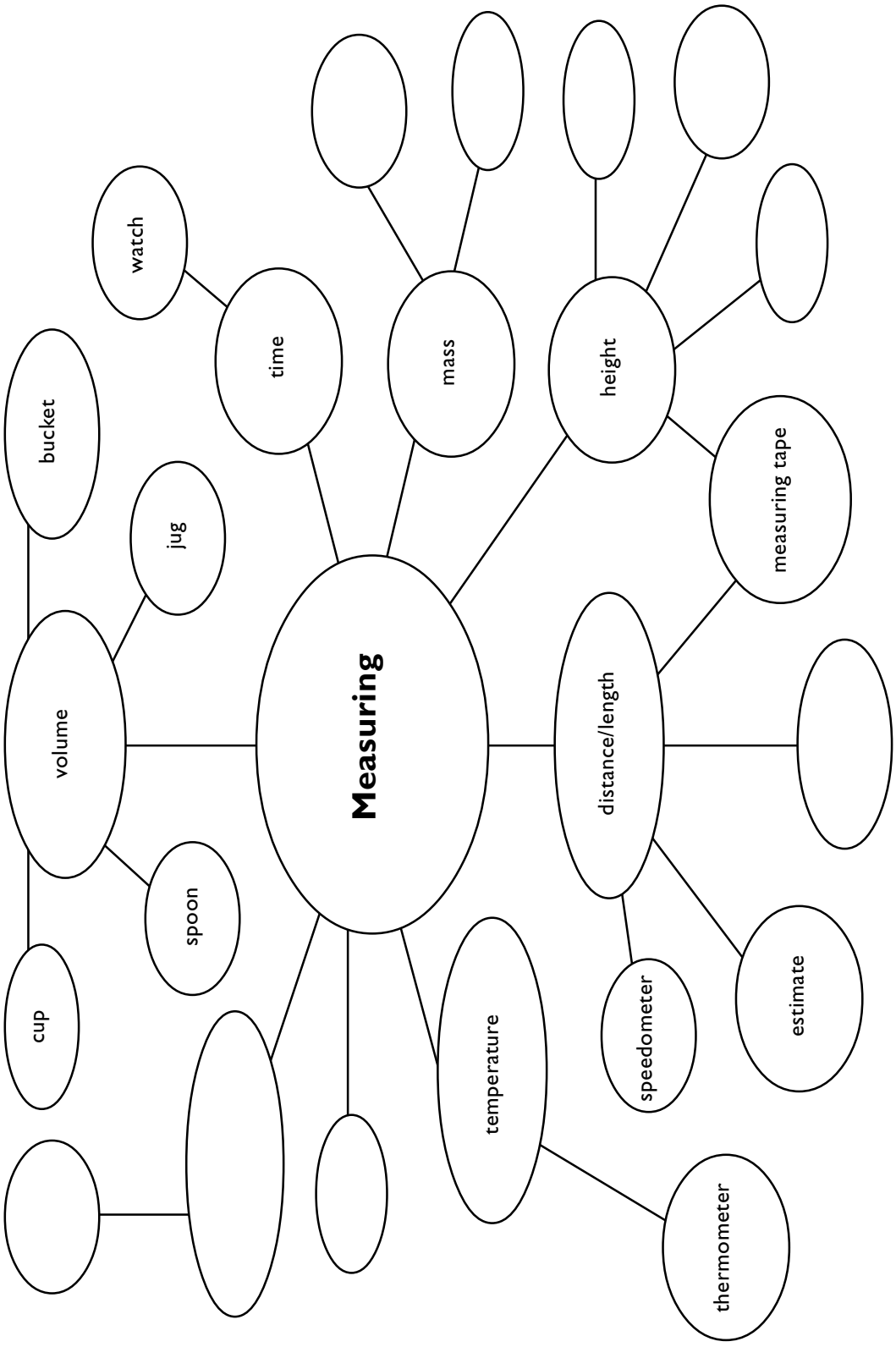
Gathering information about student learning

Sources of information could include:

- the students' designs for their instruments;
- the students' explanations of the usefulness of their instruments.

Concept map

Resource Sheet I



What to use when

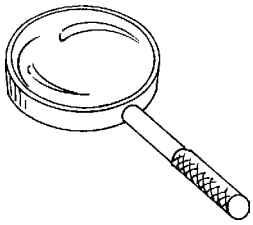
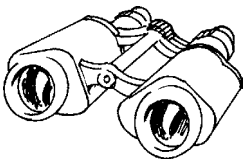
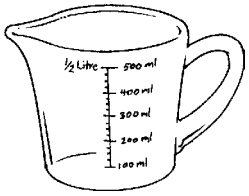
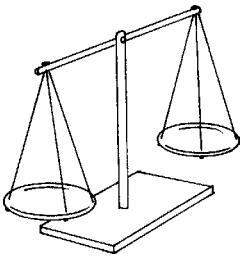
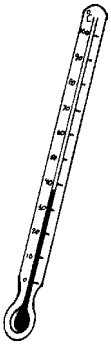
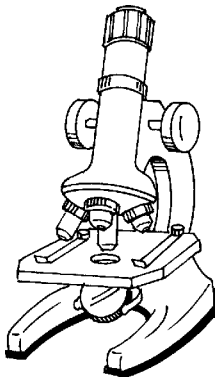
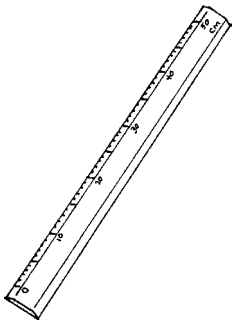
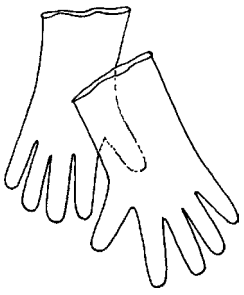
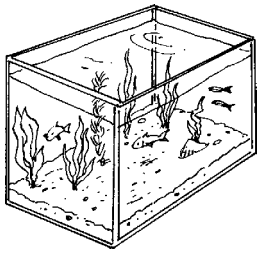
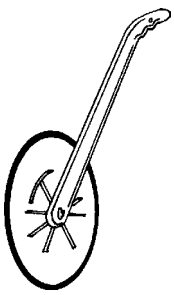
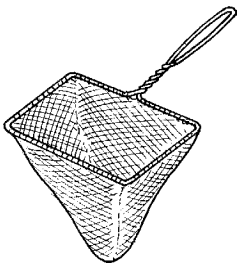
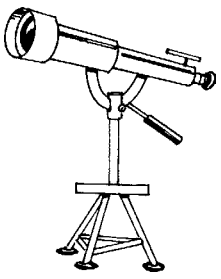
Situation	Measuring instrument that could be used
Watering a pot plant inside the house	
Measuring an exact amount of water	
Finding the mass of a rock	
Finding the mass of a person	
Measuring the temperature of water	
Measuring a person's temperature	
Measuring the length of a rectangular box	
Measuring the length of a beetle	
	Inclinometer
	Egg timer
	Radar gun
	Protractor
	Callipers
	Sphygmomanometer
	Speedometer
	Tachometer
	Electrocardiograph

The tools of science

Paste here Makes very small things visible **Microscope**	Paste here Used to measure short distances **Ruler**	Paste here Used to measure the mass of objects **Scales**	Paste here Used to measure amounts of liquids **Measuring jug**
Paste here Makes small things look bigger **Magnifying glass**	Paste here Used to collect insects, fish and other small animals **Fishing net or insect net**	Paste here Used to observe things that are very far away — for example, to see stars and planets **Telescope**	Paste here Used to make things appear closer — for example, to observe birds **Binoculars**
Paste here Used to measure temperature **Thermometer**	Paste here Used to create living spaces for fish and small animals **Aquarium**	Paste here Used to measure long distances **Trundle wheel**	Paste here Used to protect people from infection **Plastic gloves**

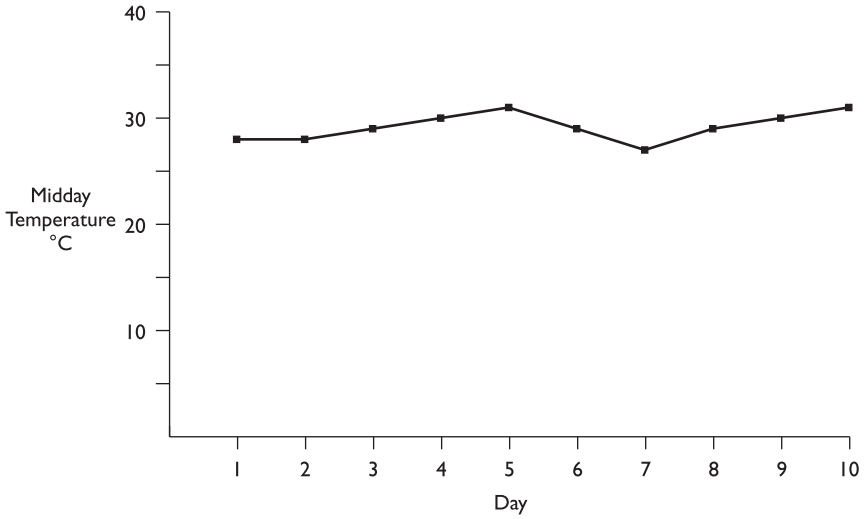
Tools

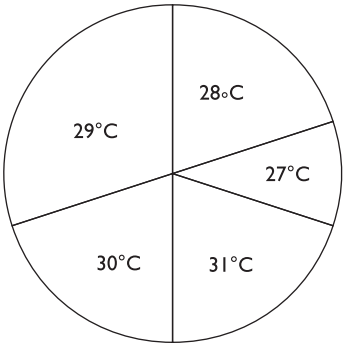
Resource Sheet 4

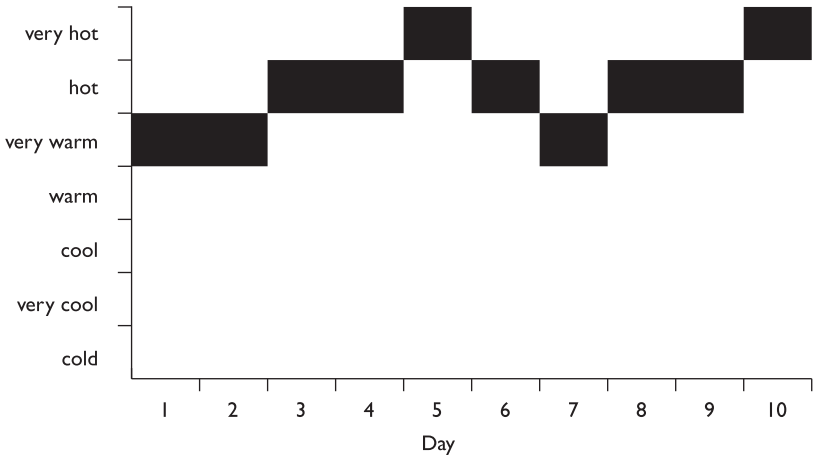
1 	2 	3 	4 
5 	6 	7 	8 
9 	10 	11 	12 

Temperature recordings over a ten-day period

Day	1	2	3	4	5	6	7	8	9	10
Temp °C	28	28	29	30	31	29	27	29	30	31







Acknowledgments

This module is based on material developed by Andrew McCosh who attended a module writing workshop organised by the Science Teachers' Association of Queensland and the Queensland School Curriculum Council.

This sourcebook module should be read in conjunction with the following Queensland School Curriculum Council materials:

Years 1 to 10 Science Syllabus

Years 1 to 10 Science Sourcebook: Guidelines

Science Initial In-service Materials

ISBN 0 7345 2051 4

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