

**Seventh-day Adventist
Secondary Curriculum**

First Edition November 1990

Science



**Institute for
Christian
Teaching**

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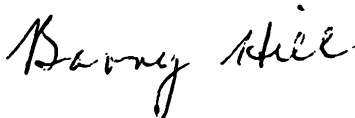
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We in the South Pacific Division Education Department are pleased that teachers are engaged in developing science curriculum materials, and we look forward to seeing more evidence of thorough planning and professionalism in our teaching as we attempt to implement the intentions of this framework.

Yours sincerely



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Some Science Skills
Assessment Guidelines

SUGGESTIONS FOR USING THE FRAMEWORK

There are many ways to use the framework to help you plan courses, units of work, or topics. The aim is to provide a basic checklist for planning. For topics or units, try the following steps, summarizing your plan on a page or two.

Read the philosophy, rationale, objectives, and underlying premises on pages 6-9 to gain a picture of the key emphases of your subject.

Check through the list of values and attitudes on pages 14-16. An example is 'integrity'. Select those that seem to need most emphasis, and write them down.

Consult the list of issues on pages 20-24. Select those you wish to include.

Refer to the set of skills on pages 25 and 26, and select those that are applicable to the topic or unit. There need not be numerous skills. Write these down.

For ideas about assessment, check pages 27 and 28. Assessment must be linked with your teaching content, emphasis and methods. Jot down some ideas.

Look at how values, skills, issues, and teaching methods can be worked into planning, look at examples of topic and unit summaries on pages 29-35. These may give some ideas for your own topic or unit. You can now refine your own summary overview page of the topic or unit.

To make your overall planning more systematic, it could be helpful to use the correlation charts on pages 36. See the instructions for using these on page 36.

Refer to the appendices for further teaching resources. As you can see, you are required to thoughtfully bring together a number of strands in the planning process. By this stage, the topic or unit is certain to be taking on a values-oriented Adventist Christian perspective.

WHAT IS A FRAMEWORK?

In the Adventist school context, a 'framework' is a statement of values and principles which guide curriculum development. These values and principles are derived from Adventist educational philosophy which states important ideas about what is real, true and good. The objective of the framework is to show how Adventist Christian values and faith can be integrated with academic learning, and it provides some examples of how this can be done. The framework is organized as a resource of ideas for subject planning, so it is intended to be useful rather than exhaustive.

In attempting to present an Adventist perspective, it is clearly understood that some aspects of a course may be taught in similar fashion no matter where it is taught. However at a superficial level the objectives and content of other topics taught in Adventist schools will seem little different from state syllabi merely because the content appears relatively neutral in philosophical terms. With thoughtful teaching there will in fact be differences in content emphasis and approach for these topics, while there will be more noticeable differences in other topics and curriculum processes. These differences of varying degree will stem from the underlying philosophy of the framework.

This science framework contains: an overview diagram; a philosophy; a rationale; a set of underlying premises; aims; a list of student attitudes and values; a list of issues; samples of how values are integrated into teaching content; a list of processes and skills; guidelines on assessment; a set of correlation charts for planning; and summaries and flowcharts to demonstrate unit planning procedure.

In the framework there is acceptance of the requirement to teach the basic skills, topics and thematic links outlined in the various state syllabi. The document sets out some of these in checklists and gives practical suggestions which will be used in the preparation of course outlines, programs, units and lessons. It therefore becomes a basic reference point for teachers. No attempt has been made to replace an individual teacher's personal programs, but rather to guide the development of these programs. Overall, the framework mainly attempts to show how good practice can be placed in a value perspective which is Christian. It is a tool teachers can use to help them either reinterpret state curriculum documents from an Adventist perspective, or to simply teach from that perspective if the subject is an elective one.

WHO IS THE FRAMEWORK FOR?

The framework is primarily designed for all science teachers in Adventist secondary schools. It also provides a reference point for curriculum planning for principals and administrators in the Adventist educational system. Further, it attempts to show government authorities that there is an Adventist curriculum emphasis which provides some justification for the existence of an Adventist school system. The document is to be used in establishing the direction for any curriculum planning, whether it involve creating courses from scratch, adding to state syllabi, or evaluating units and resources.

FRAMEWORK OVERVIEW

A DEFINITION OF SCIENCE IS:	The continuing search for understanding of ourselves and of our relationship to our changing physical and biological environments.
OUR UNDERSTANDING OF SCIENCE IS BASED ON PREMISES WHICH INCLUDE:	• God is the source of ultimate truth • Science enables man to better view the design and order of creation • The world was created by God
ITS DESIRABLE ATTITUDES AND VALUES INCLUDE:	• Enthusiasm for science • Open-mindedness • Persistence • Willingness to apply science outside the classroom
ITS STUDY HELPS STUDENTS ADDRESS SOCIAL AND TECHNOLOGICAL ISSUES WHICH INCLUDE:	• Drug use and abuse • In vitro fertilization • Irradiation of food • Lasers in industry • Pollution
ITS PROCESSES AND SKILLS INCLUDE:	• Communication • Experiment design • Problem solving • Valuing

WHAT IS SCIENCE? — A SEVENTH-DAY ADVENTIST PERSPECTIVE

Science is:

- The continuing search for understanding about ourselves and our changing physical, technological and biological environment. Rightly interpreted and understood, it must be consistent with ultimate truth which is embodied in God, who is as yet only glimpsed by man.
- A set of processes which facilitates the systematic acquisition and refinement of data. These processes enable us to generalise and predict.
- A way of viewing life. It involves attitudes and values and is a way of thinking about our interaction with our environment and with God.

A PHILOSOPHY OF SCIENCE FROM A SEVENTH-DAY ADVENTIST PERSPECTIVE

God is the source of ultimate truth. Science is the continuing search for understanding about ourselves and our changing physical and biological environment. Therefore, rightly interpreted and understood, it must be consistent with ultimate truth, which is embodied in God and glimpsed by man.

Science provides the student with an opportunity to explore and attempt to comprehend the order and perfection of the original creation. Although creation is marred by sin, men may possess a closer relationship with the Creator as they seek to understand His creation.

God created man as an intelligent being with a capacity for logical thought and creativity. Science provides scope for the utilization of these capacities in investigating God's creation and the laws by which it is governed and maintained.

RATIONALE

Science is taught for a number of reasons. Some of the most important of these are grouped in five categories below:

Search for Understanding:

Science is more than just a body of organised facts. It also represents a way of organising knowledge about our physical and biological environment. Since knowledge is continually changing, science becomes man's attempt to correctly represent knowledge. Truth can only be found in a knowledge of God, since He is the source of ultimate truth.

Development of Processes:

Scientists use many different processes - ways of doing and thinking - to investigate and generate ideas.

These processes include: observing; classifying; measuring; guessing; hypothesizing; predicting; testing; experimenting; describing; communicating; interpreting data; brainstorming; inferring from data; and identifying and controlling variables. All of these are ways of exploring and discovering, and are transferable to many aspects of life.

Enhancement of Creativity:

An understanding of scientific processes can lead to the enhancement of a student's imagination and creative thinking. God has demonstrated a great deal of imagination through His acts of creation. A student's creativity in terms of questions, possible explanations, and testing ideas is central to science.

Some important abilities here include: visualizing, combining objects and ideas in new ways; producing alternate or unusual uses for objects; solving problems and puzzles; fantasizing; pretending; dreaming; designing; producing unusual and new ideas; identifying; isolating; merging; diverging; converging.

Development of Positive Attitudes:

Students bring to the classroom a set of pre-determined attitudes to God, themselves, other people, and to their environment. Science teaching, especially in a Christian context, endeavours to address human feelings, values and decision-making skills and direct them along positive lines.

Examples of positive attitudes that could be developed are: willingness to explore human emotions; sensitivity to, and respect for the feelings of other people; expression of personal feelings in a positive way; making well-informed decisions about personal values and social and environmental issues; open-mindedness; curiosity; a sense of responsibility; and a willingness to test ideas and explore arguments on either side of an issue.

Personal Relevance:

Science needs to be relevant to the world of the student. Students experience science in a number of different contexts as it relates to: self, home, leisure, work, and the environment. Science includes a substantial amount of information, skills, and attitudes that can be transferred and used in students' everyday lives. Hopefully it will enable them to understand, use, and create new applications for elements of technology.

UNDERLYING PREMISES

The world view and definition of science supported in this framework are based on a number of assumptions about what is real, what is true, and what is good. Such assumptions have been already set out in the philosophy, rationale and definition of science. Some of the important ideas which relate to these assumptions are called 'underlying premises' because of their importance. They are listed here to show how aspects of science may be linked with the most prominent ideas of the framework philosophy.

1. Creation

- God is the omnipotent, omniscient, omnipresent creator of matter and intelligence.
- Creativity is a characteristic of intelligent beings.
- Our creation model is an interpretation of the observable facts and divine revelation which attempts to answer the question of origins.
- Man was created with the capacity and desire to enquire and expand knowledge.

2. Environment

- The environment is made up of physical, biological and social interactions.
- The environment is fragile due to the critical interdependence of physical and biological systems.
- The consequences of man's sin cause the degradation of the environment.
- Humans have the God-given obligation to care for and conserve the environment.
- Since ecology is the study of the interrelationships within the environment it is a significant study for man.

3. Ethics

- God, portrayed in His Word, is the absolute standard of ethics.
- Honesty, accuracy and integrity will be displayed in the collection, interpretation and reporting of information.
- All human observations and interpretation are fallible.
- Potential sources of error and their significance will be acknowledged.
- Sometimes we must choose between apparently conflicting values, and to do this we must use our God-given powers of reason.
- The benefits of developing scientific discoveries must be weighed up against the possible social and environmental consequences of doing so.

4. Human Body

- The human body is the temple of God.
- There is value in individuality and uniqueness.
- There are God-given guidelines for good health.
- The human being is created in God's image.

5. Natural Laws

- From our observations of nature, we acknowledge our changing perception of patterns and natural law.
- Natural laws are evidence of God's orderliness.
- God is a source of awesome power and the perpetuator of natural laws. He is the sustaining force behind the maintenance of the universe.
- Miracles are instances where perceived natural laws are overridden.

6. Nature of Science

- Science is one means of understanding and manipulating the environment.

- Science is a useful tool for solving some problems.
- Scientific knowledge has limitations. These limitations are found in sensory experience, human assumptions and the ability to interpret information.
- The application of scientific knowledge does not solve all the problems of mankind.

7. Relationships

- Appreciation for the beauty, order, complexity and interdependence of creation leads us to love, reverence and honour God.
- Human relationships are based on respect for the rights and preferences of others and our responsibility to them.
- Social interaction is an aspect of learning science.

8. Safe Practices

- Safe practices are an integral part of the investigative process.
- The potential damaging effect of ignoring safe practices should be demonstrated.
- Safety practices are learnt from people in authority as well as personal experience and observation.
- Routines, forethought and alertness are essential elements of safe practice.

9. Science and Religion

- Scientific information can lead one to an appreciation of the Creator.
- Scientific information is interpreted by some as denying the existence of a loving Creator.
- In some areas of science, there is potential for conflict between observations, or some interpretation of them, and our understanding of Divine revelation. These areas need sensitive treatment.
- Although science is studied by using the senses, Christians allow the possibility that unknown laws and relationships, extra sensory events and the supernatural are also part of reality.
- Christians need to be open minded about issues for which there are alternative explanations which seem plausible.

10. Sources of Knowledge

- God is the source of all true knowledge.
- Divine revelation is the vehicle for communicating some true knowledge to man.
- Accepting the discoveries of others is a way of gaining knowledge.
- Individual independent research is a way of exploring knowledge.
- The observation of nature is a source of knowledge.
- The scientific method is a procedure for the effective investigation of the physical and biological world, but it is inappropriate to apply this method to events that cannot be replicated or which exist outside the physical world.
- Reliability, validity and relevance to our objectives are important considerations in determining the value and use of knowledge.

11. Value of Life

- All life is a sacred gift from God.
- Each person is of inestimable value to God.
- Because of its great worth, life is to be guarded and maintained as long as possible.
- Because only God can give life, humans need to guard the life they have.

12. The Reporting of Research

- Part of Christians' mission is to share their scientific perspectives with others.
- When investigating, we should be prepared to share our results for the benefit of others.

BIBLICAL REFERENCES FOR UNDERLYING PREMISES

The following list of Biblical references is provided to give more information about some of the values listed in this framework. **The list is not exhaustive**, and can be added to in future. It is intended that teachers refer to the list to increase their consciousness of the possible place of scripture in their subject content.

Creation:

- | | |
|---------------|---|
| Genesis 1 | • In the beginning God created |
| Isaiah 45:18 | • God has made the earth |
| Psalms 33:6-9 | • By word of God everything was made |
| Isaiah 45:12 | • God formed earth to be inhabited |
| John 1:1 | • Jesus of New Testament is the Creator God |

The Environment:

God's Ownership:

- | | |
|-----------------|---|
| Psalms 24:1 | • Earth is the Lord's and the fulness thereof |
| Genesis 9:11-16 | • God has made a covenant that the earth will not again be destroyed by water |

Man's Dominion:

- | | |
|-----------------|--|
| Genesis 1:26 | • Man made by God to have dominion over fish, fowl of air, cattle and over all the earth |
| Genesis 1:28 | • Be fruitful and multiply, replenish the earth, and subdue it; and have dominion |
| Psalms 8:6 | • Man made to have dominion |
| Genesis 3:15-19 | • Because of sin the quality of life changed for the worse |
| Genesis 6-9 | • World-wide flood brought further deterioration to the quality of life for man and the extent of his dominion |

Ethics:

- | | |
|--------------------|--|
| Isaiah 43:11-15 | • God is; there is none equal |
| Isaiah 45:5-8 | • None beside God |
| John 3:16 | • God loved the world and valued the people in it |
| 2 Corinthians 13:7 | • Do that which is honest |
| Hebrews 13:18 | • In all things be willing to live honestly |
| Joshua 24:15 | • Choice is offered to all |
| Romans 14:12 | • All are accountable to God |
| Psalms 8:3-6 | • Man is inferior to God and the angels, yet he is of value in God's sight |
| Jeremiah 10:2 | • Learn not the way of the heathen |

Human Body:

- | | |
|------------------------|---|
| Psalms 139:14 | • We are fearfully and wonderfully made |
| 1 Corinthians 6:19, 20 | • Body belongs to God and we are responsible to God for what we do |
| 1 Corinthians 10:31 | • Whatever we eat or drink or do it is to be done to the glory of God |

Natural Laws:

- | | |
|-----------------|--|
| Psalms 19 | • Nature reveals God's ways and His laws |
| Revelation 19:1 | • Glory, honour, and power belong to God |
| Nahum 1:3 | • God is great in power |

Sources of Knowledge:

Colossians 2:3

1 Samuel 2:3

2 Chronicles 1:10

Job 37:16

Proverbs 2:6

Proverbs 1:7

Psalms 19:1

Romans 1:28

Job 38

Luke 24:25-31

Ecclesiastes 1 & 2

1 Thessalonians 5:21

- In God we find all the treasures of wisdom and knowledge
- The Lord is the God of knowledge
- Wisdom and knowledge are a gift of God to man
- God is perfect in knowledge
- Knowledge and understanding come from God
- The fear of the Lord is the beginning of knowledge
- Natural world reveals the knowledge of God
- Leaving God out of our knowledge leads to confusion and error
- God challenges the mind by asking us to consider the natural world
- Questioning and reasoning are the preferred processes to establish knowledge rather than miracles
- Seeking out, observing, experiencing, proving, and contemplating are all desirable forms of attaining knowledge
- Prove all things, accept and hold to that which is good

Value of Life:

John 8:1-11

Matthew 6:25-30

- Even those despised by others are of value to God
- Man's value is greater than that of animals and plant life

SCIENCE AIMS

Science Education should provide opportunities for students to:

ATTITUDES

1. Recognise the value, legitimate roles and limitations of scientific and technological knowledge, and their subordination to the knowledge revealed through Divine inspiration.
2. Appreciate and respect the handiwork of the Creator, demonstrated by a respect for others, themselves and the environment.
3. Value honesty and integrity and while striving for accuracy, recognise that all observations are subject to uncertainties.
4. Recognise through the study of nature the evidence for the existence of an intelligent, powerful and orderly Creator who established natural laws through which He sustains the universe.
5. Develop attitudes of inquiry, open-mindedness and interest in current scientific issues.
6. Develop an attitude of curiosity toward the natural world and experience the excitement of discovery.
7. Utilize scientific knowledge and skills to glorify God and benefit mankind.
8. Develop responsible attitudes towards the environment and natural resources.
9. Develop confidence in using problem solving skills.

KNOWLEDGE

1. Develop and maintain an awareness of safety procedures and learn to follow safety practices.
2. Acquire scientific knowledge appropriate to the interest, needs and aspirations of the student.
3. Be informed about the impact of science and technology on society, and explore courses of action regarding science-related issues in society.
4. Learn and apply basic scientific terminology, literacy skills, and numeracy skills.

PROCESSES

1. Design, implement and report the results of scientific investigation.
2. Recognise and use appropriate problem solving skills.
3. Develop a creative approach to formulating and testing hypotheses, planning investigations, and presenting data.
4. Develop and express powers of critical thought, recognise the need to possess evidence before making judgements, and develop the capacity to honestly evaluate evidence that may contradict current beliefs.

5. Acquire and develop manipulative skills in using apparatus (both field and laboratory), and make measurements.
6. Develop the ability to locate, retrieve, organise, interpret and evaluate stored information.
7. Develop concepts and models that will help in the comprehension of the natural and technological world.
8. Develop skills in social interaction by communicating, cooperating, organizing and respecting other viewpoints.

SKILLS

1. Manipulate laboratory and field equipment.
2. Make accurate and consistent measurements.
3. Accurately observe and describe properties and changes.
4. Accurately record results.

ATTITUDES AND VALUES

An important part of teaching science is to develop worthwhile scientific attitudes and values. The two lists are set out below to remind teachers of a group of important attitudes and values which should be emphasized continually, both in formal teaching, and when interacting with individual students. It could be useful when you attempt to include attitudes in assessment. We recognize that the list is only a beginning.

Scientific Values and Attitudes

Acceptance of scientific inquiry as a legitimate way of thinking about issues and problems

Accuracy in calculations and thought

Appreciation of design

Appreciation of the role of science and technology in shaping society and in enhancing the quality of life derived from the increased range and availability of consumer goods

Awareness of detail in nature

Challenge: disposition to challenge the status quo to improve

Compassion for wildlife

Creativity in problem solving

Curiosity about the world

Discrimination between data sets

Enjoyment of nature as a leisure source

Enthusiasm for science and science-related interests

Honesty and integrity in carrying out and reporting experimental work

Informed and healthy scepticism based on recognition of the limitations of science. This would include the capacity to resist claims unsupported by evidence or theory

Inventiveness in seeking solutions

Open-mindedness: willingness to change one's mind in the light of new evidence; willingness to suspend judgement if there is insufficient evidence

Orderliness in practical and theoretical work

Quality of results

Reliability of assertions

Responsibilities for conclusions and reporting

Safety awareness for procedures and issues

Sense of adventure: disposition to attempt new and challenging things

Sensitivity to the needs of living things

Skepticism of unsupported research

Stewardship: the disposition to preserve and account for natural resources including animals

Tenacity in problem solving

Tentativeness about the nature of theories

Tolerance of competing ideas and theories

Willingness to predict, speculate and take 'intellectual risks'

General Values and Attitudes

A capacity for self-motivation and acceptance of responsibility for one's own learning

Appreciation of nature

Appreciation that most issues and problems can be approached from a variety of perspectives

Awareness of consequences of values and procedures

Balance: appreciation of the need for balance between activity and rest

Belief in God's Word in the face of apparently contradictory conclusions

Confidence in the reliability of God

Conservation of materials and environmental resources

Cooperation with others, consisting of carrying out tasks together and a willingness to pool data and ideas

Courage: standing for one's convictions in relation to social and environmental issues

Empathy with others

Environmental sensitivity

Faith: a disposition to accept what cannot be proven

Following directions explicitly and willingly

Giving glory to God by the development of one's abilities

Independence of thought, self-confidence and self-respect

Intellectual curiosity

Knowledge: wanting to acquire knowledge for its own sake

Logic in thinking

Perseverance and tenacity in the face of difficulties

Punctuality

Rationality in thinking

Respect for authority

Responsibility for one's own actions

Self-criticism and a willingness to evaluate and be evaluated by others

Self-motivation in pursuing knowledge

Self-worth: positive assessment of self as part of creation

Time awareness: appreciation of time as a limited resource

Tolerance and respect for others' views, rights, needs and opinions

Truth: disposition to seek truth

Unselfishness in sharing findings

Work ethic: the value of getting things done

STRATEGIES FOR TEACHING VALUING

This section of the framework briefly outlines some types of possible teacher tactics for introducing and emphasizing values.

Analogies

An example is titration, where one drop makes a very large change in colour.

Analysing Values

For example, we may look at the alternatives for fossil fuels. Look at long range consequences such as cost, and support industries.

Application of Values

This tactic involves putting values into action. An example would be conserving power in the home.

Building Support for a Position

For this tactic, we would show how to support a case both for and against a position. For example, we would support a case for a universal flood by building up arguments.

Classroom Organization and Procedures

We can teach values such as orderliness, organization, attention to detail, and good preparation by insisting on them in day to day classroom organization.

Comparing and Contrasting

We can draw out values by comparing opposing views on topics such as creationism. We can also contrast values such as scientific logic and personal bias.

Debate

By debating issues such as loggers versus greenies in rainforests, we can draw out a range of values.

Demonstration

We are constantly demonstrating values in the classroom. For example, we may demonstrate safe procedures with acids and bases.

Experiments

Scientific experiments can show values such as safety, accuracy, inventiveness, and creativity of design.

Explanation

We often have a duty to explain why we hold value positions, or why values are important to students. For example, we would explain why smoking is dangerous.

Field Experience

Field experiences such as biology excursions can highlight values such as duty, compassion for animals, and the place of nature in leisure.

Hypotheticals

We may pose hypothetical problems for students to solve. Examples are case studies about abortion or euthenisia.

Identifying Values

We should take opportunities to identify values in many topics we cover. For example, when talking about the ozone layer, we might identify scientific responsibility.

Media Stimulus

We can use media such as, news items, Quantum, and Towards 2000 programs, to raise issues and weigh them up.

Modelling

The teacher constantly models values such as enthusiasm, care in procedures and an attitude that science is God's book in nature.

Narration

We can use narration to identify and support many values. Examples of narration are sketches of the lives of Galileo, Newton and Keppler.

Problem Solving

We can help students weigh up values by asking them what to do next in problem situations. An example of this approach is the ABC program entitled, 'What Do We Do Next?'

Projects

Projects on environmental and social issues, such as the greenhouse effect and AIDS, can include a valuing component.

Questioning and Clarifying

We are constantly questioning students to help them identify and clarify their values. For example, we ask leading questions so that students formulate values for themselves.

Raising Issues

We may, for example, raise issues about animal rights to have students explore the tensions between competing values. The gains of research may involve some cruelty to animals.

Role Plays

When students act out roles they are forced to think about the values the role represents. For example, we could have a student act out the role of a manager of a cement company who chooses to destroy bat caves.

Simulation

Simulation forces students to cast themselves in life-like problem situations. For example, a student can be asked to make out he is operating a nuclear reactor, and in the process, making decisions about its use.

Visiting Speakers

Visiting speakers present value positions on many topics. For example, a greenie may talk on mining in Kukudu.

Work Experience

Students learn value by visiting work sites. For example, a visit to a museum or a pathology laboratory may illustrate numerous values in action.

ISSUES IN SCIENCE

One way to enable teachers to discuss values in science is to focus on issues which affect our lives. Some of the most common issues relating to scientific study are enumerated below. It is hoped that if you consult this list before teaching units of work, you will save time and enable yourself to remember issues and resources that go with them.

Animal Rights:

- Pharmaceuticals
- Physiology and biochemistry research
- Pesticides
- Vivisection
- Manipulation of animals - caging of birds, reptiles, amphibians, mammals, fish
- Extinction of species
- Conservation of animals - national parks

Biotechnology:

- Genetic engineering
- Genetic counselling
- Tissue culture
- Use of hormones - growth hormones
- Use of antibiotics

Changing technology and employment:

- Labour saving machinery replacing human labour - robotization
- Artificial intelligence

Conservation expenditure:

- Wetlands
- Rainforests
- Mangroves

Drugs:

- Use and abuse
- Socially acceptable
- Costs - economic and health
- Legal

Effective use of resources:

- Mining, mining ocean, Antarctica, moon
- Mining wastes
- Finite nature of resources

Electrical Supply:

- Effects of EMR from power lines, computer screens, fluorescent lights
- Interference of machines in power supply.

Engines:

- Orbital engine - place of manufacture
- Superconductors

Epidemiology:

- AIDS
- Hepatitis B
- Ross River Fever
- Malaria
- Dysentery

Finite carrying capacity of earth:

- Population density.
- Food supplies.
- Birth control

Flood Model of Creation - Evolution:

- Speciation
- Geological column
- Age of earth
- Fossil gaps
- Rates of change
- Continental drift
- Sceptics' society

Food additives:

- Effects
- Preservatives
- Synthetic food - square eggs

Fuels - energy sources:

- Renewable or alternative
- Non-renewable or fossil
- Nuclear
 - Waste disposal
 - Irradiation of food - medical, laboratory research
 - Research
- Alternative energy resources - wind, wave, and solar
- Politics of changing from fossil fuels

Geological Catastrophe:

- Earthquakes
- Volcanic eruptions
- Tidal waves

Greenhouse Effect:

- Global warming
- Ice cap melting
- Press dramatization
- Means of bringing world unity
- Different hopes of different countries

Life - Preservation of:

- Euthanasia
- Improving the quality if life

Life - Preservation of (cont'd):

- Transplants
- Cryogenics

Lifestyle - Diet/health/fitness:

- Costs to industry
- Diseases
- Junk food
- Vitamins
- Cost to community
- Personal costs

Ozone Layer:

- Ozone depletion
- Skin cancer
- CFC's
- Nitrogen oxides

Plastics:

- Production from fossil fuel
- Disposal
- The use of oil for plastics or petrol
- The problems of degradable or biodegradable plastics
- LPG burnt off at refinery - waste

Politics, Industry and Science:

- Industry laws
- Government monitoring and regulation
- Rights of protest - MFP land grab in Brisbane
- Waste laws
- Mutual interdependence of government and industry
- Rate of law change
- Commonwealth versus state laws
- Problems of reporting discoveries eg cold fusion

Pollution:

- Atmosphere
- Waterways
- Rubbish disposal
- Pesticides
- Fertilizers
- Herbicides
- Noise - industry - industrial deafness
- Moral pollution - effects of television

Recycling - resource management:

- Organic garbage
- Glass
- Paper
- Metals
- Plastic
- Keeping recycled materials high in cost

Reproductive Technology Issues:

- Abortion
- IVF
- Surrogacy
- Cloning
- Narrowing of genetic base of food crops
- Embryo experimentation
- Genetic counselling
- Sex determination
- New reproductive technologies
- Genetic engineering
- Contraception
- Gene splicing
- Ownership of embryos

Resource Usage - Economics and Science:

- Helping AIDS victims versus joint replacement
- Choosing patients to help
- Waiting lists for major operations

Retaining Scientists:

- Brain drain

River control:

- Flood mitigation
- Damming

Road Toll:

- Speed
- Accidents
- Alcohol
- Seat belts and child restraints
- Cost of medical work
- Road costs versus medical research
- Investigation costs

Siting of industries:

- Waste disposal
- Environmental concerns

Soil Conservation:

- Salination
- Economic loss - loss of topsoil
- Extraction of ground water

Space exploration:

- Economics
- Space junk
- Nuclear devices in space - power plants of satellites
- Spying
- Satellites
- Supersonic travel
- Giving high technology to political rivals

Warfare:

- Chemical weapons
- Biological weapons
- Nuclear weapons

PROCESSES AND SKILLS

Below are listed groups of processes and skills which are thought important to develop in order to learn science. The list is far from exhaustive, and it is not intended to be prescriptive. It is rather to help teachers check that the basics are touched on somewhere in a course, sometimes in a systematic way.

Scientific

- Practical/experimental
 - Designing experiments
 - Observing
 - Measuring
 - Experimenting
 - Recording
 - Discriminating
- Organizational
 - Classifying
 - Organizing
- Interpretation
 - Inferring
 - Hypothesizing
 - Authenticating
 - Analyzing
 - Synthesizing
 - Evaluating
- Application
 - Predicting

Problem-Solving:

- Recognize a problem
- Represent the problem
- Devise/choose a solution plan
- Execute the plan
- Evaluate the solution

Decision-Making:

- Define the goal
- Identify alternatives
- Analyze alternatives
- Rank alternatives
- Judge highest ranked alternatives
- Choose 'best' alternative

Conceptualizing:

- Identify examples
- Identify common attributes

Conceptualizing (cont'd):

- Classify attributes
- Interrelate categories of attributes
- Identify additional examples/non-examples
- Modify concept attributes/structure

Critical Thinking:

- Distinguish between verifiable facts and value claims.
- Distinguish relevant from irrelevant information, claims, or reasons
- Determine the factual accuracy of a statement.
- Determine the credibility of a source
- Identify ambiguous claims or arguments
- Identify unstated assumptions
- Detect bias
- Identify logical fallacies
- Recognize logical inconsistencies in a line of reasoning
- Determine the strength of an argument or a claim
- Participate in discussion using scientific terms
- Ask for evidence for statements made in discussion
- Give evidence for statements made in discussion

Social:

- Work with others
- Contribute to discussion
- Responsibility
- Persistence
- Willingness to learn

Communicating:

- Describe, verbally or in writing, a procedure or investigation.
- Ask relevant questions about a report given by the teacher or another student.
- Design diagrams and illustrations to convey information (including maps, flow charts, wiring diagrams).
- Choose and use the most appropriate means of communication eg diagram, texts, display and photographs

ASSESSMENT

WHAT IS ASSESSMENT?

Assessment in science refers to any method teachers use to measure the performance of students in relation to the objectives of the science course.

ASSESSING ATTITUDES AND VALUES

What are the advantages of assessing attitudes?

- Students are more likely to think that attitudes are important if they are assessed in some way.
- It provides evaluation information on different ways appropriate attitudes can be fostered amongst students in particular learning activities.
- It allows teachers to determine whether attitudes are being established.

What are the problems associated with assessing attitudes?

- Some people have ethical objections to assessing attitudes, such as:
 - Establishment of objective criteria and applying them without subjectivity;
 - Attempting judgements of students which may be subjective.
- Some students reveal their attitudes more readily than others. Quiet steady workers may have excellent attitudes, but they are rarely exposed.
- If students are aware that attitudes are being assessed in a particular session, they can easily adopt the desired attitude.
- Attitudes cannot be easily quantified, and there are educational objections to including them in a students' global mark.
- The time required to assess attitudes.

How can attitudes be assessed?

- First students need to be aware of what the desirable attitudes are, and why they are important.
- It is important to look for changes in attitudes if students attitudes are different to the intended ones early in the year.
- Assessment of attitudes needs to be primarily based on observation of students over the whole of the course, not just on isolated incidents.
- Observation of students' attitudes needs to occur in contexts where students are likely to display their attitudes, eg field trips, practicals, projects, discussions and seminars, and records kept by using rating scales and/or criteria listings.
- Observations of students' attitudes can be done by:
 - Teacher assessment - the standard method.
 - Self-assessment - here students assess themselves. Students can be surprisingly honest and perceptive about their own attitudes.
 - Peer assessment - here a student is assessed by his/her peers. This can bring out some revealing insights that may not have been apparent to the teachers. However, care must be taken here.
- Besides observations, students attitudes can be assessed by completion of questionnaires or by the expressing of their opinions in essays, eg Do we mine in the Antarctic?

How can students' attitudes be recognised and reported?

- Mark - Attitudes could be given a weighting when compiling the over all course mark (eg 10% or less). This could be as a part of a test or not.
- Profiles - A listing of desired attitudes could be listed and then either:
 - Indicate on a check list those which are observed (based on reflection or impressions over the term, or accumulated check lists);
 - Report only those observed (based on reflection or impressions over the term, or accumulated check lists);
 - Use a four or five point rating scale (based on reflection over whole term).
- Descriptive statements - Assessments could be referred to when completing reports or testimonials.

INTEGRATING VALUES WITH TOPICS

One of the principal objectives of this framework is to help teachers systematically plan how to integrate values with the content and process of their teaching. The summaries of topics and units of work set out on the next seven pages attempt to show in different formats how the elements of the framework can be used to assist the planning process. The topics are not intended to be exhaustive or prescriptive. They merely suggest some possibilities.

TOPIC — CELLS

Content	Issue	Value/Attitude	Valuing Process	Process/Skill
• Structure • Plants • Animals • Protista	• Drugs • Antibiotics	• Honesty and accuracy of observation • Appreciation of complexity • Recognise God as the sustainer of all life • Cooperation • Care of equipment	• Teacher demonstration of drawings • Check student drawings • Discussion on cell complexity extending to an appreciation of design in creation • Ensuring on task sharing • Teacher demonstration of equipment care	• Observing • Recording • Discriminating • Microscope use • Draw • Prepare slides • Working with others • Responsibility • Contribute to discussion • Describing

TOPIC — ACIDS AND BASES

Content	Issue	Value/Attitude	Value Strategies	Process/Skill
- Acids and Bases. - strong and weak - concentrated and dilute - Indicators - pH - Common acids and bases - Types of reactions	- Acid rain - Lake sterility - Photochemical smog - Soil conservation - Age of limestone Caves Safety	- Accuracy and precision - Avoid presumptions - Willingness to follow instructions - Environmental safety Personal safety - Honesty in recording - Cleanliness to prevent contamination - Decision making - Acceptance of God's natural laws	- Classroom routines - Questions about different results - Demonstration of techniques - Research assignments - Examining consequences of issues - Demonstration of techniques - Discussion using the analogy that great consequences rest on small decisions eg acid/base end points - Use acid-base equilibrium to show it is an example of God's natural laws	- Using indicators - Filtration - Weighing - Pipetting - Rinsing - Calculation - Interpreting pH - Comparing - Matching colours and codes - Using symbolism - Identification of unknowns as acids and bases - Making indicators from plants - Working with others - Working sequentially on a task

MOTION

Context/Issue	Process/Skills	Unifying Statements	Values	Value Strategies
• Motion: • Speed • Velocity • Acceleration • Forces • Gravity • Crumpling car fronts • Deformation on impact • Road toll - seat belts. Who pays?	• Measuring: • Time • Distance • Calculating: • Speed • Acceleration • Drawing and interpreting graphs: • Distances and time • Velocity and time • Interpolation • Extrapolation • Designing table for data • Design and perform experiments using tickertimers and stop watch • Use of special apparatus • Measurement of forces	• Conservation of energy • Newton's laws of motion • Concept of momentum	• Need for care, accuracy and discernment in making measurements • Honesty in reporting and conducting experiments • Willingness to predict outcomes • Willingness to own their predictions and findings • Acceptance of scientific method of enquiry • Emotional response to relationships between: • Time • Velocity • Mass - God is omnipotent, omnipresent • Order which appears out of apparent chaos	• Demonstration • Computer simulation to predict effects of forces • Challenging students to publicly own and affirm their predictions and conclusions • Set up and use controlled experiments • Teach model of enthusiasm • Scale modelling of astronomical sizes and distance • Question to focus on apparent conflict

A TOPIC OVERVIEW — THE GREENHOUSE EFFECT

VALUES

- Environmental sensitivity
- Integrity of industry, government
- Inventiveness in seeking solutions
- Open mindedness
- Responsibilities
- Unselfishness - balancing personal wants against global needs

ISSUES

- Acid rain
- Changing technology
- Coastal ecology
- Commercial interests
- Global warming
- Individual rights
- Press dramatization

UNDERLYING PREMISES

- The environment is fragile due to the critical interdependence of physical and biological systems.
- The consequences of man's sin cause the degradation of the environment.
- Humans have the God-given obligation to care for and conserve the environment.
- Science is a useful tool for solving some problems.
- The application of scientific knowledge does not solve all the problems of mankind.
- All life is a sacred gift from God.

ACTIVITIES

1. Attempt an experiment to see how the greenhouse works. For example, measure the temperature inside and outside a car or model greenhouse and account for the difference.
2. Survey car port use or use of public transport to emphasize responsible fuel use, environment sensitivity, and balancing personal and global needs.
3. Determine students' pre-conceived ideas about the issue.
4. Contact the EPA or NRMA Associations for information about the greenhouse.
5. Screen a report from Beyond 2000 etc, list the issues and values, and then discuss or debate them.
6. Get students to role play to pretend they are a radio announcer to report on the issues as they see them. They can attempt to pose solutions for some problems.
7. Have students bring information about exhaust gases from tune up specialists who analyse engines. Compare gas, diesel and petrol engines. Analyse the data and suggest ways to reduce CO₂.

8. Go on to role play the car owner told to repair a catalytic converter when he knows he keeps using the car without doing so. Also, play the roles of the engineer, analyst and mechanic involved.
9. Pose a hypothetical: You are a factory manager who knows the law is outdated. Should your company be more responsible than the law? What should you do?

Also use value analysis to weigh up the consequences of the choices made, and evaluate the values that underly the choices.

10. Record or stage a debate between a greenie and an industrialist or a minister. Class members could also stage a debate.

TEXTS

- John 14:6
- Psalms 21:1
- Psalms 8:6
- Genesis 3:15-19
- 1 Corinthians 10:31
- Romans 1:28
- Matthew 6:25-30

SUMMARY OF A UNIT

PROCESS ORIGINATED UNIT - ASTRONOMY

PROCESSES TO BE TAUGHT

- Observing the sky
- Describing and recording observations
- Classifying observations
- Interpreting tables, diagrams and pictures
- Communicating by spoken and written word
- Researching information – book references, videos, data bases

UNDERLYING PREMISES

- Scientific information can lead one to an appreciation of the Creator
- Our creation model is an interpretation of the observable facts and Divine revelation which answers the question of origins

CONTENT TO ACHIEVE PROCESS OBJECTIVES

LOOKING UP! – Astronomical Observations

ATTITUDES/VALUES

- Appreciation of design, magnitude, scale, development of knowledge with increased technology, creativeness of early astronomers, scepticism to new ideas
- Open-mindedness to new theories
- A recognition of the limits of science in predicting origins
- Perseverance and tenacity log of observations

SKILLS

- Observing
- Describing
- Researching information
- Collecting information
- Summarizing
- Interpreting descriptions – text, tables, diagrams and pictures
- Classifying according to criteria

ISSUES

- Space exploration: the economics of satellites and political use of (including spying) pollution, space junk, nuclear devices
- International cooperation
- The origin of the earth, solar system, matter
- Life on other planets
- Space invasion for resources

INTEGRATION

Observations beyond our immediate environment lead to the consideration of the ultimate sources of energy, matter and life. The unit provides opportunity to link scientific observation, speculation and theories to a foundation of the school's philosophy. God's creation of the worlds as revealed in scripture is supported.

CORRELATION CHARTS

To make your overall planning more systematic, it could be helpful to use the correlation charts on the following pages. You can develop each chart to make an overview of the use of values, issues or skills in your course, unit or topic. When using the charts, write the title of your units vertically.

						T O P I C	UNDERLYING PREMISES
						S	Creation
							The Environment
							Ethics
							The Human Body
							Natural Laws
							Nature of Science
							Relationships
							Reporting of Research
							Safe Practices
							Science and Religion
							Sources of Knowledge
							Value of Life

APPENDICES

APPENDIX 1

SOME SCIENCE SKILLS

This list contains science skills which could be assessed in a written test. It is by no means finite. You may be able to add more science skills to this list as you use it.

SKILLS RELATED TO THE LABORATORY

- Identify basic laboratory apparatus
- Select the most suitable item of equipment for a stated task
- Identify hazards in the laboratory
- Suggest means to maximise safety and minimise anticipated hazards

SKILLS RELATED TO OBSERVING

- Make qualitative observations of an object or situation
- Make quantitative observations of an object or situation
- Make observations which describe change
- Make observations in correct sequence
- Discriminate between relevant and irrelevant observations
- Identify similarities and differences
- Recognise limitations of making observations unaided by mechanical devices
- Record observations accurately
- State sources of error in observation
- Explain sources of error in observations
- Explain inconsistent observations
- Repeat observations to check accuracy

SKILLS RELATED TO INFERRING

- Make inferences about an object or situation
- Distinguish between an observation and an inference
- Identify observations that support an inference
- Suggest additional observations that could support or disprove an inference
- Make logical inferences from data presented in tables or graphical form

SKILLS RELATED TO MEASURING

- Select appropriate instrument required to make a measurement
- Accurately read linear, curved or circular scales
- Compare accuracy of various instruments used for similar purposes
- Estimate readings which fall between scale divisions
- Use appropriate metric unit when recording measurements
- Convert between various metric units
- Identify sources of errors in measurements
- Record measurements at an appropriately significant level

SKILLS RELATED TO CLASSIFYING

- Categorize objects according to a predetermined set of properties
- Identify the basis on which a set of items has been grouped
- Use a classification key to identify an object (keys can be branching, dichotomous or circular)

SKILLS RELATED TO TRANSPOSING INFORMATION

- Identify the most appropriate form to present information
- Draw a diagram from a written description
- Write a description of information contained in diagrammatic, pictorial or symbolic form
- Draw a flow chart or map from written information
- Graph information presented in table or written form
- Construct a table from information presented in graphical or written form

SKILLS RELATED TO INTERPRETING DIAGRAMS

- Use title, subtitles and/or labels to extract information presented in diagram form
- Use the key to interpret symbols used in diagrams
- Identify the relationships, steps, cycles or sequence of events from diagrams
- Relate information in diagram to any accompanying prose

SKILLS RELATED TO READING MAPS

- Locate and identify compass direction displayed on a map
- Locate and interpret symbols used in a key or legend on a map
- Locate, identify and use the scale on a map
- Use grid marks (co-ordinates) on a map
- Extract information from a weather map
- Extract information from a geological map

SKILLS RELATED TO READING TABLES AND GRAPHS

- Use the title, subtitle and/or keys to interpret information in tables
- Locate and extract specific information from tables
- Use the title, subtitle, labels and/or key to interpret information in line, column or pie graphs
- Locate and extract specific information from graphs
- Compare and contrast different quantities plotted on the same grid
- Recognise trends in graphed data

CONSTRUCTING TABLES AND DRAWING GRAPHS SKILLS

- Construct appropriate cell grid for entering data
- Devise appropriate headings of columns and/or rows
- Record data in correct cell grid
- Write an appropriate heading for a table
- Recognise dependant and independent variable
- Select and label axes
- Choose a suitable scale for each axis
- Plot points
- Draw a line or curve of best fit when appropriate
- Connect plotted points with a straight line when appropriate

SKILLS RELATED TO MAKING PREDICTIONS

- Recognise patterns and trends in data
- Predict outcomes from observations of patterns or trends in data
- Interpolate information from a graph
- Extrapolate information on a graph
- Predict the consequences of changing the variables in an experiment

SKILLS RELATED TO DESIGNING AN EXPERIMENT

- Define the purpose of the experiment
- Construct a hypothesis
- State any relevant assumptions underlying the hypothesis
- Define clearly what is to be measured or observed
- Identify variables which can/cannot be controlled
- Plan adequate control of variables
- Select equipment required and plan procedure
- Suggest appropriate means to collect, record and analyse observations or measurements
- Plan repeated trials when necessary
- Recognise that variables can only be investigated once at a time

ANALYSING RESULTS AND MAKING CONCLUSIONS SKILLS

- Use simple mathematics to re-organise quantitative information eg averaging
- Recognise when data supports hypothesis or not
- Recognise trends and relationships in data
- Recognise consistencies and contradictions in data
- Make tentative conclusions on the basis on simple observations
- Make correct conclusions on the basis of multiple observation
- Identify observations that support a conclusion
- Make generalisations from analysed data
- Solve problems which require the drawings of tangents to curves in order to determine gradients
- Solve problems which involve the use of the area under a curve

SKILLS RELATED TO EVALUATING AND APPLYING

- Evaluate conclusions
- Evaluate experiments in terms of stated purpose
- Recognise interpretations which are over generalisations
- Identify criteria when making judgement
- Judge the validity of interpretations of data
- Evaluate solutions to problems in terms of outcomes which might affect individuals or groups
- Distinguish between evidence, hypothesis and opinion
- Modify hypothesis in the light of non-supporting observations
- Apply the results of an experiment to make inferences about another situation
- Apply the information with a map to make reasonable and consistent conclusions
- Use models to explain phenomena

SKILLS RELATED TO CRITICAL THINKING

- Formulate cause-effect relationships
- Recognise ambiguity
- Give reasons
- Defend a point of view
- Use analogies
- Suspend judgement in the absence of evidence
- Make appropriate decisions based on the results of experiments
- Accept a 'no conclusion' result if evidence is inconclusive
- Apply a critical approach to all thinking tasks
- Disclaim the validity of non-scientific and pseudo-scientific arguments

SKILLS RELATED TO PROBLEM-SOLVING

- Use a 'scientific approach' to problem solving
- Identify parts of the scientific method
- Isolate the single major idea of a problem
- State problems as a definite, concise questions
- Recognise the difficulty in clearly defining some problems
- State sub-problems or hypothesis related to the main problem
- Categorise the nature of the problem (moral, political, social or scientific etc)
- Distinguish between problems which can and cannot be solved by science
- Identify the relevant variables in a problem
- State methods of collecting evidence on problems (direct observation, interviewing, research, experimenting)
- Recognise causes of problems eg new technology
- Apply existing knowledge in formulating possible solutions to the problems
- Make recommendations as to the best solution to a problem

APPENDIX 2

SUGGESTIONS ABOUT ASSESSMENT

INTRODUCTION

What is Assessment?

Assessment in science refers to any method teachers use to measure the performance of students in relation to the objectives of the Science course.

Assessment can be done by:

- Evaluating pen and paper test
- Appraising discussion with students.
- Observing student behaviour in class.
- Marking assignments.
- Marking books.
- Evaluating experimental research work.
- Criticising students lectures and debates.
- Commenting on student performance in role plays and simulations, or on excursions and field work.
- Monitoring student response to audio-visual materials.
- Observing the student's practical work.

Why Assess?

- To ascertain the existing knowledge and prior experience that students bring to the learning task.
- To monitor the progress of students.
- To provide feedback to students.
- To establish a single global mark.
- To measure the extent to which students meet the course objectives.
- To assess a student's potential in a subject.
- To provide feedback to the teacher.
- To provide feedback for employers.
- To provide feedback for parents.
- To enhance self-esteem by encouraging students .

What is the Role of a Teacher in Assessment?

A teacher has three separate and distinct roles in assessing students' performance in science.

- To act as an agent of the various government education departments, or ministries, in certifying that students have satisfactorily studied the prescribed course.
- Fulfil the school's requirements that certain assessment practices be carried out.
- As a respected professional give account of the students' development.

Science teachers have no control over the first role, and have varying input into the second. It is the third role which is their total responsibility.

Because of the importance of meeting the needs of each student in science as much as possible, this requires teachers to base programs and teaching strategies on the needs, interests and abilities of students. It follows therefore that assessment procedures should also reflect this basic philosophy. Consequently, science departments should:

- Monitor the performance of individual students using continuous and appropriate assessment procedures in order to:
 - Determine student mastery of skills and processes;
 - Detect and diagnose learning difficulties;
 - Provide feedback to teachers and students;
 - Plan relevant activities and strategies,
 - Assess the effectiveness of programs and strategies.
- Maintain an accurate and continuous record of each student's performance in order to -
 - Monitor student developments;
 - Report student progress;
 - Assist future planning.
- Move towards profile reporting in order to -
 - Communicate student progress;
 - Describe the range of student achievements;
 - Report on different areas of achievement in their most appropriate form.

What to Assess?

In assessing a student's performance in science a measurement must be made of the extent to which the student has achieved the objectives of the teaching program(s).

These objectives should focus on knowledge, processes, skills, attitudes and values.

USE AND INTERPRETATION OF ASSESSMENT

The results from assessments are usually interpreted in two different ways depending on the purpose. A **Criterion Referenced** interpretation, being mastery based or diagnostic in purpose is the most philosophically compatible with Christian values. However because of the need to cope in a real world the **Norm Referenced** interpretation, which ranks students, is also important for they must prepare for life in society.

When to Assess

A wide variety of assessment methods need to be used to meet the broad range of the objectives established for the teaching of science.

Assessment procedures should be planned at the same time as your objectives.

You should use your objectives for each topic unit as the basis of the assessment scheme for the unit. Consider each objective in turn and decide:

- Which objectives will be assessed during the teaching of the unit;
- Which will be assessed at the end of the unit;
- The method(s) by which each objective will be assessed.

Objectives relating to practical skills, social interaction skills, expression and communication and attitudinal development might best be assessed during the teaching of the unit, while knowledge and the ability to apply information and solve problems might best be assessed at the end of the unit. This is not to suggest that formative or diagnostic assessment procedures should not be used during the unit. In fact in some cases, diagnostic tests should be given to assist in determining the teaching strategies to be used and the point at which the next teaching sequence should start.

TYPES OF REPORTING SYSTEMS

The reporting system you use to communicate information to parents, students and others should be consistent with the aims of your science department, which in turn must be consistent with the philosophy of the syllabus and school.

Above all it should tell its audience what the student has actually achieved - many report forms only indicate how the student compares with other students. It should be an effective communication to the audience for whom it is prepared, simple to understand and not open to misinterpretation.

Single Mark System:

The 'global index'. The candidate's achievements are reported as numerical scores, commonly on 0-100 scale - ie a percentage mark.

Simple Ranking Systems:

Such as position-in-year or position-in-class.

Two Category Systems:

Such as PASS/FAIL gradings, or SATISFACTORY/UNSATISFACTORY gradings. (Unsatisfactory may only be implied by the omission of the 'satisfactory').

Multi-Category Systems:

Typified by A-E or 1-5 gradings or percentile bands. These may be based on a fixed percentage of students in each grade or the student's level of achievement may be determined by the subjective judgements of teachers.

Descriptive Statements of Students' Achievements:

These are written statements which describe what a student can and cannot do, how skills and attitudes have developed during a course of work, where interests lie, strengths and deficiencies of the student, etc.

Profiles:

Use one or other of the systems above but present the various components of the total assessment in a course separately with no attempt to combine the components to a single or global index.

Since not all students will progress at the same rate, nor will they reach the same endpoints your assessment strategies should be designed to determine how far they have progressed and your reporting strategies should be designed to communicate their current levels of progress and achievement on a wide variety of syllabus objectives. For example you might decide to report on:

- Elected objectives in each unit of work, or;
- Each area which is indicated by the statement of minimum acceptable objectives;
- Other areas which reflect the policies of the school and/or science department.

These judgements may be conveyed by either a profile or descriptive report.

ASSESSING KNOWLEDGE

From time to time, teachers will need to test the acquisition of knowledge of scientific concepts. This should not be done simply to determine which students are best at

learning and recalling facts. The concepts should be those which students need to proceed to higher level skills.

ASSESSING SKILLS/PROCESSES

Practical work, including classroom, field and laboratory activities should form the basis for the majority of the science experiences of students. Regular assessments are required to measure the extent to which students have achieved the practical skills objectives. Because the syllabus emphasises the development of individual students it is important that assessment of practical skills be continuous so that individual needs can be identified for the purposes of remediation or enrichment.

Concepts and skills developed in science can frequently be used in everyday situations to solve problems. This is implied by the syllabus in both the statement of aims and content.

Communication refers to the basic skills of reading, writing, speaking and listening, as well as to the more specific skills which we use in science such as drawing, tabulating data, graphing, using symbolic expressions and using other means such as photographing and tape recording.

The social interaction skills referred to in the syllabus involve students in communicating, cooperating and organising with each other, and tolerating other viewpoints. Assessment policies should include components which will assess students' achievements in these areas.

INSTRUMENTS OF ASSESSMENT

ASSIGNMENTS

In assignments the student is required to answer questions or solve problems. Doing an assignment may involve a student visiting a library. The response could involve writing, diagrams or listing steps in the solution of the problem.

Objectives which may be achieved and used as a basis for assessment include those related to:

- Locating and extracting information;
- Organising and presenting information;
- Interpreting and evaluating information;
- Drawing diagrams, graphs, tables;
- Collecting objects;
- Taking photographs;
- Creative expression.

BOOKWORK

It is common for a bookmark to be used in a science assessment. This may not have much relevance to science objectives unless suitable criteria have been established and communicated to students. In the context of the syllabus, neatness and completeness of work records are not suitable criteria. However, those aspects may have relevance in the context of other school objectives.

Objectives which may be achieved and used as a basis for assessment include those related to:

- Accurate records of observations, eg tabulation of data, graphs, drawings of observations or pieces of apparatus;
- Reporting conclusions;
- Determining hypothesis and inferences;
- Writing creatively about science experiences.

EXPERIMENTAL RESEARCH WORK

Experimental research projects are under-used in the assessment of many objectives associated with developing problem-solving and communication skills.

Before setting an experimental research project, the teacher must decide on how structured/open-ended the project should be and the objectives for the project.

These objectives should be communicated to students to guide them and should also be used as a basis for assessment. The assessment should be on the basis of the degree of mastery of each objective.

Objectives which may be achieved and used as a basis for assessment include those related to:

- Using and obtaining information;
- Designing experimental research;
- Designing and constructing apparatus;
- Controlling variables;
- Making observations;
- Drawing conclusions from observations of experiments;
- Presenting information.

SEMINARS/DEBATES

Developing communication skills is an important objective of the syllabus. Therefore, assessing reading, writing, speaking, listening and social interaction skills are essential. One method of assessing some of these skills is by student lecturettes and debates.

In a seminar the student is required to give a short talk about an assignment, project or report. The student may also have to answer questions from other students.

In a debate students present two sides of an issue. Debates may be Oxford or Parliamentary in style. The latter provides more students with the opportunity to speak.

In planning a seminar or debate students will need guidance on how to locate, organise, prepare and present the information.

Objectives which may be achieved and used as a basis for assessment include those related to:-

- Communicating and cooperating with others;
- Locating and extracting information;
- Citing evidence in support of claims;
- Evaluating information and ideas;
- Communicating information orally;
- Listening;
- Thinking critically.

EXCURSIONS AND FIELDWORK

Excursions and fieldwork are essential for achieving many objectives in the science syllabus. Such field experiences might include visits to museums, zoos, botanic gardens, local industry and field observations in the local or school environment.

Before leaving the classroom it is important to specify a set of objectives for the excursion. This is a vital step if valid assessment of student performance on the excursion or during fieldwork is to occur.

Objectives which may be achieved and used as a basis for assessment include those related to:

- Describing observations;
- Compiling data;
- Making connections between observations;
- Analysing and synthesizing information collected;
- Communicating information;
- Working cooperatively.

Some ways to assist achievement of objectives and facilitate assessment are:

- To compose structured worksheets with directed responses (N.B. It is important to trial these at the site(s) beforehand);
- To provide appropriate time and resources to enable individual students to complete the worksheets;
- To communicate the marking, grading and assessment scheme to students in advance;
- To pre-teach the skills necessary to carry out the fieldwork.

AUDIO-VISUAL MATERIALS

Viewing films, videos and computer simulations allows students to experience phenomena not normally accessible to them.

Objectives which may be achieved and used as a basis for assessment include those related to:

- Listening and observation skills;
- Interpreting skills;
- Applying information;
- Critically analysing information.

PRACTICAL WORK/TESTS

Laboratory activities and other practical work should form the basis for the majority of the science experiences of students. In order to achieve many of the science department objectives students will need to be involved in a wide variety of practical experiences.

Objectives which may be achieved and used as a basis for assessment include those related to:

- Manipulating equipment;
- Following a set of instructions;
- Controlling variables;
- Making observations;
- Using measuring devices;
- Recording data;
- Cooperating with one another;
- Verbally reporting to the class.

CONCEPT MAPPING

The understanding of the relationship between various ideas can be conveyed visually by a concept map. This can be used as an assessment tool to determine whether students recall the ideas related to a concept and the relationships they have formed between those ideas.

Objectives which may be achieved and used as a basis for assessment include those related to:

- Organizing and presenting information;
- Analysing and synthesizing information collected;
- Making connections between the ideas that form a major idea or concept;
- Communicating relationships in a visual presentation.

PROFILE REPORTS

What's Wrong With Our Current Reports?

Possibly a lot!

Reports which only give a mark and/or grade within the year or class quite often involve the practice of adding a test mark to a book mark and an assignment mark in order to arrive at a final mark which is then used to grade students. Such a practice cannot be justified and is liable to much misinterpretation.

This style of report also usually involves the adding and/or averaging of a number of test marks. Again this practice cannot be justified statistically.

Why Use A Profile Report?

Profile reports concentrate on what a student CAN DO.

Assessment of the student's ability in a larger number of areas may be reported ie the six broad areas of assessment stipulated in the syllabus. This type of assessment is criterion referenced rather than norm referenced. This means that the student's performance is measured against a previously determined standard rather than against the performance of his/her peers. This type of assessment is obviously best reported with a descriptive comment rather than a mark or grade.

This does not mean that some areas of the student's achievement cannot be reported by a mark or grade. The more traditional area of assessment ie knowledge, can still be reported in this way. Assessment strategies for this area may still be norm referenced if it is desired that a ranking of students be achieved.

In designing a profile report the consumers of the report (students, parents, prospective employers, etc) must be kept in mind. The student's **strengths and abilities** in each of the broad areas of assessment may be identified. The report becomes more meaningful as different areas of assessment will be considered more important than others by the various consumers.

The most important aspect of profile reporting is that the comments should concentrate on the **positive** aspects of the student's achievements.

The sample of reports basically use a mixture of reporting styles and may represent an important interim measure before moving to a full profile reporting format.

There are many other designs which could be used. Those included in this document should be used by teachers to generate a form of reporting which is suitable to their particular situation.

Achievement Profile in this Class:

COMMENTS: _____

SDA HIGH SCHOOL
SCIENCE DEPARTMENT

Profile Report on:

For the Period: _____ to _____

Science Class:

Assessment Result: _____ Mark: _____ /100 Position in Class: _____

Achievement Profile in this Class:

KNOWLEDGE	Grade	A	B	C	D	E	(Circle appropriate one)
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PRACTICAL SKILLS

- ☐ Can manipulate equipment.
- ☐ Can observe accurately.
- ☐ Can record observations.
- ☐ Can follow simple instructions.
- ☐ Can make relevant conclusions.
- ☐ Can control variables.
- ☐ Can design an experiment.

RESEARCH SKILLS

- ☐ Can find information with guidance.
- ☐ Can use various resources to find information.
- ☐ Can extract and assemble information.
- ☐ Can show initiative in seeking and gathering information from a wide variety of sources.
- ☐ Can analyse and interpret extracted information.

PROBLEM SOLVING SKILLS

- ☐ Can solve simple problems using experimentation.
- ☐ Can solve simple problems using logical thought.
- ☐ Can solve simple problems using stored information.
- ☐ Can solve simple problems using mathematical manipulation.
- ☐ Can solve difficult problems.
- ☐ Can solve complex problems easily.

WRITTEN SKILLS

- ☐ Can convey simple information in sentences.
- ☐ Can write a simple report.
- ☐ Can write a clear and accurate description of an experiment.
- ☐ Can write a critical analysis using a variety of sources.

READING SKILLS

- ☐ Can follow straight forward verbal instructions.
- ☐ Can follow straight forward written instructions and explanations.
- ☐ Can select and judge written materials in support of an argument.

ORAL SKILLS

- ☐ Can report verbally to the class.
- ☐ Can communicate ideas to others.
- ☐ Can present a logical and effective argument.

SOCIAL INTERACTION

- ☐ Can participate as an active member of a group.
- ☐ Can organise the activities of a group.
- ☐ Can assume responsibility for the decisions of a group.
- ☐ Can tolerate opposing opinions.

COMMENTS: _____

Science Teacher: _____

Science Head Teacher: _____

SDA HIGH SCHOOL
SCIENCE DEPARTMENT

Profile Report on:

For the Period: _____ to _____

Science Class: _____

Assessment Result: _____ Mark: _____ /100 Position in Class: _____

Achievement Profile in this Class:

Grades	1	2	3	4	5
KNOWLEDGE OF SCIENCE CONCEPTS					
PRACTICAL SKILLS					
PROBLEM SOLVING					
WRITTEN COMMUNICATION					
VERBAL COMMUNICATION					

Grades : (An explanation of grades should be included)

COMMENTS: (Include, among others, comments on attitudinal development and social interaction skills)

Science Teacher: _____

Science Head Teacher: _____

It is envisaged that this report could be totally computer generated and presented horizontally on A5 paper for presentation in book form with other sheets for other subjects.

SDA HIGH SCHOOL
SCIENCE DEPARTMENT

Profile Report on:

For the Period: _____ to _____

Science Class:

Assessment Result: _____ Mark: _____ /100 _____ Position in Class:

Achievement Profile in this Class:

Mark : _____ / 100 _____ Position in Class :

KNOWLEDGE

This mark and position have been determined solely on the basis of pen and paper tests.

PRACTICAL SKILLS

- Ability to manipulate equipment.
 - ☐ Can manipulate simple equipment with guidance.
 - ☐ Can manipulate equipment to perform a sequence of tasks after demonstration.
 - ☐ Can select and use suitable equipment for a task, without help.
 - Ability to make accurate observations.
 - ☐ Can make accurate observations with guidance.
 - ☐ Can make accurate observations without guidance.
 - Ability to record observations.
 - ☐ Can record observations in prose.
 - ☐ Can record observations in tabular form.
 - ☐ Can select the most appropriate method of recording data.
-

ABILITY TO APPLY INFORMATION AND SOLVE PROBLEMS

- Ability to classify scientific information.
 - ☐ Can recall the main ideas and important details of scientific reports.
 - ☐ Can distinguish relevant from irrelevant material.
 - ☐ Can recognise the limitations of scientific knowledge.
- Ability to make generalizations from scientific information.
 - ☐ Can evaluate the usefulness of scientific information.
 - ☐ Can apply scientific knowledge to novel situations.
 - ☐ Can analyse data and draw conclusions.

- Ability to extrapolate scientific ideas.
 - ☐ Can solve scientific problems and explain everyday phenomena.
 - ☐ Can synthesize scientific information to solve problems.
 - ☐ Can discuss the impact of scientific discoveries on society.
-

EXPRESSION AND COMMUNICATION

- Ability to express scientific information orally.
 - ☐ Can make sensible replies to simple scientific questions.
 - ☐ Can follow and give simple scientific descriptions and explanations.
 - ☐ Can present a logical and effective argument and analyse others arguments.
 - Ability to present scientific information in a written form.
 - ☐ Can write simple answers to scientific questions.
 - ☐ Can write explanations of work done in scientific terms.
 - ☐ Can write a critical analysis using a variety of sources.
 - Ability to select the most appropriate method of presenting scientific information.
 - ☐ Can write a simple practical report which includes tables, graphs, diagrams, etc.
 - ☐ Can present researched information in prose, tables, graphs, diagrams, etc.
 - ☐ Can produce a structured report based on researched information.
-

ATTITUDINAL DEVELOPMENT

- Displays self-discipline.
- ☐ Is willing to persevere with a task.
- ☐ Can work independently.
- ☐ Displays correct behaviour.
- Seeks solutions to problems.
- ☐ Is willing to seek solutions to problems using classroom resources.
- ☐ Is willing to seek solutions to problems using whole school resources.
- ☐ Is willing to seek solutions to problems using resources from outside the school.
- Suspends judgement till all evidence is presented.
- ☐ Displays an unbiased approach when assessing information.

SOCIAL INTERACTION SKILLS

- Ability to work in a group.
- ☐ Can cooperate with others when asked.
- ☐ Can work with other members of a group to achieve common aims.
- ☐ Can understand own position and results of own actions within a group.

- Ability to help others.

- ☐ Can be an active and helpful member of a group.
- ☐ Can be a decisive member of a group.
- ☐ Can adopt a variety of roles in a group.

- Ability to tolerate another viewpoint.

- ☐ Is willing to listen to the viewpoint of others.
- ☐ Modifies own viewpoint as a result of considering the viewpoint of others.