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UNIVERSITY OF FORT HARE

Eastern Cape Education Department

Distance Education Project

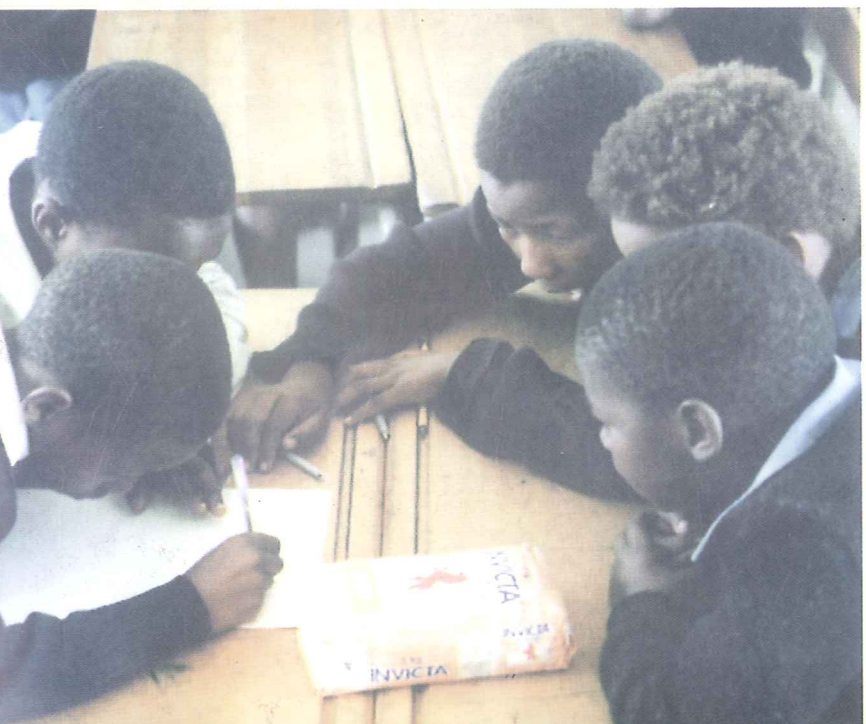
Core Learning Areas Course

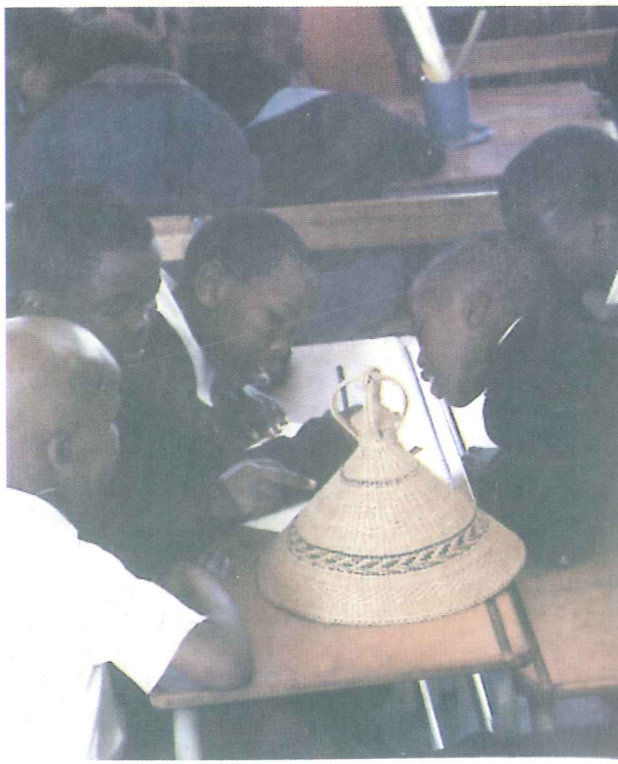
Natural Science

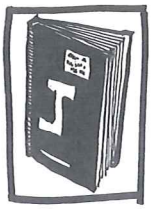
Umthamo 4

Finding out more about Science

(Pilot Edition – April 2000)







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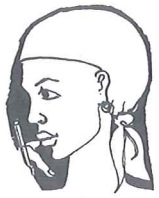
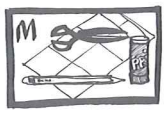


Thinking and Reflecting

Written Report

Classroom or School

Key Activity



Making materials

Reading and Thinking

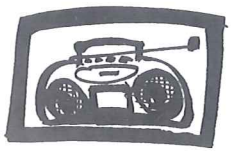
Discussion

Face-to-face umkhwezeli

Concertina File for Portfolio

Time

Very Important – take careful note



Tape-recorder

Multigrade

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The way I think of what we're doing is, we're exploring - we're trying to find out as much as we can about the world. People say to me, "Are you looking for the ultimate laws of physics?" No, I'm not. I'm just looking to find out more about the world. If it turns out there is a simple ultimate law which explains everything, so be it; that would be very nice to discover. If it turns out it's like an onion, with millions of layers, and we're sick and tired of looking at the layers, then that's the way it is. But whatever way it comes out, it's nature, and she's going to come out the way she is! Therefore when we go to investigate it we shouldn't predecide what it is we're going to find, except to try to find out more.

If you think that you are going to get an answer to some deep philosophical question, you may be wrong - it may be that you can't get an answer to that particular problem by finding out more about the character of nature. But I don't look at it like that; my interest in science is to simply find out more about the world, and the more I find out, the better it is. I like to find out.

Richard Feynman in Sykes, C. 1994. *No Ordinary Genius: The Illustrated Richard Feynman.* (New York: WW Norton & Co.)

REPORT OF LEADER TEACHER WORKSHOP
STANDARD TWO AND THREE
9th and 10th September 1996

IN PRAISE OF ..... PLANTS

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made possible by funding from
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Introduction

This is the fourth Natural Science umthamo of the B Prim Ed course. It is designed to build on what you have learned so far from the other Science imithamo. We have tried to link the contents of this umthamo to other strands of the course. We also try to emphasise the value of **integrating** different learning areas. And you will find that you are required to make more choices and decisions of your own.

What you will find in this umthamo

This umthamo has only three Units. The first two Units are structured in a similar way. They each have a practical activity that is developed from a specific Reading. The Readings and activities of each Unit are related to each other. You will find the **Key Activity** in the third Unit. In that Activity, you are first asked to review the previous activities. Then you will make a choice regarding the specific aspect that will be the focus of *your* **Key Activity**. The basis for the **Key Activity** is an approach that looks at how a teacher can help learners **extend** their knowledge and understanding in Science. You will find guidelines for a hand-in research assignment at the end of the third Unit.

The Science content that is incorporated into this umthamo relates to the living world (biology). The focus is mostly on **plants**. But if you work with older learners, there are also suggested activities that deal with a certain type of animal - that is **lizards**. You will find that there is a Content Audit included in the Appendix.

Intended Outcomes

The intended outcomes for this umthamo are as follows:

- You will have experienced the value of **integrating** a learning area like Arts and Culture with the learning area Natural Science.
- You will have had direct practical experience of using different forms of **continuous assessment** for different purposes.
- You will have planned for and researched a teacher's role in **extending science knowledge.**

Some thoughts on Continuous Assessment

Continuous assessment means different things to different people. Some interpret continuous assessment to mean many little tests throughout the year to replace the one major exam at the end of the year. Others see it as using a year mark to decide pupils' progress rather than an exam. Towards

the end of the course, there will be an umthamo devoted to assessment in the Core Education Studies Course. At this stage we are giving you a range of experiences that involve assessment. This will help you to gradually build up your own working knowledge and understanding of assessment.

In this umthamo we are going to ask you to consider three forms of assessment. The three forms relate to each other, but they have different purposes.

The first form of assessment could be called *diagnostic assessment*. This type of assessment can be used at the start of a particular unit of work with learners. It is used to try to find out in a reliable way what the learners already know about something, or what skills they have, or what their values and attitudes are. So *diagnostic assessment* involves finding out the pre-knowledge of learners.

There are many different ways to go about *diagnostic assessment*. The important thing is that this type of assessment becomes the basis on which a teacher makes choices about *how* the work that follows will be tackled. It is important as a *basis* for planning.

The next form of assessment could be known as *formative assessment.* In this case the teacher is thinking of ways to assess progress while learners are busy with some work. It answers questions like, How well is this going? or, Is this the best way to be doing this? Do I need to change my approach? The results of such assessment can help a teacher see that some change in strategy is needed. Perhaps certain work is beyond the level of the learners and needs to be modified. Or perhaps certain learners are not being sufficiently challenged. *Formative assessment* tells you how things are going and whether any changes need to be made.

The third type is known as *summative assessment*. This is used to help a teacher sum up how well things have gone. It happens at the end of a unit of work. And it tells you two things. Firstly, you can compare what the learners can now do or know with what the *diagnostic assessment* revealed. *Summative assessment* enables a teacher to get a measure of the gains that have taken place. Secondly, it gives a measure of how successful the approach has been.

Summative assessment could also be used as the basis for the next cycle of action and turn into *diagnostic assessment.* This means we could have a sequence or pattern of different forms of assessment going on continuously. So, at any moment in time, a teacher should have a fairly clear picture of how things are going in her classroom.

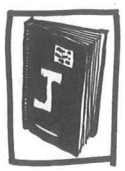
Unit 1 - Making use of Models

In a conventional classroom, the teacher finds out what learners know by asking them questions orally, or by setting a test where the questions are in a written form. If you think about it, the disadvantage of this approach is that the teacher's *own ideas and thinking* will dominate. She will find out only what she expects to find out. She is unlikely to be surprised by what children know. She won't discover any unexpected outcomes. The learners' light will remain hidden 'under a bushel'.

In this Unit we want you to think about, and to try, an approach that is likely to reveal more truly what is actually known by the learners. When learners are asked to think about something so that they can make a **model** of that thing, then they have to think differently from when they are simply asked a direct question. You can actually **see** what they are thinking and know by looking at the **model** that they have made.

Before you try the Activity in this Unit, we would like you to read the following selection from a paper presented at the last National Maths and Science Convention in Gauteng in 1995. In this paper Sandra Mdani, a primary school teacher from Khayelitsha and Alan Kenyon describe how primary school science teachers were experimenting with the use of **models** and **model making** as a means to improve science teaching and learning in Western Cape township and rural schools.

We think that you will get more out of the Reading if you spend a little time on a short pre-reading activity.

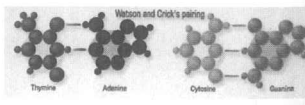


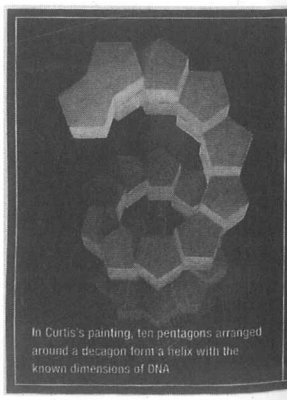
- **Before** you read, just jot down in rough a few points that list what you expect to find as you work through the Reading.
- Then when you have finished reading, you will jot down a few notes that list what interested you.
- Finally, you will compare your two rough lists.

Reading 1 - Models and Meaning for Primary Science

Abstract

Mainstream Science makes extensive use of models and modelling to articulate scientific ideas (eg DNA, double helix, the Aids virus etc). However, this aspect of science is conspicuous by its absence in young children's science in South Africa. This short paper reports on recent PSP Western Cape attempts to incorporate models and modelling as devices to promote the development of scientific understanding and science processes in children.

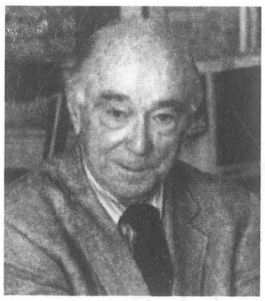




Why Models

Township and rural children who attend historically disadvantaged schools struggle to make sense of the curriculum menu that is presented to them. For some years now, non-governmental organisations have been attempting to support teachers as they in turn struggle to present a sensible curriculum. Conventional practice has content mediated by teacher talk, text-books and note-taking. Moves have been made to find ways to make science learning a more hands-on, practical or activity based experience and to take account of international trends in science education towards constructivist, process oriented science teaching and learning.

Making sense, establishing meaning or constructing knowledge needs to be seen as a complex many layered set of activities. This involves learners and teachers in having to translate experiences and ideas across a range of different models of representation. These translation processes often remain the most hidden or neglected aspects of teaching-learning events. Very often if children do get a chance to experience direct hands-on activities, these activities are then re-represented directly in quite arbitrary language in the form of written notes which are often lifted directly from text-books and don't relate to the actual experiences of the learners.

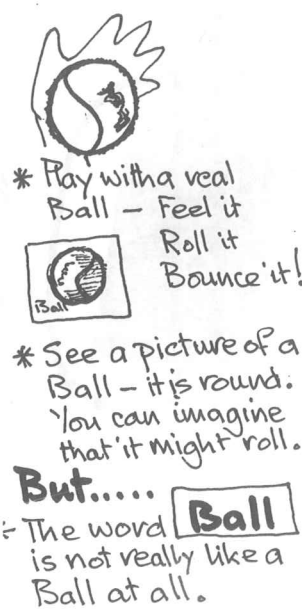


In Primary Science Programme workshops in the Western Cape, we have tried to take account of Jerome Bruner's three 'modes of representation' - ways in which learners can make sense of their world.

- The ENACTIVE mode based on real actions or physical interaction with the real world.
- The ICONIC mode which makes use of images, pictures or models of reality.
- The SYMBOLIC mode where specific symbols, mainly language or numerals play an increasingly complex role. (Bruner, 1974:33)

When we have co-planned lessons and attempted these lessons with pupils in real classrooms, we have tried to take more conscious account of the iconic mode as a sense-making bridge between direct experiences and language.

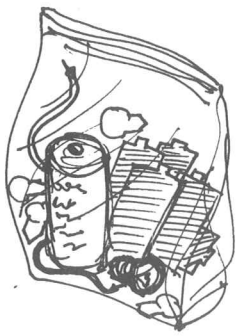
It is important to note that the schools in which we work have been particularly impoverished when it comes to the visual arts. Little or no attention is given to developing artistic skills (two- and three-dimensional representational

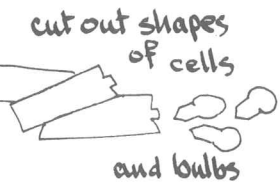


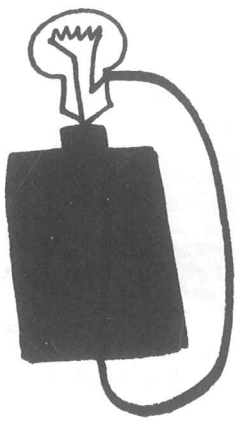
skills and the reciprocal interpretation skills that go with them). The consequences of this impoverishment has not been carefully or systematically explored. Giving attention to the iconic in science, can also be seen as an element of redress.

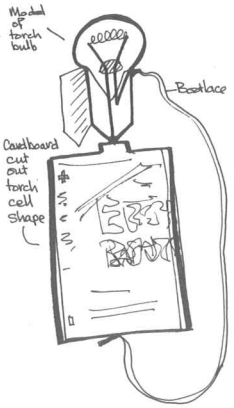
Another important aspect to note is that when science processes are listed, the use of models to represent understanding (ie modelling as a process) is significantly left out. Yet modelling is a most important element of scientific work. It is a crucial element of the way in which scientists establish and communicate their developing ideas and findings. If one looks at the way the primary science curriculum is devised and presented to learners, modelling is given no specific emphasis.

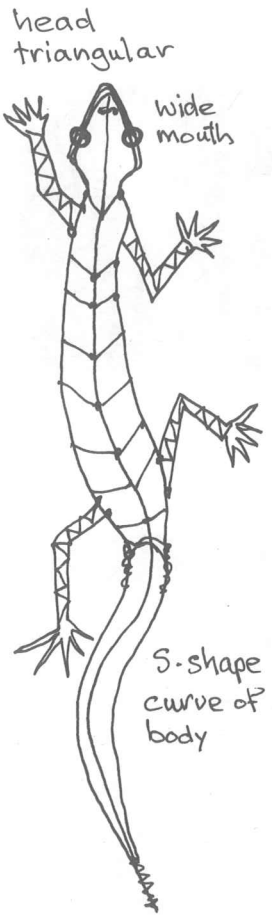
In this paper we discuss some attempts that have been made to make more deliberate use of models or the process of modelling in primary science lessons.











Electricity

One of our earlier attempts was with electricity for Standard four pupils. We found that life-size, simple, flat cardboard cut-outs to represent cells and light bulbs facilitated the process by which children could discover and represent a range of configurations of a bulb, a cell and wires which would get the bulb to light. A simple flap-open model of a bulb that revealed its inner workings helped pupils develop a clearer notion of a complete circuit.

Lizards

At special science enrichment classes run after hours for pupils in three Nyanga schools in 1993, we asked pupils to make simple wire models of lizards to show us what they knew about the form and structure of typical lizards. It was quite clear from the models that the children's intuitive sense of lizardness was quite sophisticated. The Standard five syllabus underestimated their knowledge as revealed through the models they made.

They got the basic shape of the body of lizards right.

- The proportions were often accurate.
- The limbs tend to jut out laterally from the body.
- The body is dorso-ventrally flattened.
- The heads tend to be flattened and triangular.
- The mouth is wide.
- The shape of the lizard is sinusoidal.

We found that the cultural traditions of wire-model making meant that the children could represent lizards with quite expressive sophistication and that we could move on to far more challenging work on lizards than the syllabus conventionally requires.

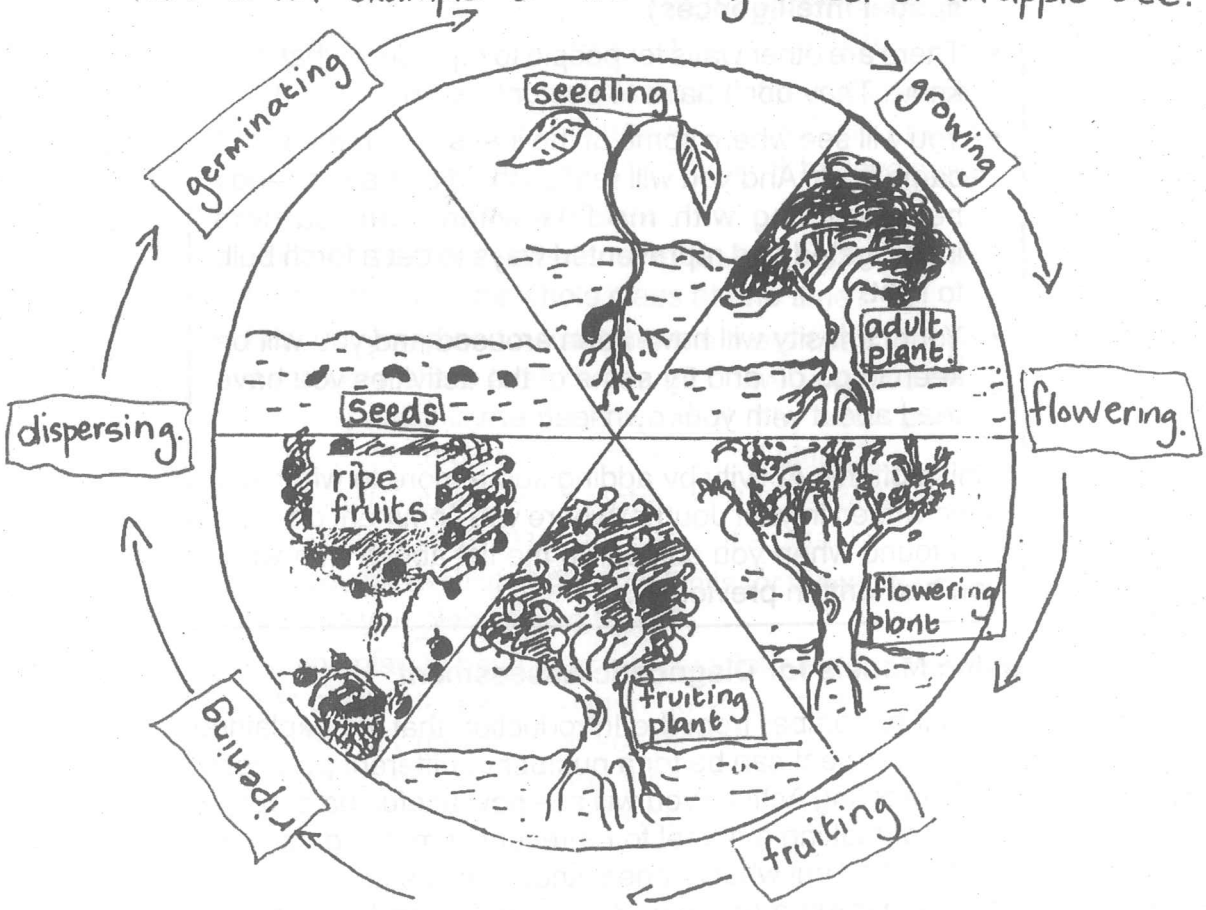
Plants

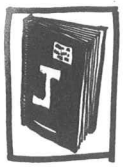
Using model making from scraps proved an interesting way to assess pupils' pre-knowledge before teaching or planning subsequent lessons.

What we have begun to realise is that there may well be another intermediate mode of representation that could be called the SCHEMATIC. This incorporates a set of ideas represented spatially in a diagrammatic way so that a logical sequence or pattern becomes self-evident. An example of such a representation that has a logical or organising function would be the use of the story wheel in the lesson that was devised at the workshop series as a follow-up to the diagnostic lesson

(Mdani and Kenyon, 1993.)

Here is an example of the story wheel of an apple tree:





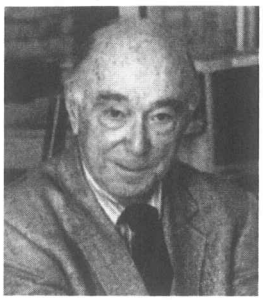
Activity 1 - Reflecting on the Reading

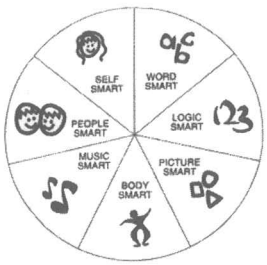
Think about what you have read and re-read the points you jotted down for pre- and post-reading activities. Then spend some time recording your more careful thoughts in your Journal. Try to write about a page of reflective thought.

When you have done that, we think you might find it interesting to compare what you have written with what we hoped you would gain from the reading. These ideas are listed below.

- You find out that real scientists make use of models a great deal.
- You will realise that there is not enough attention given to developing the **iconic** mode in our primary schools.
- You will notice that you are coming across an important educational theorist, Jerome Bruner, yet again. You will see that he gives importance to the use of images to express understanding.
- You see that there is a link between the ideas here (the **enactive** and the **iconic**) and the previous umthamo, Umthamo 26, which introduced you to the idea of multiple intelligences (**bodily-kinesthetic** and **spatial intelligences)**.
- There are other ways for people to represent what they know. They don't have to use only words.
- You will see where some of the ideas for Umthamo 19 came from. And you will realise that you have already been working with **models** when your learners investigated and represented ways to get a torch bulb to light.
- Your curiosity will have been aroused and you will be keen to go on and try some of the activities you have read about with your own learners.

Finish off this Activity by adding some more to what you have written in your Journal where you comment on what you found when you compared the list above with what you had written previously.





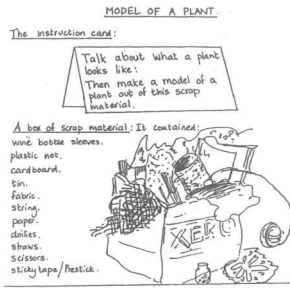
Using Models for Diagnostic Assessment

You will remember from the Introduction that we explained that assessment can be for a number of different purposes. In the following Activity you will see how useful the practical activity of making a model to represent something can be a means to find out what learners know about something. This kind of assessment could be considered *diagnostic*

assessment because you can use it to determine, or find out, what is known. You can plan to build on what you have found out as a basis for productive work in the future.

If you are working with Foundation Phase or pre-school learners, then we suggest that you try the Activity in which your learners think about and then construct a model that demonstrates their ideas about the structure of a typical plant. If you are working with Intermediate Phase or older learners, we suggest you try the Lizard wire-modelling Activity.

Activity 2 - Option A - Modelling a Plant



Before you start the activity you will need to collect sufficient scrap material for all the groups in your class to make a model of a plant. Remember, this is an **open** task so you won't have a clear idea of what will be needed or how it will be used. This means that you will need to provide a wide choice of scrap material. You could also ask learners to contribute to the supply of scrap material. But, we would suggest that you **don't** tell them what they will be doing with it. Keep this as a surprise.

You will need to make sure that you have enough scissors to cut up the material. And you will have to provide the means for learners to stick and glue parts of their model. You will need stuff like string, prestik, sticky tape, some different glues, and even wire might be useful for this.

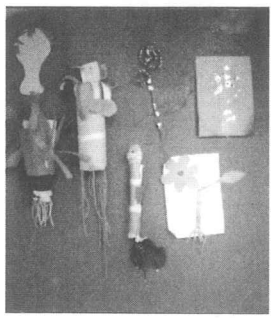
When it comes to the actual planning of the work learners will do, there are a few things which you will have to consider, and a few choices which you will have to make.

- How big will your groups be?
- Will you prepare self-standing task cards, or do you plan to instruct the whole class at one time?
- How do you plan to distribute the materials? Will you hand out a share to each group? Or will you give them the responsibility of deciding what they need and let them come and take it from a central place?
- When will you show the material? Before, or after you have asked them to talk about what a plant looks like?
- Will you be explicit about time limits for the work? How long do you plan to give them?
- Do you plan to have them present their **models** to the rest of the class? If so when do you plan to tell them that this will happen? Do you plan to give them time to prepare their presentation (who will talk and what will he/she/they be expected to say)?
- What do you plan to do afterwards? Will you display the models anywhere?

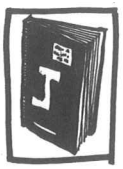
When you have sorted out all the details of your planning, you are ready to start. Remember not to interfere with the learners. You want to see what they can do **on their own**. If you get tempted to give advice and help..... DON'T. If you do interfere, your assessment will not be authentic. You will have a chance to provide guidance and help when you do the **Key Activity** in Unit 3.

As they work on their models, try to be a good observer. Listen carefully to all the things that the learners are saying as they work, and make notes of what they do. You can also learn a lot from observing what they *change,* or what they decide **not** to do.

When we tried these activities before, we often observed that there can be a learner in a group who makes a suggestion that is in fact correct or accurate. But if that learner is not a dominant child, the information s/he gives may be ignored by the rest of the group. It is important that the alert teacher notes such things. At a later stage that quieter learner can be affirmed either privately or publicly. (As the responsible adult you will need to decide which is the most appropriate.)



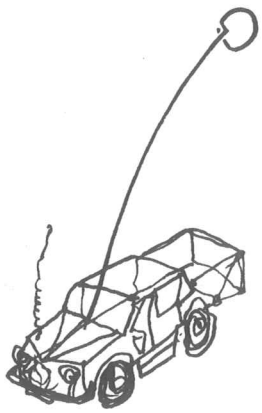
At the end of the day, consolidate the notes that you have made. Make sure that you have an accurate list of what is known for each one of the groups. If there is anything that you are not sure about, make sure that you find time the next day to discuss it with that group to make certain that your assessment of their revealed knowledge is in fact accurate.



When you feel that you have completed the assessment task to your satisfaction, round off the activity with a final Journal write.

Activity 2 - Option B - Modelling a Lizard from wire

This activity is essentially the same as the previous option except that it has a different subject, and different scrap material (wire) is used to make the model. We feel that teacher-learners who decide to do this option should be able to work out what is required by carefully reading Option A and making modifications themselves.



With regard to the material, you will need to collect old wire scraps of the kind that boys mostly use to make the technologically-wonderful working-wire-model cars that are so common in this and other parts of Africa. If your school has funds you can buy a cheap roll of binding

wire from a hardware shop for about R10 for 100 metres. You will also need to arrange to borrow wire cutters and pliers so that any thicker wire can be cut and bent safely.

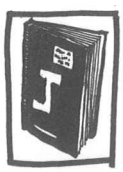
Please also think about the fact that wire has sharp ends and that proper safety precautions must be taken so that no-one gets hurt. It would be a good idea to plan to discuss safety with the learners **before** they start work on making their models.

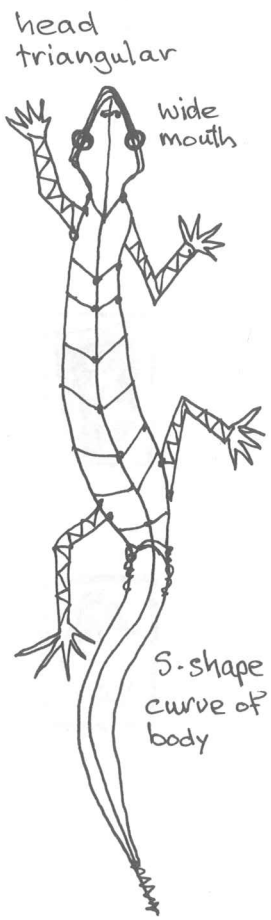
If you think wire is difficult to get hold of, and you are concerned about safety, you may decide to use clay as the material from which learners make their models. This should work just as well. But we haven't tried using clay as yet.

You should consider the same bullet points on page 9 when it comes to the specific planning you do for the work on making Lizard **models**. Make sure that you also read the advice about not interfering with the learners.

At the end of the day, make sure that you consolidate the notes that you have made, and that you have an accurate list of what is known for each one of the groups. If there is anything that you are not sure about, make sure that you find time the next day to discuss it with that group to make certain that your assessment of their revealed knowledge is in fact accurate.

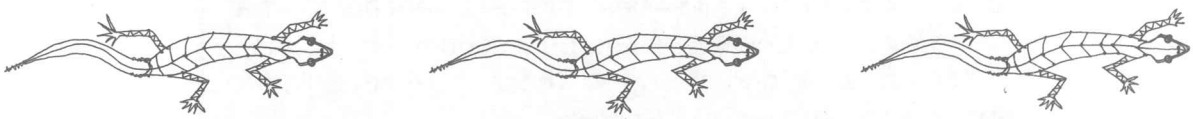
When you feel that you have completed the assessment task to your satisfaction, round off the activity with a final Journal write.





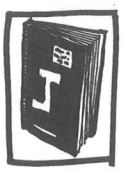
In this Unit you have had a chance to think about and try a form of *diagnostic assessment*. You now have a careful record of what your learners actually know about a particular aspect of Natural Science. You will be able to decide whether you want to use your work from this Unit or the work from the next Unit as a basis for the **Key Activity** in Unit 3.

In the next Unit we will introduce you to another way in which you can find out what learners know. Again, we suggest that an Activity usually associated with another learning area is useful for Science. In this Unit you have used modelling or sculpture. In the next Unit you will be seeing what happens when you use Poetry.



Unit 2 - Science Knowledge revealed in a Cultural Mode

In this Unit we start again with a Reading. This time it is a selection taken from a chapter of a recent book called *Challenging Ways Of Knowing*. You will need to read this extract with the Reading from Unit 1 in mind, because there are important links between the two Readings.



This time, don't bother with a pre-reading and a post-reading activity. Instead, write a careful entry in your Journal **after** you have carefully worked through this Reading. Try to *identify* and *see* where ideas from the Reading, "Models and Meaning for Primary Science" (from the first Unit) are *re-enforced* and *built on* in the Reading for this Unit.

Evolving shared discourse with teachers to promote literacies for learners in South Africa

In this paper Alan and Viv Kenyon draw on their collective experience as teacher educators and, more importantly, as storytellers in promoting literacies in intending teachers and school students. They have achieved considerable success in advancing the acquisition of complex literacies in two ways. Firstly, by valuing and recognising the rich and varied culture that learners possess and bring to education, and by developing ways of thinking and doing through the poetry, song, and myths/legends of the learners' vernacular languages and cultures. Secondly, in their teacher education programmes, they have developed bold and exciting ways of planning, delivering, and evaluating teaching material where student teachers are engaged as partners rather than as recipients of privileged knowledge delivered from 'experts'. Like Heath, Alan and Viv Kenyon argue that science and the arts can be integrated in learning, and they demonstrate this for us in their account of primary science teaching in township classrooms in South Africa. Their analyses of the poetry and song texts that children know as part of their culture show that these literary forms are capable of carrying detailed and accurate knowledge of the environment. The knowledge becomes the beginning of scientific enquiry by starting from where the children are, rather than from where the teacher or the 'science' is. Their emphasis on the uses of narrative in science education links this paper to the ensuing one by Leone Burton.

A Story

In January 1994 9-year-old Nonkokheli, a Xhosa speaker, found herself in an English medium 'Model C' school in Cape Town, barely able to communicate with her peers and teacher. She had come from a rural area to stay with an aunt who 'in the child's best interests' sent her to what had previously been a whites only school. Nonkokheli, already reading and writing in Xhosa, now struggled to speak, read and write in English.

In August we went to her school to tell and work with stories, changing and adapting them and making books. For Nonkokheli, the story of Demane and Demazana unlocked the door to English print literacy. A traditional story from her culture was given status in English. Suddenly there was reason to engage in print literate behaviour in a language other than her own. Her culture was valued and she had something to say. She could bring what she knew to her learning experiences and she wrote! Previously it had been a struggle to write two or three sentences in English, but now it was hard to stop. With the continued support of her teachers, Nonkokheli is now participating enthusiastically and thoughtfully in literacy events in English.

Nonkokheli is one of the small group of pioneers known by township teachers as the 'five-per-centers'. These are children to whom real opportunities to gain literacy are denied because what they bring to the learning situation is rarely acknowledged and counts for nothing. But what about the 95 percent who remain in what were Department of Education and Training (DET) schools, where the curriculum and methods which prevail in classrooms bear little relation to their culture and life experiences? Doors to various literacies are closed to these children as well.

The 95 percent

The average school learner in a primary school in South Africa struggles to become literate on a number of fronts:

- On the home front, against *the disadvantages of severe poverty.*
- At school, to make sense of and succeed in *a repressive and inefficient education system,* which will inevitably outlive the eras that spawned it.
- In broader social and cultural terms, to participate in the creation of a better, more equitable society with *diminishing resources.*

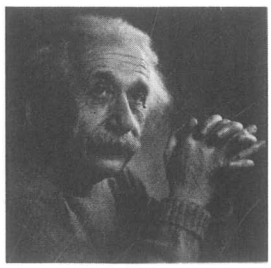
To transcend the past and climb out of poverty, school learning is given priority in the minds of most stakeholders. To move towards success in education children must confront, make sense of, and then take possession of significant aspects of a whole range of literacies - ways of articulating and interpreting meaning - from basic print-literacy and numeracy, to other more subtle and complex literacies from fields like science and technology, art, music, history, health sciences, and geography. There

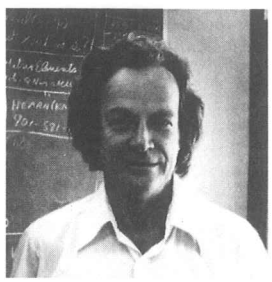
are also other emerging and competing fields such as environmental education (eco-literacy) and computer literacy. Not only do learners have to do this from the perspective of disadvantage and impoverishment, but *they are expected to do it mostly in a language that is not their own.*

What makes Science teaching problematic?

In our scientific and technocratic age, science discourse is probably one of the most powerful discourses. In contrast with a competitive world economy, based on highly sophisticated scientific and technical development, one finds that science and technology education is relatively under-developed and unproblematized. There is a lack of deep concern for the way in which the majority of learners are systematically 'cooled out' and switched off the sciences.

In South Africa, science education tends to remain focused on the fixed and rather sterile products of science, mediated through written texts which stress the facts, correct terminology and technical explanations of science content. Science discourse has evolved specific ways of encoding its own invented world in the written form (Halliday and Martin, 1993), and this effectively excludes the less advantaged, the less confident and the less powerful. Do the powerful in science rely solely on conventional scientific, written language when they think scientifically? Einstein claimed that such language played little part in his mental operations: signs, images and even muscular sensations played a far more important role. Nobel Prize winner, Richard Feynman, identified playing around experimentally, switching representations, being alerted to noticing things, having interesting discussions, translating ways of seeing and imagining as important aspects of his developing interest in science (Sykes, 1994).





A page of Richard Feynman's science notes.

Another problem in science teaching is that what our common sense tells us about reality often is not the case when looked at more closely, carefully, or more systematically in order to find out. Do teachers ever realise this and/or try to make this fact explicit? Do they unpack with learners the fact that scientific understanding can often seem counter-intuitive? How can they take account of the apparent contradictions between the way things are seen through a common-sense frame and the way science discourse sets things out? If we want learners to operate more powerfully in science, what changes are

needed to help teachers effect a more inclusive, learner-friendly science education for young children?

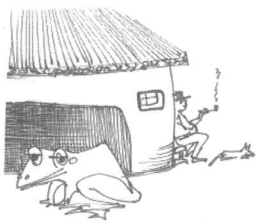
Young learners and Science

We found in workshops that teachers of young children are quick to draw parallels between the natural curiosity of their pupils and the science process skills conventionally associated with scientists. Going through an excerpt from Paley's research (1981), describing very young children's science discourse, many science process skills were evident: problem solving, experimentation, prediction, hypothesis and comparing.

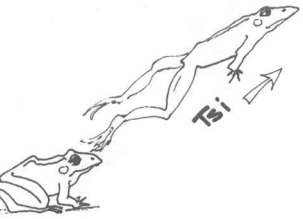
If very young children exhibit these scientific process skills naturally, what happens in primary schools to the incipient science they bring with them? How does it get deformed, stunted and shut off? How can teachers find ways to take account of and give status to children's capabilities? What aspect of the culture of the home, of the riches of African languages and of the oral tradition lend themselves to being incorporated into the day-to-day life of school?

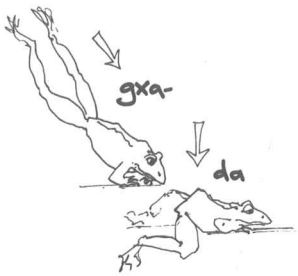
Another Story

Introducing lessons on frogs, a local teacher and accomplished storyteller, Maureen Figlan, appropriates the Frog Prince story but makes it completely her own and imbues it with many elements that are culturally part of African oral literature. She tells in Xhosa and incorporates traditional sayings and parts of rhymes. The onomatopoeic last line of a well known Xhosa rhyme, 'tsi-gxada; tsi-gxada; tsi-gxada' enriches the visual image of the way the frog jumps. The storyteller's ample body transforms itself dramatically as she mimes the frog propelling itself through the water with smooth, powerful thrusts. The crowded class of fifty-plus children sit spellbound. Riveted, they hang onto and relish every nuance of the telling.



Before we look at live frogs the next week, the class discusses how frogs move. Did the storyteller get it right? Does a frog really tuck its forelegs close to its chest when it swims? How accurate is 'tsi-gxada' in describing the arching jump of the frog? Suddenly the room is full of science and other talk, in Xhosa and in English, in gesture and in mime. Hands and arms move and swing in attempts to recapture or represent what is in the mind's eye. Cheeks bulge, eyes roll and frog sounds pervade the room. There is discussion, disagreement and more debate.





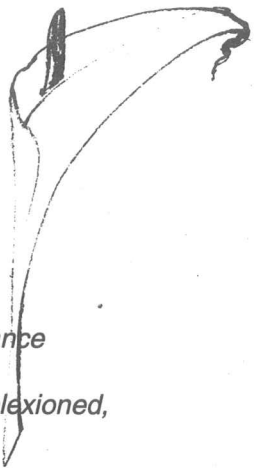
Observing frogs and looking at photographs, we find the storyteller was right. Perhaps the implicit knowledge came from her rural experience of listening to traditional tales (iintsomi) as a child and an apprenticeship into storytelling conventions where you 'memorise nothing, but remember many things' (Scheub, 1975). When it comes to jumping we observe that the frog kicks off with powerful hind legs and flies spread-eagled in an arc through the air (tsi), lands on its fore-parts first (gxa-) and the hind-parts follow (-da). So there is found, culturally imbedded in the poetry of the language and the conventions of storytelling gesture, scientifically accurate knowledge.

Models, praise poems and plants

In recent years the PSP teachers have been exploring ways to carefully assess the science knowledge children bring with them. We have tried drawing and mind-mapping and have moved onto model making. Modelling, both mentally and physically, is seldom given any conscious attention in the current curriculum. Yet it has always been a powerful African symbolic, expressive form. And in science it is a dominant means by which scientific findings are rendered and made explicit. Young African children improvise ingenious model toy cars from scraps of wire and bottle tops. The notion of modelling is not alien. The idea that a model can also be a tool to help conceptualise something scientific is under-exploited in our primary schools.

The heritage of oral literature for many South African people incorporates praise poets. At the 1994 inauguration of President Mandela, praise poets were part of the ceremony. Spontaneous oral poetry (umbongo) lends itself to formative assessment by revealing what children know in an expressive and lively form rich in metaphor and poetic associations. At a workshop on the 'Value of Plants', teachers tried composing praise poems of their own to plants like aloes, grasses, reeds and umhlonyana (a variety of wormwood). The teachers were quite struck by the way the unconventional exercise tapped and revealed a hidden resource of cultural and factual knowledge not usually given status in school-associated learning. We tried it with children and the results have been quite stunning. Considerable factual and accurate knowledge is revealed, knowledge that makes a particularly appropriate and empowering starting point for subsequent work, knowledge that celebrates what learners bring to school and in particular, their oral literacy skills and the potency of their primary language.

The following poem comes from a pupil at Sosebenza Primary School in a particularly impoverished shack area on the outskirts of Cape Town. Teachers at this school have been promoting literacy by encouraging children to make their own books.



Inyibiba ngu Ayanda Silumko
Nzwakazi ndini ebuqhaqhawuli
Nzwanekazi ndini engenasiphako
Mbelukazi ndini emanzandonga
Buqaqawuli besizwe sakowethu
Sihombo sesizwe siphela Isizwe
siyazingca ngawe

Awunamdintsi uyathandeka eluntwini
Udumo lwakho lungumangaliso
Singayini na isizwe nqaphandle
kwakho
Akubuni ebusika nayiqabaka
Lishushu ilanga uyadlisela

Akulali ebusuku uyaphuthelwa
Nasemini akozeli uyayokozela
Imbalela akuzazelento
Imimoya evuthuzayo ayiluthu kuwe
Indudumo zifika ziphinde zigqithe
Nyibiba ndini egeva zimanga

Arum Lily

Queenly, of silky bright appearance
Queenlier, blemish free
Beautiful woman, creamy complexioned,
like donga floodwater
Beauty for all our nations
Beauty to appease all our nation

People, never tiring of your beauty,
love you
Your glory is immeasurable
Plucked you don't wither or wilt and the
nation is privileged by your presence
Even winter cannot dry you out
Your thrive on morning dew and in the
heat of summer look even more proud.

You don't sleep at night. No you are never
drowsy.
By day you don't even doze and your
beauty is resplendent
You transcend droughts
Blowing winds are nothing to you
Storms come and go without affecting you
Arum Lily! You remain untouched regardless.
(Not even an unknown thing to come can
harm you.)

(Inyibiba was translated by Ncebekasi Saliwe and Ndileka Mavumengwanana.)

This pupil is aware of soil erosion, knows the drying effect of sun and wind, knows that cool air carries less water vapour, knows that some flowers close at night, and that the arum is not a seasonal flower. Most interesting of all, is the way he alludes to new pending ecological dangers.

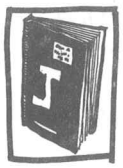
More About Story

Stories are an untapped resource from the strong cultural tradition of oral literature throughout Africa. There is evidence that many traditional stories provide explanations of natural phenomena which parallel scientific theories (Levi-Strauss, 1978). Children like Nonkokheli find themselves in the texts of these stories and in situations which could otherwise be alienating, they are more likely to feel included when a story from their

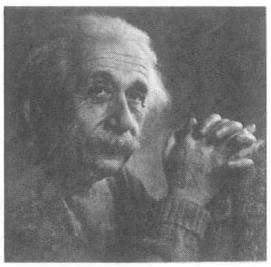
culture is used. Through using stories we believe teachers are likely to open the doors of the science literacy club to more children.

We believe that stories lend themselves to teaching implicit and incidental lessons. They can also be used to subtly open up cognitive space for subsequent work and talk. People come to learn things by revisiting them in different contexts, at different times, in different modes for different purposes and with differing degrees of interest and attention.

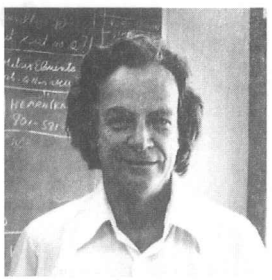
Perhaps a major problem with the development of science literacy for children has been a narrow focus and reductionist approach. You end up with a lowest common denominator type of science education. If the matrix from which children must make sense of science is narrowly framed and the register arbitrary and inflexible, is it any wonder that children vote with their minds and opt out?



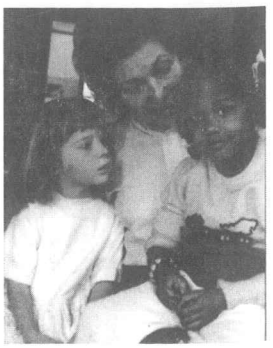
After you have written your own notes about what you have read in your Journal, we would like you to think a little more deeply about one or two of the things that you will have read about in the Reading.



First, go back and find the reference to Albert Einstein and identify what he says helped him in his thinking. Do you see a link between what helped him and some of the multiple intelligences items from Umthamo 26? If the 'person of the century' used signs and images, as well as bodily feelings to help him think about scientific ideas, why don't we make it possible for young children to do the same in school?



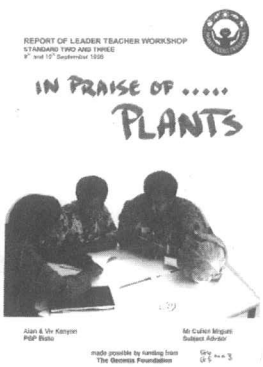
Then go on to remind yourself of what the famous American nuclear physicist, Richard Feynman, says helped him to develop an interest in science when he was young. Ask yourself how often you were allowed or encouraged to switch representations (to draw, or model, or act out your ideas), to discuss, to translate ways of seeing into other forms (maybe poems or songs), or to just spend time imagining things when you were at school. Then ask yourself how often you let the learners in your class do such things.



Next, we wonder if you made the connection between the reference to Vivian Paley's research (1981) and the Reading you worked with when you first thought about Science Process Skills in Umthamo 3. Well done if you made the link on your own.

Now, *before* you go on to think about the activity for this Unit, we would like you to *back* and carefully re-read the

section headed, **Models, praise poems and plants**. We want you to do this because this is the basis for Activity 3.



In September 1996, the academic co-ordinators for the Core Learning Areas Course of this B Prim Ed ran leader-teacher workshops in the Central region for Grade 4 and Grade 5 teachers. At workshops on Plants, we brought in the idea (developed first in the Western Cape) of making use of the skills and abilities that learners have, which are an essential part of their cultural background and knowledge. We had read that an important part of traditional Xhosa culture is the creative art of making up spontaneous praise poems.

In preparation for the following activity we hope that your umkhwezeli will give you the opportunity to have a go yourselves at a face-to-face session. We expect that your umkhwezeli will have a selection of plants, parts of plants, and things that are made from plants available for you to select an item from as the stimulus for a praise poem. You will be given a few minutes in your groups to think about and plan your praise poem based on what your group has. Then one of you will get up, holding the chosen thing to be praised, and you will praise that plant in the traditional way.

If it is possible, you may get the opportunity to watch a short video clip of teachers working with a Grade 4 class, getting groups of learners to create praise poems to plants. It may also be possible for you to borrow the video-tape from the library of your resource centre, if you want to see it for yourself. In this video, you will see evidence of

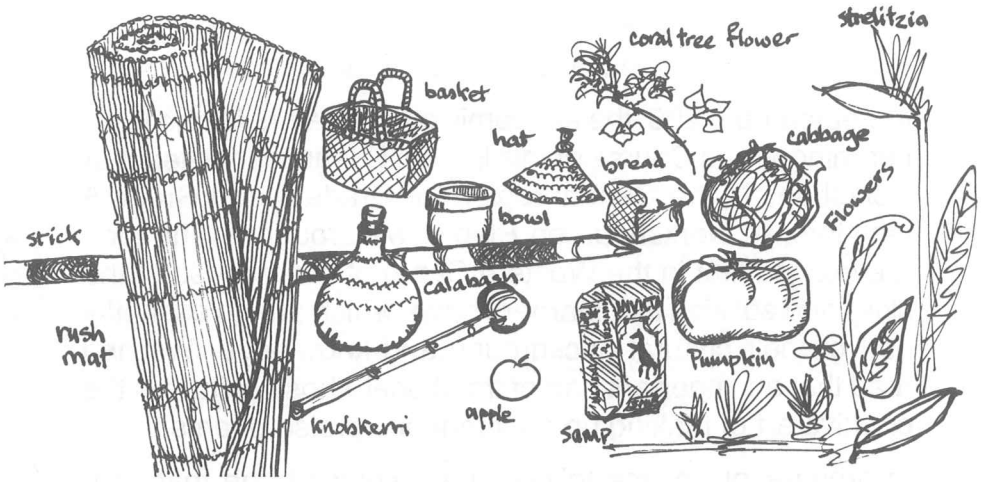
- children working together,
- children helping each other to produce some lovely thought-provoking praise poetry, and
- children getting really excited about the outcomes of their work.

With this background, we think that you are now ready to try the following activity with your learners at school. We really hope you find it an exciting and rewarding experience.

Activity 3 - In Praise of Plants

Planning for the activity

You will need to think carefully about what you need for this Activity to work well. You will need to collect plant material for a display from which groups can select the thing that they want to 'bonga'. Try to include examples of local plants that the learners know. You could also have some produce like fruit or vegetables. Processed plant products like samp or bread are a good idea. And you could include cultural craft items like mats, baskets, hats and wooden bowls.



Another thing that you need to arrange is to get a skilful imbongi to prepare something as a demonstration. This is important because it will provide the learners with a clear model of what is expected from them. It should help both to challenge them and to give them confidence. If you feel confident, then you can do this yourself. Otherwise you could ask a fellow teacher to do it for you. Or invite a parent or someone from the nearby community who might be willing to help.

Remember that the **purpose** of this activity is to *assess* the learners' pre-knowledge about some aspect of plants. You are also interested in finding out whether an artistic, cultural activity like creating a praise poem can reveal accurate knowledge and information.

The Activity itself should be very straightforward. You will need to think of a way of introducing the Activity. Perhaps you could get the learners to work in pairs to see which pair can write down the most different names of plants in just 5 minutes. Decide what you want to do, but don't spend a long time on this introductory task.

Next, demonstrate a good example of a poem in praise of a plant. Then explain the task clearly. Tell the groups that you want them to send a member of their group to select something from the display that they would like to 'bonga'.

They must then discuss carefully what they have. They need to share ideas as a group in preparation so that one of the group can come forward to present the praise poem to the class later.

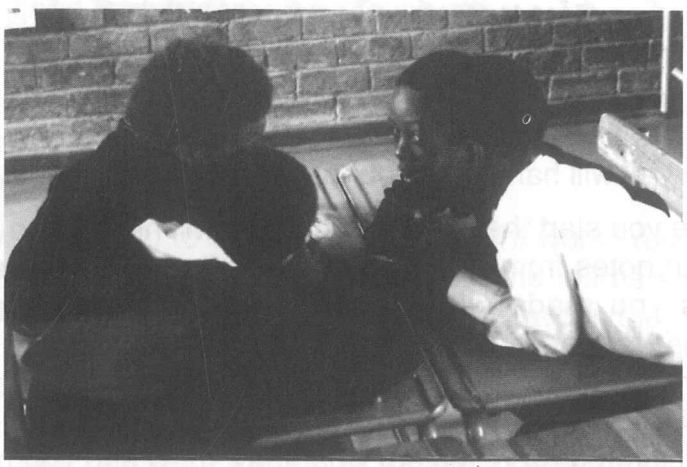
(You might want to have your tape-recorder ready. But don't use it if you think the tape-recorder will inhibit the performers and make them shy.)

While the groups are working, you need to observe them carefully and even make notes of what they know. Do the same thing when they are presenting their poems.

Afterwards, you can ask the learners to reflect on their poems and make a list of all the facts about the plant that they thought of in their planning, preparation and presentation.

At the end of the Activity you should have an assessment list in which each group's revealed knowledge has been carefully recorded. That evening you need to think back over the Activity. You also need to look at the diagnostic assessment lists you have made. When you have done this, take out your Journal and write your own reflective comments.

You have now completed two different Activities that have enabled you to assess what your learners already know about something. Your task in the next Unit will be to think of how you can plan to **extend** what learners know. When they are working on extending what they know, you will be assessing them in a different way. You will be trying *formative assessment*. You will also be thinking how you can use this formative assessment to inform your planning for what happens next.

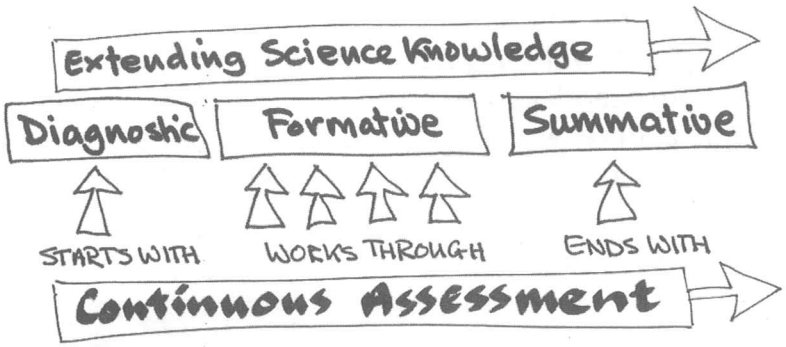


Unit 3 - Extending what children know

In this Unit, which includes the **Key Activity**, you will think carefully about the things that a teacher can do when she wants to push the learners so that they make progress in their science learning.

You will first consider what you learned from your *diagnostic assessment* of your learners. Then you will need to consider and try the strategies (means) you can use to **extend** what your learners can do and know. When you do this, you will need to consider how effective your strategies are, and you will need to make notes of the progress of the learners. In this way, you will be making use of *formative assessment*.

Then finally, you will have to think of an Activity that will enable you to make a *summative assessment* of the extent to which your learners have improved or made gains in terms of science knowledge. One way to do this would be to repeat or try to improve on the task for the *diagnostic assessment*.



The above three steps will form the basis for your **Reflective Report** which will be assessed by you and your peers, and which you will hand in to your umkwezeli for appraisal.

Before you start the **Key Activity**, you will need to go back to your notes from Activity 2 and Activity 3. These are the notes you made when you reflected on the science knowledge that your learners demonstrated as outcomes of the previous activities. When they made models and talked about the models that they had made, the learners demonstrated (or revealed) what they knew and you made a list to share with them. You did the same thing when the learners had the opportunity to 'bonga' some plants.

Read your notes carefully, because what you have to do next is to make a choice. You have to choose **one** of the lists as a focus for the **Key Activity**. It is important that you make a wise choice here because it will effect the success of your work on the **Key Activity**. It might be a good idea to read ahead to see what is required in the **Key Activity**, before you make your final choice. Once you have made your choice, then you are ready to start.

If you work with younger children in the primary age range, you will be working with a general model of a plant or a poem about a specific plant, as a specific starting point. If you work with older children in the upper grades, then you will be working with what is known about lizards from the models that they made, or you will be thinking about the specific science knowledge that comes from a group's attempt to 'bonga' a plant of some specific type.

Activity 4 - Key Activity - Extending what children know

Step 1 Planning to extend learners' science knowledge

The first thing that you need to do is to *identify* the gaps in what learners know, or the knowledge that is missing. To do this, take the list of what learners know, which you have chosen, and use a *different* colour and add all the things *you* know about that topic.

After you have listed additional relevant science knowledge, make a *selection* of what you think is appropriate for the learners. Not everything will be suitable. What sort of criteria should *guide* a teacher's selection of what learners need to know? **Before** you read the list in the margin box, try to think of, and list the criteria for yourself. How many did you think of? Did you have any good ones that we didn't think of?

When you have thought a little about the criteria, you can go through your list. Mark the things that you think your learners ought to learn, and mark the things that might interest them.

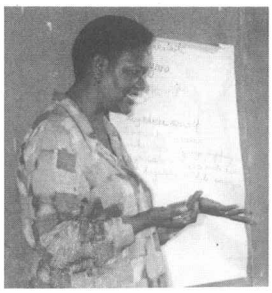
Now you need to *decide how* you might work. You are going to think a little about how best the learners can access the things they need to know. What can they find out for themselves? What might you need to tell them? How will you tell them or help them to find out what you think they need to know? What materials and resources can you lay your hands on to help them? You are beginning to plan provisionally for what might happen when you try to extend science learning.

The next thing to do is to *consult* with the learners to see if your thinking is on track. In fact, you are going to involve the learners as **partners** in the planning process. In a way you will be **negotiating the curriculum** with your learners which is a very progressive and modern thing to be doing. So give yourself a pat on the back for being brave enough to do this.

Is the information -
interesting,
of value,
relevant,
related to what is already known,
meaningful,
important as a basis for further learning,
at a suitable level for the age, etc.

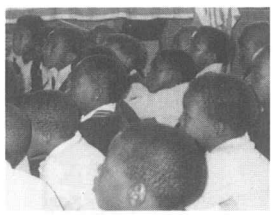
If you are not too confident about your own science knowledge, then you might want to consult with someone who knows a little more than you do. Find out if there is a local high school teacher who has done botany or agriculture at university. Someone who has done forestry will also have specialised knowledge about plants.

If you are working with lizards then you need to find someone who has done a few years of zoology. You can also make use of reference books if you have access to a local library. We will include supplementary material about plants and lizards in the resource file that goes with this umthamo.



Step 2 Planning alongside your learners

Make sure that the rest of the class has something meaningful or worthwhile to do *before* you gather the group that you plan to work with around you. Start by reminding the group of the previous activity. Tell them that you want them to build on their knowledge. Tell them that you have given this some careful thought yourself, and that you want them to help you decide what it is that they need to learn or find out next.



This should be a very interesting discussion, so make sure that later you will be able to reflect accurately in your Journal by being carefully aware and alert to what happens. You may want to make notes as you go. Or, you may decide to tape-record the discussion. It is up to you.

You have some choices now. What is the best way to recap for the learners, what has already been recorded as known? Should you simply tell them? Should they try to remember? Would it be easiest just to give them a list? Would it be useful to build up a mind map together? You don't want to spend too much time revising what is known. Make your own choice. But, be sure to explain, or justify your choice with reasons when you write up your reflective research report.

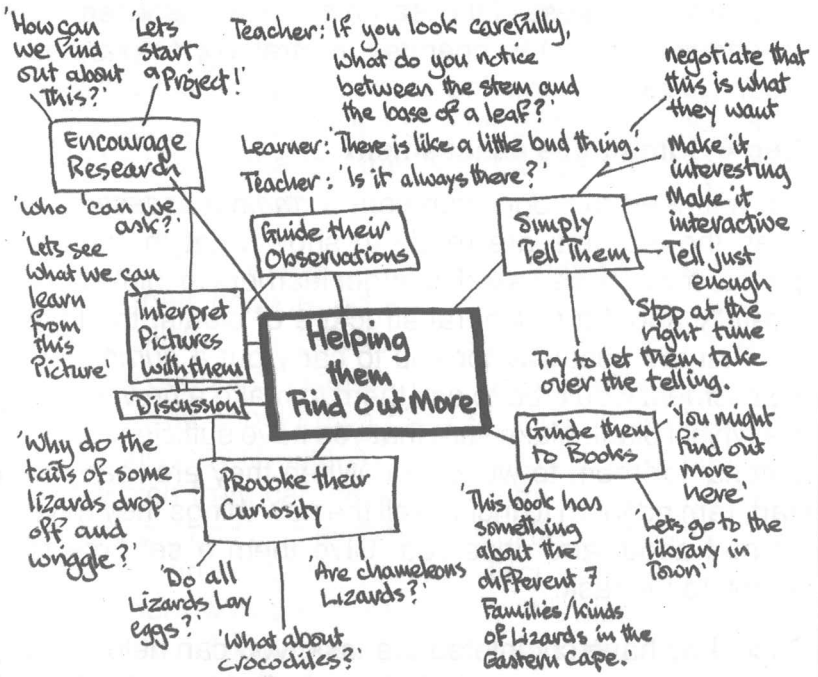
Once you have revisited what was known, you need to give the learners a chance to think about what they would like to know more about. Do they have any unanswered questions in their minds? Are there things that they are already aware that they don't know? What you should be doing at this stage is helping the learners *raise questions*. You will remember that you did this when you were promoting independent investigations in Umthamo 19. You may want to go back and read what is written about raising questions on pages 9 and 35 of Umthamo 19.

After they have been given a chance to raise their *own* questions and to discuss or compare the importance of their questions, you have a chance to include some suggested questions of your own. This is where *you*, as the responsible adult, must make wise professional judgements. It is *your* responsibility to get the level right. You need to challenge the learners *without* discouraging them. This is where a teacher needs to be thinking about the theoretical idea of the *Zone of Proximal Development*. We hope that soon in the Helping Learners Learn strand of the Core Education Studies Course you will get

information and encouragement to become familiar with this term, as well as the important idea of 'scaffolding' as a strategy for helping learners learn.

Now you need to share some of the things that you wrote down as extra or additional relevant knowledge. You also need to suggest possible ways for the learners to find the answers to the questions, or to get access to the information that you and they feel will be valuable and interesting.

What can a teacher do to extend knowledge?



Please make sure that you make careful detailed reflective notes on how this part of the activity goes. What went well? Did anything surprise you? Were you disappointed by anything? What happens here at this joint planning stage, and the way that you record what happens, is an important part of *formative assessment*. You should be able to use this assessment information to help you plan and adjust what comes next.

Now that you and your learners have thought about what it is that they need to know and find out, you are ready for the final part of the planning step. You need to decide how best the learners can go about finding out. You also need to decide just how much help they want, or need, from you, and what your role will be. Finally, you need to set a time limit for the 'finding out more' part of the Activity. A week is probably about right.

Step 3 Extending science knowledge

You will need to *monitor* what happens from now on very carefully. Keep a careful check on the progress of the learners. Try to have regular short discussions in which they can share their progress. Make notes of what they are doing, on *what* they have found out, and *how* they have found things out. Try to be sensitive about how much information you feed/give them, and note down *what* you tell them and *when*. Also try to make a note of the **effect** of your intervention. Again, your notes at this stage form part of *formative assessment*. You should try to notice how the observations you make help you advise and support the progress of the learners. Do any assessment observations result in changes in strategy, or planned action (plans)?

Step 4 Summative assessment

You will need to judge from your *formative assessment* when the learners are ready to show what they have gained. If you have asked younger learners to think more carefully about the general structure of plants, then we feel that the best way for you to carry out a *summative assessment* would be to ask them to make a new model of a typical plant. Make sure that you have sufficient scrap material for them to work with. When they are ready to start, remind them to include all the new things they have learned about and observed. Give them a set time to complete the task.

This time include them in collecting the scrap material that they think might be useful. They can bring suitable waste material from home.

Once they have completed the task, you can help them to appraise the product of their work. Get them to show you all the new things that have been added, and to tell you the specific new words (or names of parts) that they have learned. Note these down. This is your chance to affirm them and make them feel good about what they have done. Praise them for their efforts. Praise is the most important motivator to encourage learning.

Make sure that you keep the models and your notes safely so that you can refer to them when you write your report, and so that you can include them in your portfolio presentation.

If your learners have 'bonga-ed' a particular plant or kind of plant, then you will work differently. You will give them time to carefully plan a new poem in praise of that kind of plant and you will stress that you want them to include **all** the new things they have found out about that plant and its use or value.

When they are ready, we suggest that you find a time for them to present their new, improved version of the praise poem to the rest of the class. We also think that it would be a good idea for you to tape-record their performance.

Afterwards you can help them make a transcript (written record) of their work. As you make the transcript together, you can assess the extent to which they have included new things that they have learned. You can do this by making a separate list of facts and terms that are evidence of new knowledge. Again, this is a good time to affirm the learners by praising them and their work.

If you are working with older learners and have chosen to use the Lizard Activity, then you will probably have to work somewhat differently. We have found when we tried this activity, older children know a great deal about the general structure of a typical lizard. They may just be uncertain about some of the finer details such as the number of toes on each foot, and whether or not lizards have eyelids. They probably won't know too much detail of the habits or way of life of various lizards. Also, they won't be too clear about the different types of lizards that we get here in South Africa.

Because of the above, we suggest that a better way to extend their knowledge and to assess how this has worked will be to get the learners to do a specific project on some aspect of Lizards. They can make an improved model. They should also draw to show what they *now* know. And they should do some research and reference work which they can write. When they are ready, they can present and display their work to the rest of the class. After their presentation you can discuss the *summative assessment* with them. As you do this, list all the new detail and information about lizards that they have included in their work.

The summative assessment process is a very good way to affirm learners for their efforts. You are making overt (openly clear) the ways in which they have made knowledge gains. They can see for themselves just how much they have gained or learned. They can be helped to reflect on their own learning and encouraged to think about successful learning strategies for future use.

Make sure that you keep the tape of the poem safely, as well as the transcript and the list. You can refer to them when you write your reflective report, and present them for others to see at your portfolio presentation at the end of the year.

Writing your reflective report.

This should be a fairly straight forward assignment. We suggest that you use the following headings, and take account of the advice or suggestions under each heading. Perhaps you should start by referring back to your notes and records and then make a rough outline of what you will be dealing with in your Report. Then write a neater first draft. It might be useful to share this first draft with a

friend or colleague who should be able to tell you whether what you are writing is logical and makes sense. Ask that person to point out anything that is *not* clear, or where more information seems to be needed. You can then concentrate on fixing these parts when you write your second draft.

Introduction

Here you will give a little background detail about your situation and your learners in the first paragraph. Then you might decide to give the reader a taste of what is to come in the next paragraph by outlining your approach and explaining what you expected to find.

Knowledge Outcomes from Diagnostic Assessment

In the first paragraph of this section, you will probably describe the task briefly and some of the skills and attitude outcomes that you observed while the learners were working. How well did the group co-operate? What skills and ingenuity did they demonstrate? What was their attitude to the task?

Then in the next few paragraphs you need to list and comment on the things which the learners showed they already knew. This is where you will be identifying the specific science knowledge that the learners have revealed.

Planning to Extend what is Known

Here you will briefly describe and reflect on how you went about your planning, and how you incorporated the learners in planning what they could do to find out more.

Working to Extend what is Known

Write a clear description of the way you and the group of learners went about finding out more. Include comments on how you continuously assessed the progress of the learners. What did you notice? Try to show how this *formative assessment* influenced the way you guided the learners. Did you make any changes to the way of working, and what were your reasons for making these changes?

Summative Assessment

Here you need to describe how you assessed the learners to find out what they had gained. Then write about the differences you observed? You need to list the type of knowledge gains that were made. Finally, you need to account for the identified gains in factual and other knowledge. How did the learners gain access to new

information and ideas? Was it from their own observations? Was it from reference books? Were they told by someone who knew? What part did you play, as teacher, in helping the learners move forward?

Reflection

Complete your research report by reflecting carefully on your role as teacher in helping the learners learn more about something. Reflect also on the effect that you think this activity has had on your learners' attitudes to science.

Criteria for assessing this reflective report

You need to think carefully about this so that you can hand in your Reflective Research Report with your own self assessment recorded in advance. Also, you will be asked to read a peer's report and to assess that as fairly as you can.

What will make your report a **good** piece of work? It will need to be clear to a reader who does not know you or your school. So there should be sufficient background information. It will also be clear that you understand the three different types of assessment that you have been using. Your description of what happened should be logical and easy to follow.

You will have identified some clear differences that show how the learners have gained science knowledge. You will have provided reasonable explanations of how these gains were made. And you will have described your role in helping learners to make these gains. Finally, you will have given some evidence of sensible reflection on your role in helping learners extend their understanding.

If any of the above are missing or not really adequate, your assessment should be **OK** (barely meets requirements). This means that a reader would be a little confused or not quite clear about your report, but basically it would make sense.

At this stage of the course, *none* of you should be scoring a **weak** assessment. But if the work has been rushed and is generally poor, then you would have to give yourself such an assessment.

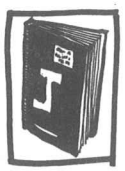
If you think what you have written is very interesting and detailed, and if you have supported all your points with logical arguments, then you can consider a **very good**. But you will need to have included reflection of a high standard.

If you think what you have written is good enough to be included as an article in an educational publication like 'The Teacher', then you can give yourself an **excellent**.

Conclusion

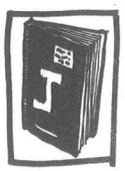
In this umthamo you have been thinking about ways to extend or develop the science knowledge of your learners. Do you think that you have been successful? You have also experimented with integrating Arts and Culture with Science. How do you feel about what you have tried? While you were doing this work, you have also been aware of, and used, different forms of continuous assessment. Was this useful? (Have you realised, as you read this paragraph and think about the three questions, that you are considering the **outcomes** for this umthamo?) Do you think the intended outcomes were successfully attained?

Your learners will have had some fun making models from scrap material or wire. But they have had to think quite carefully about what they were doing as they were doing it. Were they surprised at first when you asked them to 'bonga' something in science time? Did that go well? Did your learners surprise you with what they know?



Has this umthamo contributed to **change** in any significant way in your classroom? Has it made a difference to you in any way? Have you changed? Have your learners changed? Think carefully about these questions for a while. Then write your thoughts and answers in your Journal.

When you get a chance, speak to some of your learners about the work that you have all been busy with and have just completed. Show them the umthamo. Explain that the ideas for the work came from the umthamo. Ask them for their comments on the activities. Note and write down what they say. Later on reflect on what they told you and write about it in your Journal. Write down your thoughts when you consider the things that they have said.



Remember that we welcome comments on the imithamo. If you think we would be interested in the things that you have just been writing in your Journal, why don't you write to us - Alan and Viv Kenyon and Mthunzi Nxawe at the DEP. We'd love to hear from you. You can either post your letter to us at the DEP, or give it to your umkhwezeli or your Centre Co-ordinator to deliver by hand when they next come to Bisho for a meeting or an abakhwezeli workshop.

Please take the Content Audit on the next two pages seriously. It is up to you to stay informed and develop confidence when it comes to content knowledge and understanding. The teacher is the most important learning resource in the classroom. You have to be the resourceful one. You have to be a rich resource that the learners can draw on. The more you know and the more you go on learning, the more valuable you become as a resource for learning. The umthamo that follows this one is all about resources for learning, and we are sure that you are going to find it very interesting.

Appendix – Content Audit of Plants

If you know and understand something about each of the items in this mind-map, then you can be confident about your background content knowledge.

Content Audit of Lizards

Work through this mind-map, and then see if you and your learners can **find out** more about the different kinds of Lizards found where they live.

UNIVERSITY OF FORT HARE

DISTANCE EDUCATION PROJECT

CORE LEARNING AREAS COURSE

Natural Science

Umthamo 4 - Finding out more about Science

First Pilot Edition - 2000

Alan Kenyon, with the help of

Mthunzi Nxawe and Viv Kenyon

Co-ordinated, illustrated and edited by

Alan & Viv Kenyon

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