miniSASS

Share-Net

This pack supports the Eco-Schools theme of 'Nature and Biodiversity'

Grade 7

This pack contains:

Activity One: In this LANGUAGES activity, learners research and find out more about river water quality in their area. A newspaper article forms the focus point for a general class debate around river health.

Activity Two: During this NATURAL SCIENCES lesson, learners investigate the water quality of a nearby river, using the miniSASS toolkit to look for visible animal life.

Activity Three: During this NATURAL SCIENCES lesson, learners categorise the water macroinvertebrates that they found in Activity Two and create their own dichotomous key.

Activity Four: During this ARTS AND CULTURE drama activity, learners follow a teacher-directed warm-up routine. They also mimic the behaviour of some of the water creatures they found during the miniSASS activity earlier.

Activity Five: Water can make things look bigger than they really are. This "Just For Fun" activity gives full instructions for making a magic magnifier (convex water lens.)

WESSA
PEOPLE CARING FOR THE EARTH

This pack of lesson plans is part of a series of lesson plans which focus on water quality and the miniSASS toolkit. This resource development project has been funded by the Water Research Commission, Private Bag X 03, Gezina, Pretoria, 0031 (Website: www.wrc.org.za).

Water Research Commission

Activity	Learning Area covered in this activity	Learning Outcomes covered in this activity	Assessment Standards covered in this activity
1. Learners research and find out more about river water quality in their area. A newspaper article forms the focus point for a general class debate around river health.	Languages	**Learning Outcome 2:** Speaking: The learner will be able to communicate confidently and effectively in spoken language in a wide range of situations. **Learning Outcome 3:** Reading and Viewing: The learner will be able to read and view for information and enjoyment, and respond critically to the aesthetic, cultural and emotional values in texts.	Communicates ideas, facts and opinions clearly and with some accuracy and coherence, using a limited range of factual oral text types (e.g. discussions, short arguments.) Demonstrates basic interaction skills by participating actively in group discussions, conversations, interviews and debates, and while so doing: • tackles important issues (e.g. social and ethical issues related to the environment and human rights); • acknowledges other opinions. Shows sensitivity to the rights and feelings of others. Reads aloud and silently for a variety of purposes using appropriate reading strategies (e.g. skimming and scanning, predictions, contextual clues, inferences.)
2. Learners investigate the water quality of a nearby river, using the miniSASS toolkit to look for visible animal life.	Natural Sciences	**Learning Outcome 1:** Scientific investigations: The learner will be able to act confidently on curiosity about natural phenomena, and to investigate relationships and solve problems in scientific, technological and environmental contexts.	Conducts investigations and collects data: Organises and uses equipment or sources to gather and record information. Evaluates data and communicates findings: Generalises in terms of a relevant aspect and describes how the data supports the generalisation.
3. Learners categorise the water macroinvertebrates that they found in the previous activity and create their own dichotomous key.	Natural Sciences	**Learning Outcome 2:** Constructing science knowledge: The learner will know and be able to interpret and apply scientific, technological and environmental knowledge.	Categorises information: Compares features of different categories of objects, organisms and events.
4. Learners follow a teacher-directed warm-up drama routine. They also mimic the behaviour of some of the water creatures they found during the miniSASS activity earlier.	Arts and Culture	**Learning Outcome 1:** Creating, interpreting and presenting: The learner will be able to create, interpret and present work in each of the art forms.	Drama: Follows a teacher-directed warm-up routine.
5. Water can make things look bigger than they really are. This “Just For Fun” activity gives full instructions for making a magic magnifier (convex water lens.)	Technology and Natural Sciences	-	-

ACTIVITY ONE: RIVER WATER QUALITY – WHO IS REALLY RESPONSIBLE?

In this LANGUAGES activity, learners research and find out more about river water quality in their area. A newspaper article forms the focus point for a general class debate around river health.

ACTIVITY:
Ask the learners:

1. Have you seen or taken part in a debate?
2. What was it about?
3. Where did it take place?
4. Who was taking part in the debate? *Prompt: Politicians, general public, members of a group or organisation.*

READ THE FOLLOWING TO YOUR CLASS:
A debate is an organised clash of good ideas. Each side uses worthwhile evidence to promote their viewpoint and to challenge the "flawed" evidence advanced by the other side. Debating is a formal intellectual contest and it can take place in many different ways. However, a good debate is like a tennis match where each side, following the rules set down, bats ideas back and forth to defeat the other team. Debaters have to persuade the judges that their argument is best and that they should win. Emotions often run high in debates and it can be very exciting!

What makes a good debater?
Debaters challenge ideas, they do not attack each other. Like other sports, fair play is critical. Regular debaters will be transferred to play on the other side later in their careers, so it does not pay to be too emotionally tied. A debater is a spokesperson during a particular time for or against a motion and is not a fanatic for a cause.

How do we conduct a debate?
There are different ways to hold debates. Generally, you need a Chairman, Proposer, Opposer, Proposer and Opposer's Seconders and a Timekeeper.

ACTIVITY:
Hand out pages 2 and 3 to the learners. After reading ‘Debate Rules (page 2)’, let the learners try to work out the correct sequence that a debate should follow on page 3. *Answers on page 4.*

DEBATE RULES

1. **Chairman:** Controls the debate; is neutral; a type of judge.
2. **Proposer:** Speaks for the motion; a type of lawyer arguing for the motion.
3. **Opposer:** Speaks against the motion; a type of lawyer arguing against the motion.
4. **Proposer's Seconder:** Second speaker for the motion; helps proposer.
5. **Opposer's Seconder:** Second speaker against the motion; helps opposer.

Motion: The topic being debated; the wording is important.

How to proceed in a debate:

A) No. 1 Reads the motion
No. 2 Speaks **for** the motion
No. 3 Speaks **against** the motion
No. 4 Speaks **for** the motion
No. 5 Speaks **against** the motion

B) Then after numbers 2-5 have spoken:

I. Chairman opens debate to the floor (rest of the class).

II. Individuals ask questions of speakers 2-5 only when chairman says they can speak.

III. Individual stands up and starts by saying, "Mr/Ms Chairman."

IV. Individuals speak carefully. No insulting names, must say things like, "a previous speaker" or "the proposer's seconder says…"

V. Keep the debate impersonal, attack ideas **not** people.

VI. Individuals can make statements or ask speakers 2-5 to explain something. Speakers 2-5 answer.

C)

I. After the class has nothing else to say or ask, or if time is up, the Chairman closes the debate to the floor (the class).

II. Chairman asks the **Proposer** to briefly sum up his/her main idea.

III. Chairman asks the **Opposer** to briefly sum up his/her main idea.

IV. Chairman then reads the motion to the class (to make sure they understand it.)

D) The Chairman stands up and asks:

I. "Those **for** the motion to put up their hands." (chairman counts and writes down the number).

II. "Those **against** the motion to put up their hands." (chairman counts and writes down the number).

III. "Those who are neutral/abstaining (can't make up their minds) put up their hands." (chairperson counts and writes down the number).

IV. Chairman then says whether the motion is **carried** (proposer wins) or **defeated** (opposer wins) by saying "I declare this motion – reads motion – carried or defeated."

Remember:

- Abstainers, no matter how numerous, can never win.
- Chairman has casting vote in the event of a tie.
- Vote on the ideas heard in the room, not on what you know from elsewhere.

Source: http://www.learnquebec.ca/export/sites/learn/en/content/curriculum/social_sciences/documents/debate_rules.doc

See if you can un-muddle the steps in this debate by putting a number next to each sentence…

An opposer sums up their group's main argument.

The first proposer presents the arguments for the motion.

The Chairman announces the result of the vote.

One of the proposers presents their arguments for the motion.

Everyone votes (apart from the Chairman).

The debate is chaired by the Chairman, who reads out the motion.

This side-to-side motion continues until everyone has had their say. You can only speak ONCE during the debate.

A proposer sums up their group's main argument.

The first opposer presents the arguments against the motion.

An opposer presents their arguments against the motion.

The Chairman re-reads the motion.

Check your answers against the correct order:

1. The debate is chaired by the Chairman, who reads out the motion.
2. The first proposer presents the arguments for the motion.
3. The first opposer presents the arguments against the motion.
4. One of the proposers presents their arguments for the motion.
5. An opposer presents their arguments against the motion.
6. This side-to-side motion continues until everyone has had their say.
7. You can only speak ONCE during the debate.
8. A proposer sums up their group's main argument.
9. An opposer sums up their group's main argument.
10. The Chairman re-reads the motion.
11. Everyone votes (apart from the Chairman).
12. The Chairman announces the result of the vote.

CLASS ACTIVITY:
Photocopy *The Witness* newspaper article *'A river in crisis'* (on pages 5 and 6) – this is a shortened version of the story - and hand a copy to each learner in your class to read.

ASK THE LEARNERS THE FOLLOWING QUESTIONS:

1. Why is this newspaper article called *'A river in crisis'*?
2. Have you seen any rivers in crisis in your area? What did you see?
3. What are the many uses of rivers?
4. Who are all the people who make use of rivers? For what uses/purposes?
5. What do you think is meant by " … Man did not weave the web of life, he is merely a strand in it. Whatever he does to the web, he does to himself."

A river in crisis

15 Feb 2008

Julia Denny-Dimitriou

"Duzi Canoe Marathon 2008 has come and gone. The organisation was great, ... records were broken and with Michael Mbanjwa winning his first Duzi and Martin Dreyer his seventh, history was made. Pity about the bugs ..." So writes Dave Still, chairman of DUCT (Duzi-uMngeni Conservation Trust), on the organisation's website.

The "bugs" in the Umsunduzi river not only made local and national news, they also made many of the paddlers in the canoe marathon sick with "Duzi guts" — diarrhoea and/or vomiting. DUCT conducted a survey among competitors which found that 45% of the Duzi 2008 participants became ill. The Duzi organising committee threatened to move the start of the race, and, if necessary, to cancel it. It also expressed concern that international competitors might not return to participate in future events.

"Duzi guts", however, is not a new phenomenon. According to Still, a paddler himself, canoeists have experienced it for 30 to 40 years and the water quality during the 2006 marathon was even worse. On the first day of that race, the E.coli readings were over 50 000 counts per 100 ml (a "tolerable" or "moderately low" count is 10 000 to 20 000).

The issue of bugs in the river is much broader and more serious than the future of the canoe marathon. The state of rivers is a vital indicator of the health of the catchment area around them and how the land is being used. "If a river is stressed, it means that the whole ecological system is stressed," says Ezemvelo KZN Wildlife aquatic scientist Nick Rivers-Moore.

The Witness has carried allegations that local people are dying of sewage-borne diseases such as hepatitis and severe diarrhoea (The Witness, February 1). The Witness contacted the KwaZulu-Natal Department of Health about the effect that E.coli levels in the river have on the health of communities that live on its banks. However, the department had not responded at the time of going to press.

Why has this happened?

If the river has been polluted enough to make paddlers sick for years, we have to ask why this has been allowed to happen and what must be done to clean up the Duzi.

According to Still, river pollution has been allowed to deteriorate to its current levels because the health of rivers is not an issue of public concern. On the DUCT website he writes: "When the lights go out, everyone notices. If your water supply failed you would certainly have something to say about it. A failure of the sewerage system, on the other hand, can go on for years or even decades without anyone caring, because who knows or cares if the river is chronically polluted?"

Rivers-Moore believes the state of local rivers is also the result of "the gap between science and management". "Scientists may know why things happen and what to do about them, but their scientific knowledge needs to be mainstreamed — made available to people in management and put into practice."

Judging by the process required to gather information about this issue, it seems as though no single government authority or organisation is responsible for river management. It falls between two bodies: the Department of Land Affairs and the Department of Water Affairs and Forestry (DWAF). The process becomes even more complex when it gets down to the local level.

What causes the pollution?
The Duzi suffers three main types of pollution: solid waste, faecal waste or sewage, and industrial pollution. E.coli from faecal pollution are the bugs that make Duzi paddlers ill. Regular water quality testing shows that pollution enters the Duzi inside the city's municipal boundaries where an estimated 600 000 people live. The section of the river affected stretches from Edendale below Henley Dam to beyond the Darvill waste water plant on New England Road.

According to river scientist and environmental consultant Dr Mark Graham, faecal pollution is the biggest and most complex problem, and is tied in with solid waste. "Storm water drains and sewers become blocked because communities use them as rubbish dumps. Many sewers are broken and need repair. Damaged pipes can obviously let raw sewage out and storm water in. Unscrupulous property developers and poorly informed members of the public also illegally discharge storm water into the sewers rather than storm-water drains. Pressure build-up can make sewers overflow, sometimes discharging raw sewage into the rivers and streams.

"The situation is made worse during storms, which is what happened during the Duzi marathon. Under extreme conditions the Darvill sewage works cannot cope with the large volumes of storm water that find their way into the sewers. The plant is unable to put this mix of storm and waste water through the system and clean it properly. Instead, it is forced to treat the sewage with large quantities of chlorine and pump it directly into the river. What happens when there is a storm is like expecting the R103 to carry the traffic that uses the N3 during peak holiday season."

What needs to be done?
Sorting out the faecal and solid waste problems requires action across a broad front, with the Msunduzi Municipality taking the lead role. The major requirements are:

• provision of solid waste and sewage services and infrastructure supported by consumer education;

• monitoring, replacement, repair and maintenance of sewers;

• replacement, repair and maintenance of equipment in the municipal water and sanitation department;

• more skilled staff; and

• inspection of new property developments and enforcement of municipal building by-laws on storm and waste water management.

Dealing with the industrial pollution requires a similar effort by the municipality to monitor and control industries that illegally discharge industrial waste into the river and DWAF to prosecute offenders.

Is it too late?
Dr Graham still believes that it is not too late to clean up the rivers and that the pollution is reversible. However, he says, "...we should be realistic. While we can hope for better [water] quality [for the Duzi] next year, the work will take several years."

Rivers-Moore also says that it will take more than scientific and management intervention to reverse river pollution. "We need people to change their behaviour and values. The long-term safety of rivers is not secure until people recognise the truth of Chief Seattle's words that 'all things are connected like the blood that unites us all. Man did not weave the web of life, he is merely a strand in it. Whatever he does to the web, he does to himself.' "

Source: The Witness

IT'S TIME TO DEBATE!!!

CLASS ACTIVITY:

1. Divide the class into two groups.

2. Give them the following debate topic.

River water quality is the sole responsibility of local municipalities/local governments.

3. One group needs to prepare their debate agreeing with the topic (the proposers); the other group needs to argue against it (the opposers).

4. Using the attached three enviro facts sheets (*Water, Sustainable Development* and *Pollution*) as an introduction to water quality, learners need to find out as much as they can about this topic. If you have a well-resourced library (in your school or community), make use of it; use the Internet; search for newspaper articles or magazines; see if there are any environmental films or videos on water quality or any other sources of information that could be useful. *(Learners need to keep a record of where they found their sources and what these sources were – this will help you, the teacher, when it comes to the assessment of this lesson).* Some of the learners may have parents or relatives that work either for the sanitation/water departments of local municipalities, water boards or provincial or regional Departments of Water Affairs and Forestry (DWAF) so they will be able to interview these people. Encourage the learners to make use of as many varied sources and methods of locating information as possible.

5. When the groups are ready and well prepared, you need to select six learners to take various roles:
    - Chairman. This person chairs the debate but cannot take part or vote (unless there is a tie)
    - First proposer to speak
    - First opposer to speak
    - Proposer's seconder
    - Opposer's seconder
    - Timekeeper

Encourage all other learners to participate from the floor, reminding them that each one can only speak once. They will also need to be ready to vote at the end of the debate.

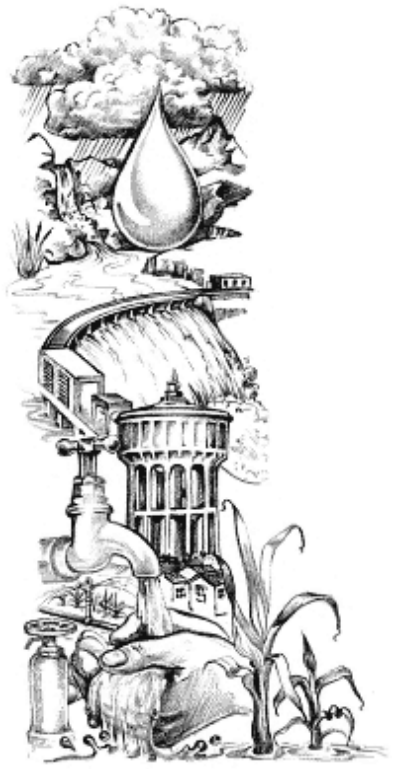
Hold the debate according to the formal order and rules.

Ask the learners:

1. What are the advantages of debating?
2. What are the disadvantages of debating?
3. Describe the strengths of a good debater. *Prompt: persuasive, confident, calm.*
4. What skills could one develop through the debating process?

Source: http://news.bbc.co.uk/cbbcnews/hi/newsid_4530000/newsid_4537100/4537177.stm

Enviro Fact 1: Water



South Africa is extraordinarily rich in natural resources - except for water. Water is a vital but scarce resource, distributed unevenly in time (because frequent droughts alternate with periods of good rainfall) and space (the eastern half of the country is much wetter than the western half). Increasing demand for water, and decreasing water quality, make careful water management very important in our country. It has been estimated that by the year 2025 there will not be enough water for domestic use (in the home), agriculture (farming), and industry (factories).

Rainfall

Our average rainfall is less than 500mm a year, with the driest part of the country receiving less than 200mm/year and the wettest receiving more than 2 500mm/year. Rain does not always fall where it is most needed, and some areas of high demand, such as Gauteng, receive less water than they need. Most rain falls in the narrow belt along the eastern and southern coasts. The rest of the country receives only 27% of South Africa's total rainfall. In addition, hot, dry conditions result in a high evaporation rate.

Water is thus a very scarce resource in South Africa. Large-scale engineering has been used to store water behind dam walls, and to share out water from regions of plenty to regions of need.

Rivers

There are few natural lakes in South Africa. We depend on rivers, dams and underground water for our water supply. Approximately 75% of the water flowing from South Africa into the sea occurs along the eastern and southern seaboards, where many short rivers occur. Flowing from east to west is the largest river in the country, the Orange River, which drains most of the rest of the country. Its water comes from sources in the Drakensberg and Maluti Mountains, and it flows into the Atlantic Ocean on the west coast.

Dams

About half of South Africa's annual rainfall is stored in dams. We have over 550 government dams in South Africa, which all-together are able to store more than 37 000 million m^3 of water. Dams have both positive and negative impacts. They can be useful for people in that they regulate the flow of a river, reducing flood damage and contributing to perennial (returning) rather than seasonal flow. In addition, sediment (which is made of dirt particles) is deposited in a dam, and the growth of aquatic plants (plants that live in water) means that nutrients are removed from the water. Thus water leaving a dam may be cleaner than water entering it. The riverine ecosystem is usually affected negatively by a dam. Changes in the flow of rivers (the amount of water and times when the river has high and low flow), temperature and water quality may cause the variety of organisms living below dams to decrease. Less water flow reduces the river's cleaning ability and this can lead to estuaries becoming silted (silt is material which is finer than sand, but still feels gritty when rubbed).

South Africa's landscape is not well suited to dams. There are few deep valleys and gorges, with the result that most dams are shallow with a large surface area. Together with the hot, dry, climate, this results in much water evaporating from dams. In addition, the high silt load of our

rivers means that the capacity of South Africa's dams is quickly reduced as they become silted. The rivers of the Western-Cape carry relatively less silt than those in the rest of the country.

Water abstraction (removal)
A growing problem for South Africa's rivers is a lack of water! Reduction in river flow because of abstraction (removal), and damming, has affected many of our rivers, for example those flowing through the Kruger National Park.

Intercatchment transfer of water
This involves the transfer of water from catchments (where water is gathered and stored) with good supplies and low demand, to those where demand for water is high and the supply is poor. There are numerous intercatchment transfer schemes already in operation, and more are under construction or proposed. A major scheme is the Orange-Fish River scheme, where water gravitates from the Orange River at the Gariep Dam, and is piped through tunnels and canals to the Sundays and then the Fish Rivers in the Eastern Cape. The massive Lesotho Highlands Water Project is a multi-billion water transfer and hydropower project put in place by the governments of Lesotho and South Africa. It transports water from the upper reaches of the Orange system in Lesotho to the Vaal River for use in Gauteng.

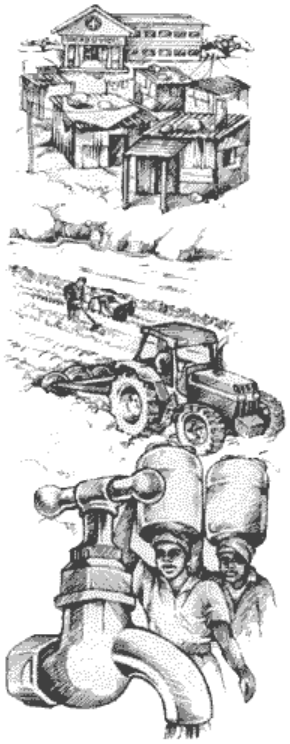
As yet, only a little research has been carried out to establish the ecological consequences of intercatchment water transfers. However, areas of concern include a reduction of streamflow and water levels in one system, changes in water temperature and chemistry, and the movement of invasive species between catchments.

Water pollution
Industrial and agricultural pollutants common in South Africa include: agricultural fertilizers, silt, toxic metals, litter, hot water and pesticides. These pollutants affect aquatic ecosystems and human health. Disease-producing bacteria are common in urban waste water, particularly from informal settlements that lack sewage and water purification facilities. For example, Typhoid, Cholera and Gastroenteritis (which are all diseases) are transmitted by water contaminated with untreated sewage. Gastroenteritis is one of three main causes of death in South African children under the age of five.

Did you know?
- South Africa has a National Water Bill that attempts to make sure that everyone has access to water and that the water supply can be sustained or kept going.
- Some 12-14 million South Africans do not have access to safe drinking water and some 21 million do not have proper sanitation. Because of this, about 50 000 children die each year from infections.

Further reading:
Davies, B. R. and J. Day. 1998. *Vanishing Waters.* University of Cape Town Press.
Camp, S. *A Guide to Water Saving in South Africa.* Umgeni Water, Pietermaritzburg.

Enviro Fact 2: Sustainable Development



In the past, development and conservation have been in conflict, because development involves using resources and conservation involves protecting resources. Recognising the need for both, the United Nations appointed, in 1987, a commission on environment and development to advise on development and conservation. In the commission' s report called "The Bruntland Report" or "Our Common Future", the concept of sustainable development was emphasised. The report defined sustainable development as "… development which meets the needs of the present without compromising the ability of future generations to meet their own needs". There are many definitions of sustainable development, however, the concept is hardly ever explained or deeply understood, and is thus difficult to put into practice.

Historical perspective. During the Industrial Revolution, industries such as mining, manufacturing and large-scale farming became popular and led to development because they enabled the owners to produce a lot of goods for less money. Industrialisation began in Britain and spread to mainland Europe, North America and Japan, all of which became known as the First World. Characteristics of First World countries are high economic growth (growth that occurs when increasing amounts of goods and services are produced over a long time), many different job opportunities, and high incomes. The Soviet Union which is governed under the economic system of communism, became known as the Second World. Third World countries, such as those in Africa, South America and parts of Asia, have slow, if any, economic growth, with a high level of unemployment (in other words, very few jobs are available) and very low incomes, but often lots of natural resources. In fact, the wealth of many First World countries is founded in part on the use of resources (natural and human) from Third World countries.

Environmental problems. The environmental problems of the First World are connected with economic wealth, high resource consumption and industrialization. These have contributed to, for example, ozone depletion and global warming. Environmental problems of the Third World, however, can be connected to poverty, high population growth rates, lack of food, shelter and water, and a lack of technical capacity.

Development as a solution? The solution to the devastating poverty and environmental problems of Third World countries is often seen as 'development'. For example, the development of Third World countries towards the First World ideas of economic growth through Industrialisation and the use of many resources. However, many people have began to seriously question the wisdom of this approach.

Limited resources. It is argued that the Earth's limited resources would not be able to support all the world' s people if everyone used the same amount of resources as those living in First World countries. Mahatma Gandhi, when asked if, after independence, India would attain British standards of living, commented that "… it took Britain half the resources of the planet to achieve its prosperity, how many planets will a country like India require?"

A different type of development? Development is usually seen as economic growth, which depends on ever-increasing use of energy and natural resources. This type of development is unsustainable. Another option being suggested involves reusing, recycling and repairing resources instead of just using them. Organisations would thus try to deliver the same high standards of service, but use fewer material resources such as fossil fuels, minerals and water.

Who benefits? Third World development programmes that focus on economic growth as a solution to widespread poverty, assume that the benefits of economic growth will trickle down to all

members of society. However, economic growth does not always benefit the poor in a country. Many development programmes now give special attention to human needs, getting people to take part in programmes, and the sharing of development benefits, rather than focusing all efforts on financial development.

Indicators of economic performance. If we are to move towards sustainable development, we will need tools with which to measure our performance. At present the performance of an economy is measured in term of its gross domestic product (GDP). The GDP is the total value of all the money transactions that take place, and is a poor measure of the effect of economic plans and practices on people and the environment.

However, there are no simple answers to how sustainable development can be measured. As situations and conditions change, so will our understanding of sustainable development change. Sustainable development is not a model to be imposed, but can be seen as a process of learning how to live on the Earth. Ultimately the focus of sustainable living and sustainable development is to find a balance between the social, economic and ecological aspects of our existence.

Agenda 21
Agenda 21 is a global action plan for socially, economically and environmentally sustainable development. It was adopted at the United Nations Conference on the Environment and Development held in Rio de Janeiro in June 1992 (Earth Summit). The conference proposed that Agenda 21 be implemented at the local authority level, and this came to be known as Local Agenda 21. The principles guiding Local Agenda 21 in South Africa are: people-centred development, meeting basic needs, integrated planning and development. Several South African cities and provinces have developed Local Agenda 21 programmes.

Enviro Fact 3: Pollution

Pollution is an unwelcome concentration of substances that are beyond the environment's ability to handle. These substances are harmful to people and other living things. In an undisturbed ecosystem, all substances are processed through a complicated network of biogeochemical cycles. During these cycles, substances are taken up by plants, move through the food chain to larger and more complex organisms, and when those organisms die, the substances are decomposed (broken down) into simpler forms to be used again when they are taken up by plants. Biodegradable substances are those that can be broken down by the environment's biological systems. Pollution occurs when the environment becomes overloaded beyond the ability of these normal processing systems.

Examples include:

- An overload of normally helpful substances, such as nutrients, nitrogen and phosphorus.
- An overload of substances that are harmless, and perhaps even necessary in tiny amounts, but toxic in high levels. Copper, for example, is necessary in small amounts for healthy plant growth, but becomes a pollutant if it occurs in greater quantities.
- Synthetic (human-made) compounds that are poisonous in the environment, often even in trace amounts, such as DDT(an insecticide), dioxin, PCBs and organochlorines (dangerous and toxic chemicals).
- Substances that, in any amount, are not biodegradable, such as plastics and highly persistent chemicals like DDT and other organochlorines.
- Some pollutants kill living organisms outright, other sub-lethal pollutants do not kill, but may cause long-term biological damage, interfere with organisms' reproductive cycles, or make them more vulnerable to disease.

Types of pollution. Pollutants can be grouped according to the main ecosystem which they affect. One pollutant often affects more than one ecosystem.

POLLUTANTS AND MAIN SOURCE	HEALTH AND ENVIRONMENTAL EFFECTS
AIR	
Sulphur dioxide - burning of coal	Acid rain and respiratory (breathing) problems
Nitrogen oxides - vehicle emissions Volatile hydrocarbons - vehicle emissions	Combine to form photochemical smog; causes respiratory (breathing) problems
Carbon monoxide – vehicle emissions	Restricts oxygen uptake, causes drowsiness, headaches, death
Carbon dioxide - burning of coal	Global warming
CFCs - aerosol, refrigeration, air-conditioning and foam-blowing industries	Destroy ozone layer
Methane - feedlots, rubbish dumps	Global warming
Noise - industry, traffic	Affects hearing, stressful
Asbestos dust - construction, mining, industry	Asbestosis, mesothelioma
FRESH WATER	
Sewage - inadequate sanitation	Pathogens cause typhoid, cholera, gastroenteritis; nutrients cause eutrophication (an increase in plant growth in lakes or dams)
Fertilizers – agriculture	Eutrophication
Silt - agriculture, construction, mining	Smothers aquatic organisms; affects light penetration
Pesticides - agriculture, and health services	Toxic; interfere with breeding of mammals and birds
Toxic metals – industry	Health and life threatening

Salinisation - industry, agriculture, landfill	Reduced crop yields; scale and corrosion in domestic and industrial water systems
MARINE	
Sewage - inadequate sanitation	Pathogens cause typhoid, cholera, gastroenteritis; nutrients cause eutrophication
Fertilizers – agriculture	Eutrophication
Oil spills	Smother marine plants and animals
Plastics	Death of marine animals
Pesticides - agriculture, and health services	Toxic; interfere with breeding of mammals and birds
LAND	
Solid waste is classified as hazardous (radioactive, pesticides, medical, poisons), or non-hazardous (domestic, urban, mining, industrial, scrap metal)	Hazardous waste is health- and life-threatening; non-hazardous is unsightly and disposal takes up much space

Dealing with pollution

In the past, most approaches to handling pollution could be summed up by the phrase `dilution is the solution to pollution'. However, pollution levels have increased so much in amount and toxicity that this approach is no longer acceptable. A different approach is source reduction, in other words, a reduction in the amount of pollution where produced.

- Point source pollution: pollutants are produced from a stationary location, e.g. industrial plants, mines, and municipal sewage works.
- Non-point source pollution: this pollution cannot be traced to a specific spot, and is far more difficult to monitor and control. Common examples are veldt fires, motor vehicle emissions, fertilizer runoff, sediment from construction and erosion, plastic packaging, and gases from aerosol cans. Some non-point sources can be addressed by laws, such as banning CFCs (chlorofluorocarbons), or requiring car manufactures to install emission controls.

Polluter-must-pay principle

This means that a polluter should bear the costs of avoiding pollution, or remedying its effects. This principle is difficult to apply when the source of pollution cannot be identified, as is often the case with atmospheric pollution. The principle can be usefully applied following a pollution disaster, such as an oil spill from a tanker. However, the consumer often pays for such pollution costs.

Movement of pollution

Pollution does not stay in one place but is moved around the world by air and water, as well as by living organisms. Even in Antarctica, birds and marine mammals show traces of pollutants such as DDT and PCBs. Some pollution is deliberately moved abroad. Companies restricted by pollution control regulations at home, sometimes move their plants to other less restrictive countries, as was the case with the plant involved in the Bhopal chemical disaster (the world’s worst industrial disaster during which an insecticide plant released 42 tonnes of toxic gas, exposing 500 000 people to toxic gas and killing thousands). Or while remaining at home, they may sell products abroad, that are classed in their own countries as too dangerous for sale, such as banned pesticides. In some cases hazardous waste may also be shipped abroad, generally from industrialised countries to developing countries willing to accept such waste for a fee, despite the dangers. When such pollutants turn up again in the originating country, as when food is imported that contains banned pesticides, the process is said to be completing the `circle of poison'.

What can you do

- *Avoid the creation of waste.*
- *Find out all you can about pollution and protest loudly when you see it happening.*
- *Report air pollution to the Chief Air Pollution Control Officer (CAPCO), Department of Health.*
- *Report freshwater and land pollution to the Department of Water Affairs and Forestry.*

Criteria to assess learners during this languages lesson

Criteria	Exceeded requirements of the Learning Outcome	Satisfied requirements of the Learning Outcome	Partially satisfied requirements of the Learning Outcome	Not satisfied requirements of the Learning Outcome
The learner read *The Witness* newspaper article *'A river in crisis'* on their own.				
The learner understood what the content of the article was about.				
The learner contributed to gathering information either supporting or rejecting the debate question 'River water quality is the sole responsibility of local municipalities/local governments.'				
The learner participated in the debate.				
The learner acknowledged other people's opinions who did not agree with him/her.				
The learner showed sensitivity to other learners during the debate lesson.				

ACTIVITY TWO: INVESTIGATING OUR LOCAL RIVER USING miniSASS

During this NATURAL SCIENCES lesson, learners investigate the water quality of a nearby river, using the miniSASS toolkit to look for visible animal life.

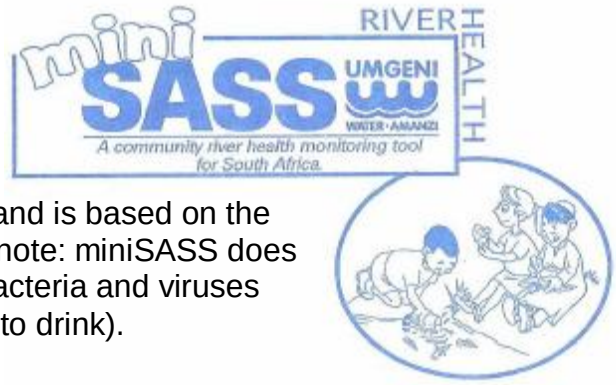
History of the miniSASS tool

In recent years, scientists have made a remarkable discovery about how to check water quality and it does not have anything to do with water chemistry, or expensive specialised water testing meters. In many cases, all water scientists need to do is find out what organisms (creatures) live in the water.

Researchers count these organisms and compare their numbers with the proportions that scientists have determined should be found there. If the right proportion of species live in the water, things are looking good for that body of water.

Some organisms have a very high tolerance to pollution. If they are found in a river in high proportions, it may be that the river is polluted. When scientists check the health of rivers and other bodies of water, they also look for species that are extremely sensitive to changes in water quality. If these species are found in high proportions, it may be good news for all those who live in that watershed!

So, are you ready for some environmental action and to find out the condition of your stream or river?



miniSASS can be used to monitor the health of a river and measure the general quality of the water in that river. It uses the composition of macroinvertebrates (tiny creatures) living in rivers and is based on the sensitivity of the various animals to water quality. (note: miniSASS does **NOT** measure the contamination of the water by bacteria and viruses and thus does not determine if the river water is fit to drink).

Safety:
Safety considerations are very important. You must never sample at any site that might be unsafe and never sample alone. At the end of the sampling session, wash your hands thoroughly before eating food.

Remember:

- Never sample alone
- Never go into the water above your knees
- Avoid contact with polluted water
- Choose safe sites
- Wear appropriate clothing
- Take safety gear and a first aid kit

ACTIVITY:

Equipment list:

- net
- shoes/gumboots
- white container/ice-cream box
- magnifying glass (optional)
- pencil

How to make your own net:

Take any piece of wire, for example an old clothes hanger, and bend it into the shape of a circle. Then tie the netting (which can be any porous material) to the wire with a piece of string. And you have a net!

Method:

The best sites are those with rocks in fast flowing water. Not all sites have rocks (**rocky type** rivers), but may be largely sandy (**sandy type** rivers).

1. Whilst holding a small net in the current, **disturb** the stones, vegetation, sand etc. with your feet or hands.
2. You can also lift stones and **pick** insects off gently with your fingers or forceps.
3. Do this for about **5 minutes** whilst ranging across the river to **different places** (habitats/biotopes).
4. Rinse the net and turn the contents into a plastic tray and **identify** each group using

the identification guide (see page 18).

5. **Mark** the identified insects off on the identification guide.
6. **Add up** the scores to determine the average score.

Scoring:

1. On the table below, circle the sensitivity scores of the identified insects.
2. Add up all of the sensitivity scores.
3. Divide the total of the sensitivity score by the number of groups identified.
4. The result is the average score, which can be interpreted below.

GROUPS	SENSITIVITY SCORE
Flat worms	3
Worms	3
Leeches	2
Crabs or shrimps	7
Stoneflies	14
Minnow mayflies	6
Other mayflies	13
Damselflies	4
Dragonflies	7
Bugs or beetles	6
Caddisflies	9
True flies	2
Snails	4
TOTAL SCORE	
NUMBER OF GROUPS	
AVERAGE SCORE (Divide 'Total' by 'Number of groups')	

Interpretation of the miniSASS score:

Although an ideal sample site has rocky, sandy, and vegetation habitats, not all habitats are always present at a site. If your river does not have rocky habitats use the **sandy type** category below to interpret your scores.

Ecological category (Condition)	River Category	
	Sandy Type	**Rocky Type**
Unmodified (**NATURAL** condition)	> 6.9	> 7.9
Largely natural/few modifications (**GOOD** condition)	5.8 to 6.9	6.8 to 7.9
Moderately modified (**FAIR** condition)	4.9 to 5.8	6.1 to 6.8
Largely modified (**POOR** condition)	4.3 to 4.9	5.1 to 6.1
Seriously/critical modified (**VERY POOR** condition)	<4.3	<5.1

Send your results to minisass@ground-truth.co.za to contribute to a developing picture of river quality in SA.
miniSASS is available from Share-Net, PO Box 394, Howick, 3290.
Tel (033) 3303931 extension 124/143/144 or download it from www.ground-truth.co.za

Flat worms

Flat worms are characterised by their flattened shape and soft bodied, worm-like form. They have an arrow-shaped head with two dorsal eyespots and are generally mottled or dark grey in colour. Flatworms move with a gliding action and are generally scavengers or carnivores.

Leeches

Leeches are segmented organisms that have very flexible bodies. When moving they expand to become long and thin, and then contract to become short and stubby. They have suckers on both ends of the body that are used for feeding and locomotion. Leeches are variable in colour, from grey, to red-brown and black. They swim with a fast, snaking movement and are found under stones, vegetation and debris.

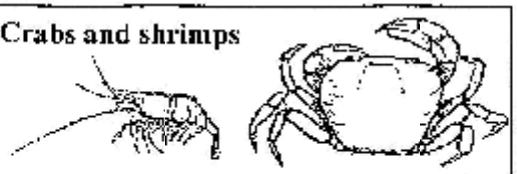
Worms

Worms are long and segmented and have a cylindrical shape much like small earth worms. Their colouring is usually pink to brown. They are usually seen writhing around in debris digesting the substrate they feed on.

Snails

Snails are molluscs with hard shells that vary in size, shape and colour. Habitats vary, with some snails such as limpets clinging to rocks, whereas clams and muscles are found in sand. The more common snails move over stones and vegetation. Some snails are host to bilharzia, a serious health hazard for humans

Crabs and shrimps

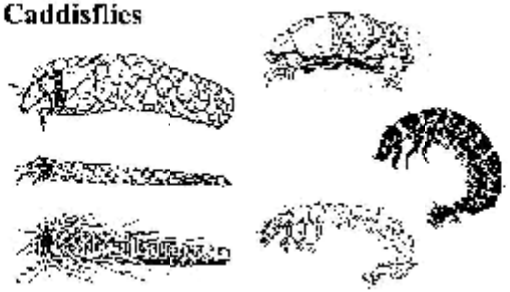


Crabs and shrimp form part of the order Decopoda (ten legs) and have bodies and legs hardened to form a tough shell. They have four or five pairs of legs, and eyes that are carried on stalks and are movable. Crabs are scavengers that feed mainly on leaf litter but will feed on animals when given the chance. Shrimps are mostly scavengers or deposit feeders.

Stoneflies

The nymphs of adult stone flies usually have two long tails and three pairs of legs each having two claws at the tip. A characteristic feature of stonefly nymphs are the tufts of gills on the side of the body as well as gills between the two tails. Wing pads on the thorax are often dark and obvious. Some species run across the substrate very efficiently and are potent predators on other invertebrates. Other species are smaller and feed on plant material. Most live in well oxygenated, clean water.

Caddisflies



The aquatic larvae of adult caddisflies have a hard head with three pairs of legs which are attached to an elongated, soft body. Finger-like gills on the abdomen and anal appendages can be seen with the naked eye. Some caddisflies construct portable shelters/cases from sand grains, bits of vegetation and/or silk that are glued together to form a characteristic case shape. Most of the case-building types cannot swim whereas the case-less type swim freely across the substrate. Some feed on algae and detritus whereas others are predators.

Damselflies

Damselflies have elongated bodies with generally three broad tails/gills on the tip of the abdomen. Damselflies are carnivorous and have a 'mask' over the lower part of the face which hinges out to reveal a pair of pincers with which they catch their prey. They are often to be found in vegetation growing on the edge of rivers.

Dragonflies

Dragonfly nymphs are robust creatures that are stout and have a large head and protruding eyes. Some have short legs whilst others have long legs. They do not have tails, but swim using 'jet propulsion' by forcefully ejecting water from the abdomen. Dragonfly nymphs are usually the largest organisms found in a sample and are the most powerful invertebrate predators in the water.

Bugs and Beetles

Bugs can be defined as having a piercing and sucking beak for mouthparts, and two pairs of membranous wings. Beetles on the other hand have 'jaws' and outer wings that are hardened to protect the inner wings. Some bugs and beetles are well adapted to swimming, such as water boatmen, backswimmers, pond skaters and water striders. Most bugs and beetles are carnivorous, but some feed on algae.

Mayflies

Mayfly nymphs vary greatly in shape and size and live only for a day or two. In this time they will never feed and live to mate and lay eggs in the water. Mayflies fly close to rivers and lakes, usually swarming in the early evenings.

Minnow mayflies

These mayflies have a narrow head and a small, slender, but not flattened body. They have leaf shaped gills on both sides of the abdomen and two but more commonly three tails, depending on the species.

Other mayflies

Other mayflies are characterised by an elongated body, large head, well-developed mouthparts and stout legs. They live in a variety of habitats including burrowing in mud, crawling amongst decaying leaves, and scurrying over stones in fast flowing currents.

True flies

Most fly larvae have a fairly indistinct head but elaborate tail ends. They often have small, soft legs (prolegs), segmented bodies and have the appearance of maggots. Some have bristles/ spines and antennae. True flies live in a variety of habitats including sand, mud and stones in fast flowing water. They can either be carnivorous or filter feeders

Criteria to assess learners during this natural sciences lesson

Criteria	Exceeded requirements of the Learning Outcome	Satisfied requirements of the Learning Outcome	Partially satisfied requirements of the Learning Outcome	Not satisfied requirements of the Learning Outcome
The learner took part in the investigation into river water quality.				
The learner collected data using the miniSASS toolkit.				
The learner could determine the water quality, using the miniSASS results.				
The learner was able to communicate their miniSASS findings effectively.				

ACTIVITY THREE: CREATING A DICHOTOMOUS KEY FOR OUR WATER CREATURES

During this NATURAL SCIENCES lesson, learners categorise the water macroinvertebrates that they found in the previous activity and create their own dichotomous key.

READ THE FOLLOWING TO YOUR LEARNERS:
A dichotomous key is one tool that can be used to identify flowers, animals, rocks, fish, and more! A dichotomous key contains a series of choices that lead the user to the correct name of an item. "Dichotomous" means "divided into two parts." Therefore, a dichotomous key will always give two choices in each step.

For example, a question in a dichotomous key for trees might be something like, "Are the leaves flat or needle-like?" If the answer was "needle-like," then the next question might be something like, "Are the needles in a bunch or are they spread along the branch?" Eventually, when enough questions have been answered, the identity of the tree is revealed.

CLASS ACTIVITY:
Designing a Dichotomous Key

1. Distribute to each group of 3-4 learners: thumbtacks, paper clips, wooden ruler, pencil, and plastic pen.

2. Ask the learners to look at the objects and, as a group, ask them to brainstorm how the objects are similar to and different from each other. Then, bring the class together to list on the chalkboard the similarities and differences of the objects. Give the learners about 2-3 minutes to do this.

3. Grouping possibilities could be: metal, plastic, and wood

4. Once this is done tell the learners that scientists uses these similarities and differences to classify the natural world around us. The tool that they use for this is the dichotomous key. From a dichotomous key, one can learn the name of any object/plant/animal, which has been included in the key. In using a key, the learner is led through a series of alternatives until the name of the object/plant/animal is reached. A dichotomous key, in its simplest form, has a few basic rules that make writing one easy.

   Rule 1: Each step involves making choices between two characteristics. These characteristics are grouped 1a and 1b, 2a and 2b, and so forth.
   Rule 2: Each step in a group distinguishes one or more objects (plants, animals, etc.) into two smaller units.
   Rule 3: Each unit either identifies and names an object (plant, animal, etc.) or gives directions as to where to go next in the key.
   Rule 4: At each step, learners must choose **ONE** of the groups, steps, and units at a time and not more than one of each.

CLASS EXERCISE 1:
Write on the chalkboard the following four objects:

- tennis shoes
- belt
- celery
- french fries

Ask the learners to list the characteristics of these items and place them into two groups. Group one should include: "tennis shoes" and "belt" as "Clothing Items". Group two should include: "celery" and "french fries" as "Food".

This is how we could key the above four items.

Objects: tennis shoe, belt, celery, french fries

1a.	Clothing	Go to 2
1b.	Not clothing	Go to 3
2a.	Fits on your feet	tennis shoe
2b.	Fits around your waist	belt
3a.	Crunchy green vegetable	celery
3b.	Crunchy fried snack	french fries

Now go back to the original objects laid out for the learners (thumbtacks, paper clips, wooden ruler, pencil and plastic pen). Let the learners create a dichotomous key for them as well. Let them do this activity in groups or on their own.

INDIVIDUAL OR GROUP EXERCISE 2:

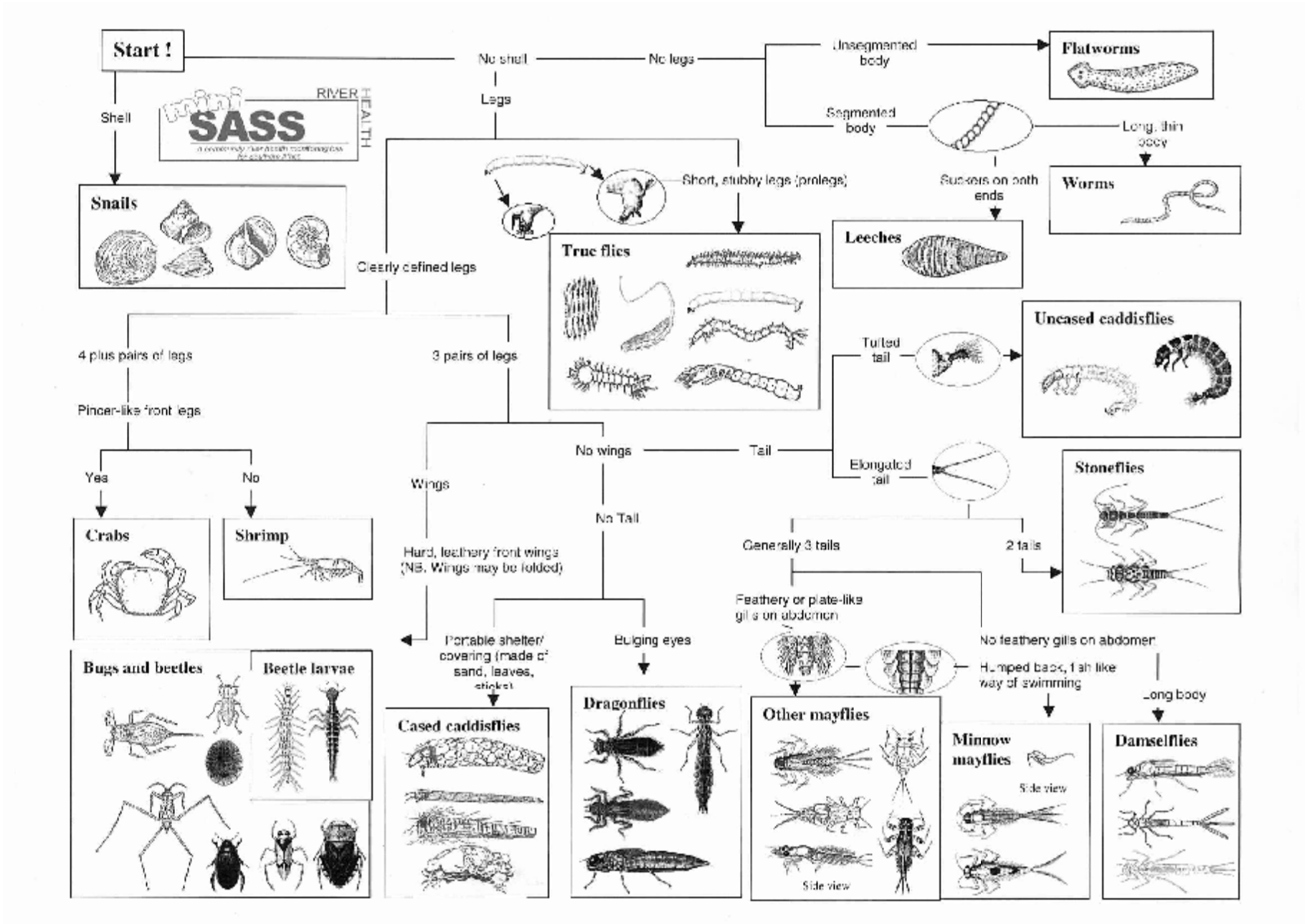
1a.	Objects made of metal	Go to 2
1b.	Objects not made of metal	Go to 3
2a.	Flat, without pointed ends, curved on two sides	paper clip
2b.	Round base, pointed, sharp end	thumbtack
3a.	Objects made of wood	Go to 4
3b.	Objects not made of wood. Made of plastic, round and for writing	pen
4a.	Flat measuring device	ruler
4b.	Round, writing utensil	pencil

Did you know? Scientists who design dichotomous keys are called Taxonomists.

ASK THE LEARNERS:

- What happens if there is a new species that is not in the key?
- Can a dichotomous key be too large? Why?

INDIVIDUAL ACTIVITY:
List all the water creatures found by the different groups during Activity Two. Individually, learners need to design their own dichotomous key. They can design it like the two done during the class exercises, or they can use a similar way to the example that follows (see page 21).


Start !
No shell
No legs
Unsegmented body
Flatworms
Segmented body
Long, thin body
Worms
Suckers on both ends
Leeches
Shell
RIVER HEALTH
SASS
Snails
Legs
Short, stubby legs (prolegs)
True flies
Clearly defined legs
4 plus pairs of legs
3 pairs of legs
Pincer-like front legs
Yes
No
Crabs
Shrimp
No wings
Tail
Tufted tail
Uncased caddisflies
Elongated tail
Stoneflies
Wings
No Tail
Generally 3 tails
2 tails
Hard, leathery front wings (NB. Wings may be folded)
Feathery or plate-like gills on abdomen
No feathery gills on abdomen
Humped back, fish like way of swimming
Long body
Portable shelter/ covering (made of sand, leaves, sticks)
Bulging eyes
Bugs and beetles
Beetle larvae
Cased caddisflies
Dragonflies
Other mayflies
Side view
Minnow mayflies
Side view
Damselflies

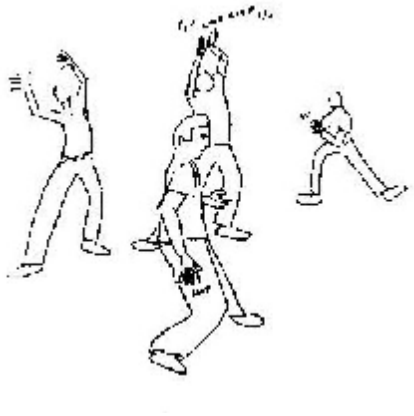
Criteria to assess learners during this natural sciences lesson

Criteria	Exceeded requirements of the Learning Outcome	Satisfied requirements of the Learning Outcome	Partially satisfied requirements of the Learning Outcome	Not satisfied requirements of the Learning Outcome
The learner was able to complete, as part of the class, Exercise 1 on page 21.				
The learner was able to complete, on his/her own or in a group, Exercise 2 on page 21.				
The learner was able to categorise the water creatures, found during Activity Two, into a dichotomous key.				

ACTIVITY FOUR: DRAMA DRAMA DRAMA

During this ARTS AND CULTURE activity, learners follow a teacher-directed warm-up routine. They also mimic the behaviour of some of the water creatures they found during the miniSASS activity earlier.

Note to teacher: Drama can offer you various skills and techniques which both raise awareness and transform awareness into real-life action. Your role is to stimulate ideas and to act as a catalyst. Instead of offering an education package which has pre-packaged solutions, you can use participatory drama as a process so that your learners can come to terms with many of the issues themselves. Through the drama process, learners are given the chance to 'rehearse' solutions to real-life challenges.



Getting Started – a space for drama

Create a physical space that encourages participation. In the classroom, clear the desks and chairs to the side to create an open space. Make sure there is place for everyone to move or sit in a circle.

Warming Up

It is a good idea to take the class through some warm-up activities. Warming up in drama is more than just a physical warm-up, it also helps to build a group spirit and encourages the learners to focus (if they are too active it helps calm them down; if they seem lethargic and lazy, it will help you to energize them!)

Warming Up 1: Walking around the space

1. Everyone in the class should walk around the space that you have created. Each learner can walk in any direction they like and change direction as often as they want to. However, they must be careful not to bump into other learners.
2. Each time you clap your hands, the learners must change direction.
3. Everyone to:
   - Walk
   - Run

- Skip
- Hop
- Leap
- Swim
- Jump
- Gallop (like a horse)
- Slide
- Move sideways
- Move backwards
- Move diagonally
- Turn around

4. Call out different situations to your learners and they must change the way they are walking for each situation. *(They must also change their facial expressions!)*
    - You are walking on hot coals
    - You are taking a puppy for a walk
    - You are swimming through syrup
    - You are walking on ice
    - You are jumping from puddle to puddle
    - You are trying to catch a water insect and it's very very fast.

Warming Up 2: Making body shapes

1. While the learners are walking around the room, call out a number. The children need to quickly get into a group of that number and keep walking. For example, if you call out "two", the children must pair up with someone, link arms, and keep walking. They must not stop walking or worry about who they have paired up with – they must pair up with the closest person. If you call out "four", the four closest children must pair up with each other.

2. After this has been done a few times with different numbers, divide the children into groups of five or six. Call out different shapes, and each group should make that shape with their bodies, for example "square" …. "rectangle"… "triangle" …. "circle". The children can make the shape standing up, sitting or lying down but everyone in the group must be part of the shape.
3. Since our theme in this series of lesson plans is WATER, ask the children to form the letters W A T E R. Then try the chemical formula for water, H_20.

CLASS ACTIVITY:

Hand out the information sheet on water macroinvertebrates (page 18). If you have already done Activity Two, your learners will have seen some of the water creatures on this page and noticed their behaviour. Let your learners read about the different creatures they may have seen to refresh their memories.

Next, with everyone standing with lots of space around them, learners need to mimic some feature of the water creatures' behaviour that you are about to call out. It may be the way the water creature swims, feeds or moves on land or water.

- Flat worm
- Leech
- Snail
- Stonefly nymph
- Mayfly nymph
- Crab
- Shrimp
- Dragonfly nymph
- Dragonfly
- Caddisfly

You may like to repeat this exercise twice: once letting the learners remember what they saw/read during the earlier miniSASS water study and a second time by reading about each creature to the learners and then calling out the name.

The teacher-learner relationship
In this kind of work, the teacher becomes part of the learning community rather than an all-knowing figure. This means that you, as a teacher, need to:

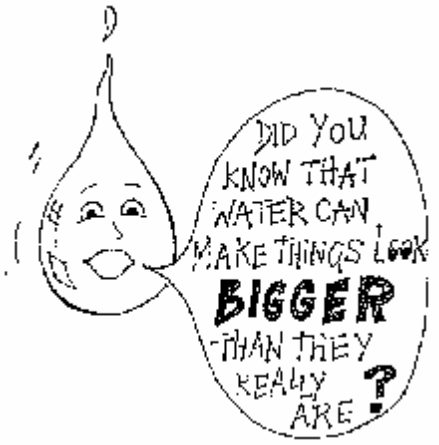
- be a good listener – listen carefully to what each learner offers and acknowledge their contribution;
- create an enjoyable atmosphere in your lesson; this does not mean that the work you do is only about 'fun', but that you create an atmosphere which allows learners to be creative, to try things out and to take initiative;
- be more of a facilitator than a 'teacher', guiding the learners' activities;
- ask the right questions – instead of telling the learners everything they need to know, see if you can draw out many of the ideas and perspectives from the learners themselves;
- be motivating, flexible, creative and encouraging;
- create a 'safe environment' in which learners feel free to participate. This means an atmosphere which is non-judgemental and in which learners feel they can make a contribution without being laughed at, scolded or ignored. Encourage and nurture the learners.

Criteria to assess learners during this arts and culture lesson

Criteria	Exceeded requirements of the Learning Outcome	Satisfied requirements of the Learning Outcome	Partially satisfied requirements of the Learning Outcome	Not satisfied requirements of the Learning Outcome
The learner followed the teacher's instructions.				
The learner contributed to the warm-up drama routine by being actively involved.				

ACTIVITY FIVE: JUST FOR FUN: MAKING A MAGIC MAGNIFIER

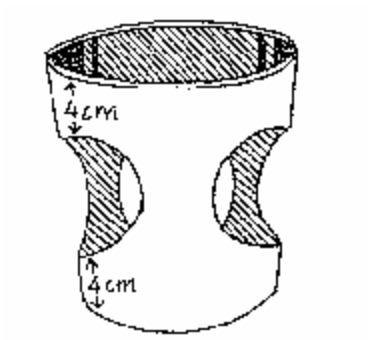
Did you notice that some of the water creatures you looked for during Activity Two looked enormous while under the water? And then, when you scooped them out of the water, they weren't quite so big! Water can make things look bigger than they really are.



You will need:

- a soft plastic bucket (25cm diameter works well)
- clear plastic wrap
- four elastic bands knotted together in a circle
- a sharp kitchen knife
- a ballpoint or felt-tip pen

What to do:



1. On the sides of the bucket draw three evenly spaced circles (big enough to put your hands through) on the outside of the bucket. Leave at least 4cm at the top and bottom of each circle. Carefully cut out the circles.

2. Cut a piece of clear plastic big enough to cover the top of the bucket with a 15cm overlap all around.

3. Put the plastic loosely over the top of the bucket and keep in place with the rubber bands. Press down gently so that it sags into the bucket. Slowly pour lukewarm water onto the plastic. Add as much as you can without overflowing. The plastic should sag at least 10cm below the rim of the bucket.

   You have now made a convex water lens.

4. Take your bucket out of the sunlight and place your objects into the bucket through the cut-out holes. Look at the objects, like a paperclip, pencil or sweet, through the lens – you'll be amazed!!