

Science (1999)

Years 1 to 10

Sourcebook Guidelines

(Part 5 of 8)

Note: The PDF version of this document has been split into sections for easier download. This file is Part 5 of 8.

Planning curriculum and assessment

The syllabus provides a framework for planning activities through which students have opportunities to demonstrate what they know and can do in the key learning area. Activities, units and programs are the main organisational structures used in schools. Experiences that promote learning and strategies for gathering information about that learning can be developed within these structures. Despite the common use of these terms, the nature, size, purpose and organisation of activities, units and programs differ widely, depending on student needs, teacher strengths, the local context and school authority requirements. This section provides advice to support appropriate, effective and efficient planning and assessment practices.

Characteristics of worthwhile activities, units and programs

Activities, units and programs that are consistent with the principles of the outcomes approach promoted in the syllabus are characterised by:

- comprehensiveness;
- promotion of self-reflection;
- appropriateness;
- sequencing;
- relevance and authenticity;
- inclusiveness;
- promotion of active learner involvement;
- efficient and innovative use of resources;
- adherence to pertinent school authority requirements.

Comprehensiveness

A comprehensive range of experiences will involve students in using a variety of learning processes so that they can achieve deeper understandings identified in the syllabus. Assessment will be comprehensive if it enables all students to demonstrate core learning outcomes and other aspects of the planned curriculum.

Promotion of self-reflection

Activities that promote reflective and self-directed learning are opportunities for students to control their own learning. These opportunities need to be provided at relevant intervals to enable students to reflect on what they have learned, on their strengths and weaknesses as learners, on their progress in demonstrating learning outcomes, and on ways to improve their learning.

Appropriateness

Activities will be appropriate when they are suited to the developmental levels and learning styles of students. This requires determining learners' current developmental levels and providing students with experiences that are realistic challenges. This process enables them to grow beyond their present level of understanding and to construct new meaning from experiences provided. Appropriateness for all students therefore requires that experiences be varied and, to some extent, individualised by providing extra scaffolding for the development towards and demonstration of learning outcomes by some students.

Sequencing

The sequencing of activities should provide time for students to assimilate new ideas and offer opportunities for students to demonstrate learning outcomes. Students should be aware of the criteria for demonstrating outcomes at different levels, and know how they are progressing in relation to them. Where there is a focus on outcomes from more than one level, it is necessary to keep in mind the conceptual sequencing of the outcomes and the embedded differences that characterise outcomes at each of the levels.

Relevance and authenticity

Activities will be relevant and authentic when their content and contexts link with students' sociocultural or geographic background and prior understandings to allow them to construct new understandings. Students' interests and understandings prior to beginning an activity should be determined, and students should be involved in the planning process. Relevant and authentic activities should also involve students in content or contexts that are engaging and enjoyable. The more relevant and authentic activities are, the more likely it is that many students will demonstrate the learning outcomes.

Inclusiveness

Activities are inclusive when they recognise the backgrounds and value the experiences of all students or groups of students, taking into account their socioeconomic status, gender, race, ability, disability, ethnic or linguistic background or geographic location. Recognition of such backgrounds and experiences will prompt consideration of how all students have equitable access to resources and participation in the classroom, and have multiple opportunities to demonstrate learning outcomes in an equitable and supportive way. Opportunities should be provided for students to value the differences between them and to challenge disadvantage and injustice through participation in activities.

Promotion of active learner involvement

Activities should actively involve each student and provide opportunities to challenge existing understandings. Sharing of ideas and intellectual risk-taking are encouraged. Active involvement promotes student ownership, which allows for more purposeful and realistic opportunities to demonstrate learning outcomes.

Efficient and innovative use of resources

Activities should make efficient, cost-effective and timely use of resources. It is necessary to support demonstrations of outcomes with adequate resources to cater for differences in learning styles or characteristics of socioeconomic background. Where appropriate, students should be encouraged to use resources in innovative ways as they strive to demonstrate learning outcomes. Teachers are encouraged to access and use a variety of resources efficiently and in innovative ways to support students' demonstrations of learning outcomes.

Adherence to pertinent school authority policies

Activities should adhere to and observe pertinent policies of schools and school authorities. These policies may relate to safety, social justice, pedagogy or other curriculum requirements. Observing such policies will improve opportunities for students' demonstrations of learning outcomes.

Planning curriculum for demonstrations of outcomes

Considerations for planning activities

When planning activities for science, teachers are encouraged to consider the needs of their students, the ways their students learn, current understandings about science and the ways students learn about science, available human and material resources, and requirements of schools and school authorities.

Consideration of how cultures other than Western ones view natural phenomena will assist students in developing their understandings of Western science, and facilitate their access to its scientific language. For example, for those Aboriginal students and Torres Strait Islander students who are steeped in the Dreaming stories and Creation stories of their cultures, special consideration in planning experiences to provide learning can assist them to move freely between their indigenous perspectives and Western science perspectives.

Learners

Planning activities involves ensuring that opportunities are provided for students to demonstrate learning outcomes from the syllabus. The valued attributes of a lifelong learner, Science key learning area outcomes and cross-curricular priorities should be referred to when planning activities and assessment which focus on core or discretionary learning outcomes.

When planning activities to meet the needs of learners, teachers:

- encourage students to clarify, evaluate and reconsider their understandings about natural phenomena and science concepts;
- provide opportunities for students to discuss the tentative nature of scientific knowledge and encourage reflection on how scientific ideas have changed over time;
- actively and explicitly teach students about scientific texts, language and vocabulary and allow time for students to develop competency in genre commonly used in scientific contexts;
- actively and explicitly develop in students a futures perspective as well as lifeskills and skills in literacy and numeracy;

- encourage critical literacy and numeracy approaches to the investigation of science in different historical, social and cultural contexts;
- facilitate active learning by providing both hands-on and minds-on activities and employing real-life and lifelike learning and assessment contexts.

Cooperative learning

Teachers who believe that learning occurs as learners discuss their work, listen to and help each other, and take responsibility for the management of tasks, provide opportunities for cooperative learning to take place.

Cooperative learning involves students working in small groups to learn with and from each other. When cooperative learning is occurring there is a division of tasks, a sharing of resources and a group goal. When students are working in groups for activities such as practical work, it does not necessarily mean that cooperative learning is occurring.

Cooperative learning needs to be carefully developed. It is built on a combination of social and learning skills. Cooperative learning develops the skills of forming and managing groups, group problem solving and metacognition.

Varied activities lend themselves to cooperative learning including those that further understanding of science concepts through practical work, outdoor studies, discussions, data collection and concept mapping. Additional information on cooperative learning can be found in Appendix 2.

‘Open’ investigations

Teachers who believe in actively engaging students in all aspects of a scientific investigation may plan experiences where students:

- decide on a problem to investigate;
- plan how they will conduct their investigation;
- gather, organise and present their data;
- communicate their conclusions.

These kinds of investigations are referred to as ‘open’ investigations. They are a powerful way of assisting students to understand and internalise the nature of scientific investigations. Open investigations also provide ‘in context’ opportunities for teachers to make judgments about students’ demonstration of outcomes.

Activities that require students to undertake investigations where the problem, equipment and procedure are given are often referred to as ‘closed’ investigations. With this type of investigation there is less active involvement of students.

Irrespective of the degree of openness of an investigation, there are a number of strategies that can be used to assist students to understand the nature of, and become more actively engaged in, an investigation. Hackling (1998) suggests the following five strategies.

1. A fair test mnemonic — Cows Moo Softly

This mnemonic stands for:

- Change something.
- Measure something.
- Keep everything else the Same.

This strategy is appropriate for introducing students to, and reinforcing their understanding of, the nature of a controlled investigation. It also assists them to design their own investigations. It requires them to recognise the various kinds of variables as they are invited to identify what is to be changed, what is to be measured and what is to be kept the same. It is an effective way of introducing the idea of a fair test and can be presented to students who have little prior experience with fair tests.

2. Variable tables

This is a suitable strategy to introduce when students are using the previous strategy efficiently. A table like the one below is used to introduce students to the terms ‘controlled variables’, ‘independent variable’, and ‘dependent (manipulated) variable’ in the context of a given problem — for example, How does the amount of light affect the growth of seedlings?

What will I keep the same?	What will I change?	What will I measure?
Controlled variables	Independent variable (IV)	Dependent variable (DV)

3. Writing researchable questions

This strategy provides a structure for students to use to frame their own researchable questions. A suitable structure could be:

What happens to _____ (DV) when we change _____ (IV)?

For example, the researchable question might be: What happens to **the growth of wheat plants** (DV) when we change **the salinity of water** (IV)?

Researchable questions tend to be used with younger children, when the independent variable is discrete and there is little prior knowledge and experience of the phenomenon. When students are proficient at writing researchable questions they can be introduced to writing hypotheses.

4. Writing testable hypotheses

This strategy provides a structure for students to write hypotheses. Hypotheses are statements of tentative ideas to be tested, expressed in the form of a relationship between an independent and dependent variable. A suitable structure could be:

This change in _____ (IV) will cause this to happen to _____ (DV).

For example, the hypothesis might be: Increasing the **salinity of water** (IV) will **reduce** (relationship) **the growth of wheat plants** (DV).

5. Student planning and reporting worksheets that encourage independence and reflection

A well-designed planning and reporting format can lead students through a sequence of decision-making steps, reduce their dependence on the teacher, provide a way for them to record their thinking (including their reflections) and ‘doing’ throughout an investigation, and provide information for assessment purposes. Three models, increasing in detail and complexity, are included in Appendix 3. The question format of each model serves to actively engage students.

Resources

Activities should be based on resources that are:

- readily accessible;
- inclusive of all students;
- used only if safe to do so;
- matched to students’ abilities, learning styles and cultural needs;
- able to help students develop understanding and demonstrate learning.

Considerations for planning a unit

Planning a unit with an outcomes approach involves identifying the outcomes to be demonstrated. This step will be informed by the school program and serves as a starting point for planning activities. Part of the planning process involves designing an appropriate sequence of learning activities and identifying opportunities for gathering information about students’ learning.

Units will include activities based on outcomes selected from:

- within or across strands of a key learning area;
- one or more levels within a key learning area;
- across key learning areas.

Students’ needs

An effective unit will meet students’ needs by:

- providing adequate time for reflection and critical thinking;
- supporting independence and interdependence in learning;
- presenting experiences that lead students to view science as a series of connected, rather than unconnected episodes;
- linking experiences in science to other areas of learning;
- recognising that all students will not necessarily be ready to demonstrate learning outcomes in the same way or at the same time, and possibly providing opportunities for negotiating learning and assessment;
- teaching strategies and skills for applying learnings to novel scientific applications.

Some learning–teaching approaches

There are a number of learning–teaching approaches to help teachers in developing units. Using these approaches, teachers sequence activities appropriately and select strategies that help students to apply learnings to novel situations. Some approaches used in science are:

- the interactive approach;
- the 5 Es instructional approach;
- Orientating, Enhancing, Synthesising.

These are discussed in Module 7 of the initial in-service materials. The relationship between these approaches and the organisation of the activities in the sourcebook modules are shown in the figure below.

Organisation of activities in sourcebook modules	Learning–teaching approach		
	<i>Interactive approach</i>	<i>5 Es instructional approach</i>	<i>Orientating, Enhancing, Synthesising</i>
Introductory	Preparation	Engage	Orientate
	Exploration	Explore	
Developmental	Student’s questions	Explain	Enhance
	Investigation	Elaborate	
Culminating	Reflection	Evaluate	Synthesise

To help students take responsibility for their own learning and assessment, it is suggested that teachers discuss with their students the main parts of the approach used.

If students are asked to engage with a number of different approaches over a short period, it is suggested that teachers discuss similarities between the approaches with their students and display these similarities on a chart so that students do not become confused.

Some teachers may choose to use only one learning–teaching approach to avoid the possibility that students may become confused.

Syllabus requirements

When teachers are planning a unit the following syllabus requirements should be considered:

- key learning area outcomes;
- core learning outcomes;
- core content;
- principles of assessment;
- cross-curricular priorities;
- inclusive curriculum principles.

Teachers should also be aware of:

- discretionary learning outcomes;
- the key learning area's contribution to development of the valued attributes of a lifelong learner.

Resources

Unit planning makes provision for appropriate use of:

- teacher and support staff expertise and interests;
- material resources;
- facilities;
- local community resources.

Considerations for planning a program

Programs are the means by which teachers plan for demonstrations of learning outcomes over extended periods of time. The planning may involve one strand or more from one key learning area or more.

A program may cater for:

- all the students in a class, year or school level for one key learning area;
- all the students in the school for one or more of the key learning areas;
- an individual student or group of students with specific needs for one or more of the key learning areas.

Syllabus requirements

When planning programs in the Science key learning area, teachers should consider the following syllabus requirements.

- *Key learning area outcomes*
The key learning area outcomes describe the contribution Science makes to the Years 1–10 curriculum and to the development of the valued attributes of lifelong learners. They will influence the selection of experiences planned for students.
- *Core learning outcomes*
The learning outcomes selected for inclusion in the program should reflect the levels at which the students within the school or year level are working. The choice of learning outcomes included in units of work will depend on a number of factors including school requirements, teacher expertise and student needs.
- *Core content*
During Years 1–10 students should be provided with experiences which promote learning and incorporate all of the core content. Coordinated planning between primary and secondary schools may be required if this is to happen. The core content should be contextualised to suit the needs of students and the school setting.
- *Principles of assessment*
The program should highlight appropriate, effective and efficient assessment practices that are in keeping with the principles of assessment. These will include identification of a range of suitable assessment techniques and instruments for use when teachers develop units to cater for the different learning styles and backgrounds of students.

- *Cross-curricular priorities*
A program should ensure that literacy, numeracy, lifeskills and a futures perspective are embedded in units wherever possible, and that students get regular contact with each of these priorities in all stages of their schooling.
- *Inclusiveness*
A program should ensure that learning processes are accessible to all students.
- *Learner-centred approach*
A program should encourage the use of a learner-centred approach in all units.
- *Multiple opportunities*
The program should ensure that students have multiple opportunities to demonstrate the learning outcomes consistently and well.

Educational setting

Planning a program in the Science key learning area will initially require consideration of the educational setting, including:

- the location — for example, geographically isolated, urban, coastal, rural;
- staffing allocations, responsibilities and expertise;
- school organisation — for example, middle schooling approach, family groupings, vertical timetable, primary, secondary, multi-age;
- school authority policies and requirements;
- school population;
- availability of resources — for example, physical, human;
- time allocation;
- reporting requirements;
- community expectations and influences.

Students' needs

All programs should take into account the school population and the individual and group differences that exist within that population.

For students with disabilities, programs should provide alternative ways for demonstrating outcomes. Some students with disabilities will make similar progress to that of their peers, while others may be working at different levels. Students with disabilities can frequently participate in the same activities as others of their peer group. Planning and assessment should, where possible, be appropriate for the student's age and draw on content in the learning area which is accessible to the student.

Some students with special educational needs may not be able to demonstrate all outcomes within a level, and may find some strands more difficult than others.

Foundation Level outcomes written using the level statements should:

- be descriptive of what students know and can do;
- be written so that they can be assessed;
- be achievable;
- reflect the intent of the level statement;
- be tailored to the individual needs of each student;
- be linked to a priority goal of an individualised education plan.

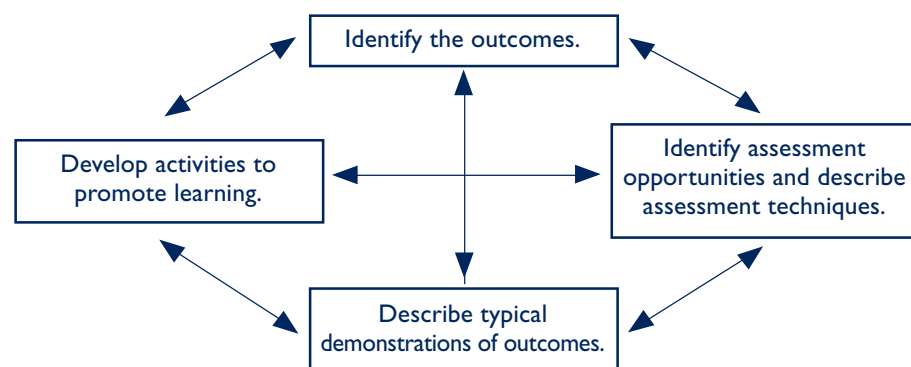
Examples of outcomes at the Foundation Level are included in Appendix 1.

Planning assessment for demonstrations of outcomes

Assessment requires that students be able to show what they have learned — that is, they can demonstrate what they know and can do. There is an integral relationship between the experiences that promote learning and the assessment techniques that facilitate students’ demonstrations of learning outcomes.

Each learning outcome describes what students should know and be able to do. The outcomes inform the assessment process and may indicate which techniques and instruments are more appropriate for their demonstration. To clarify the expectations of the assessment process, characteristics of typical demonstrations may be identified by developing criteria. Assessment items may address more than one learning outcome.

The following diagram illustrates the relationship between learning outcomes and activities. The learning outcomes are used as a starting point for planning experiences and identifying assessment opportunities. This planning process may suggest additional learning outcomes that could also be demonstrated by students as a result of particular experiences.



Relationship between learning outcomes and planning for assessment

As students and teachers progress through a unit, specific assessment tasks will enable students to demonstrate outcomes.

Techniques for gathering information

Students’ demonstrations of learning outcomes should be monitored through the use of a range of assessment techniques. The following techniques provide types of information which can be useful in different situations.

Observation is an effective technique for gaining a broad impression of students’ demonstrations of learning outcomes. It includes communicating with students and monitoring progress as they work. Most observation is incidental and takes place as learners participate in planned activities. Some observations are structured to gather particular kinds of information.

Consultation involves teachers interacting with students, colleagues, parents, carers or paraprofessionals. The varying perspectives of these consultations help enrich teachers’ understanding of students’ demonstrations of learning outcomes. Information gained through consultation may confirm or conflict with teachers’ impressions formed as they observe students. Sometimes consultations will reveal a need for more detailed assessment.

Focused analysis involves teachers in examining specific details and features of students' demonstrations of learning outcomes. Through focused analysis, teachers can identify and examine the strengths and specific needs evident in students' work. Focused analysis can employ a wide variety of oral or written tasks.

Self-assessment allows teachers to take students' perceptions of their own achievements into account when developing teaching, learning and assessment activities. Teachers communicate with students about the students' progress and perceptions. They use student goal setting to plan individual activities and identify whether students need additional support or explanation.

Peer assessment involves students in applying criteria to assess the work of others in a non-threatening but informed way. They reflect on their own work through focusing on the work of others. Students take on other classroom roles, such as that of tutor. A classroom atmosphere of negotiation, collaboration and fairness supports peer assessment.

Classroom opportunities for gathering information

The written, oral and practical assessment forms suggested in the syllabus require careful consideration in their classroom use. A variety of forms should be used to assess an individual student's or group of students' demonstrations of learning outcomes. Frequently, learning activities will also provide opportunities for gathering information that can be used for monitoring students' learning.

To be inclusive of all students, it may be necessary to use different forms of assessment to collect information about students' demonstrations of a learning outcome.

Assessment instruments

Teachers can record evidence of students' demonstrations of learning outcomes using assessment instruments that are manageable and easily incorporated into classroom activities. These include:

- annotated work samples;
- observation notes and anecdotal records;
- student folios;
- assignments, projects and research reports;
- checklists;
- criteria sheets;
- recordings of performances — audiotapes, videotapes, photographs;
- self- and peer-reflective writings and journals;
- test results over time;
- homework, worksheets and assignments.

Making judgments

Evidence of demonstrations of learning outcomes can be drawn from ongoing observations of performance or from assessment tasks specifically designed to allow students to demonstrate learning outcomes. Teachers can make judgments about students' demonstrations of learning outcomes when they are satisfied that they have sufficient evidence of demonstration.

Preferably, decisions about a student's demonstration of learning outcomes should be made without reference to the performance of other students. It is important that each outcome be demonstrated consistently and in a range of contexts.

Teachers' professional judgment is fundamental to school-based assessment and reporting processes and should involve considered and expert decisions, made according to explicit criteria, using a range of evidence assessed against the core learning outcomes of the syllabus.

The consistency of teacher judgments is developed through processes that may involve:

- shared understandings;
- criteria sheets;
- common planning and assessment tasks;
- examination of students' folios;
- progress maps;
- moderation processes (formal and informal).

Shared understandings

Where possible, teachers are encouraged to collaborate with others to develop shared understandings of tasks and consistency in making judgments about demonstrations of learning outcomes. This can be either a formal or an informal process in which teachers discuss and compare their evidence and decisions in relation to students' demonstrations of outcomes. Comparison of evidence and justification of teachers' judgments is central to accountability.

Criteria sheets

Criteria sheets contain the essential components, attributes, specifications, rules or principles used to judge student performance, responses or products.

Common planning and assessment tasks

When two or more teachers plan activities together they can reach a common understanding of expected outcomes. Where different groups of students undertake the same activities, consistent decisions regarding their demonstration of outcomes can then be made.

Examination of students' folios

A student folio is a collection of a student's work assembled over a period of time. It may include day-to-day tasks, work produced for assessment items, or selections of a student's best work showing effort, progress and achievement. A folio containing a complete collection of a student's work is often used to demonstrate progress. A folio containing selected items only is more commonly used for summative assessment and reporting.

Progress maps

Progress maps provide frameworks for monitoring student progress against described developmental continua. The concept of a progress map underlies the sequencing of the core learning outcomes in each of the strands of the syllabus. A student's progress in relation to the development of knowledge, practices and dispositions of the key learning area is plotted against the six levels used to represent the core learning outcomes.

Moderation processes (formal and informal)

Formal moderation processes occur when schools or school authorities involve teachers from within or across schools in comparing student work and discussing the consistency of judgments about demonstrations of learning outcomes. Informal moderation occurs any time teachers share their understandings of judgments of students' demonstrations of learning outcomes.

Assessment in modules

Strategies for assessment are viewed as integral to the planning process. In activities teachers identify opportunities for gathering information that will enable them to make judgments about students' demonstrations of outcomes.

Assessment across key learning areas

When gathering information about student learning, teachers may find opportunities to make decisions about students' demonstrations of outcomes in other key learning areas. For example, a written task using a specific genre may also be used as assessment in English. Assessment developed for integrated units of work which combine learning outcomes from more than one key learning area may provide information about student demonstration of outcomes from each of the key learning areas represented. Activities that feature cross-curricular priorities of literacy, numeracy, lifeskills and a futures perspective will often provide opportunities for this to occur.

Reporting

In an outcomes approach, reporting occurs in terms of outcomes; however, a range of approaches for reporting is possible. While the final decision rests with schooling authorities or individual schools, teachers could report to parents or carers on students' demonstrations of all or some of the core learning outcomes or could use the level statements to guide reporting to parents or carers on student performance in strands. Students could be demonstrating outcomes at different levels in different strands.

Results of assessment need to be clearly communicated through reporting to others — students, parents, carers, other teachers and paraprofessionals — who support students' learning progress.

Reference

Hackling, M. 1998, *Working Scientifically: Implementing and Assessing Open Investigation Work in Science*, Education Department of Western Australia, Perth.