Revised National Curriculum Statement Grades R-9 (Schools)

Teacher's Guide for the Development of Learning Programmes

Natural Sciences

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ISBN 1–919975–07–1

Design, layout and printing by Formeset Printers Cape for the Government Printer, Pretoria

This document must be read as part of the
Revised National Curriculum Statement Grades R-9 (Schools).

The Revised National Curriculum Statement Grades R-9 (Schools) includes:

1. An Overview
2. Eight Learning Area Statements:
    - Languages
    - Mathematics
    - Natural Sciences
    - Social Sciences
    - Arts and Culture
    - Life Orientation
    - Economic and Management Sciences
    - Technology

FOREWORD

The majority of South African teachers have grappled with an education system that has been in the throes of rapid transformation sparked by the student cohort of 1976. Throughout the 1980's, education served as one of the focal areas that characterised resistance to the injustices of apartheid.

The 1990's, and the advent of change characterised by negotiations, saw the education system enter the current period where changes in education reflected systematic initiatives, research-based programmes and policy-driven, large-scale transformation. Teachers are now challenged to exert their professional judgment, curriculum expertise, teaching prowess and management skills in the interest of learners, schools, communities and the nation.

We are convinced that teachers implementing Curriculum 2005 have gained skills, experience, knowledge and techniques that have provided them with a base for engaging with the Revised National Curriculum Statement Grades R-9 (Schools). This Teacher's Guide for the Development of Learning Programmes builds on and enhances that base.

The Revised National Curriculum Statement Grades R-9 (Schools) will be implemented in schools by means of Learning Programmes. Learning Programmes are structured and systematic arrangements of activities that promote the attainment of Learning Outcomes and Assessment Standards for the phase. Learning Programmes ensure that all Learning Outcomes and Assessment Standards are effectively pursued and that each Learning Area is allocated its prescribed time and emphasis. Learning Programmes are based on relationships amongst outcomes and Assessment Standards without compromising the integrity of Learning Areas.

These Guidelines have been produced as a support mechanism to teachers. Over time, teachers will enhance their capacity to develop their own Learning Programmes. These Learning Programmes will take cognisance of the diverse learning contexts, availability of resources, different learning styles, multiple intelligences of learners and the barriers learners may experience.

These Guidelines are geared to assist teachers in accommodating Learning Outcomes and Assessment Standards that are prescribed, yet create space and possibilities for the use of judgments and insights based on particular contexts and a diverse learner population. As insights that are informed by practice, research and refinement, emerge from these Guidelines, it is anticipated that over a period of time teachers will develop as curriculum leaders. The majority of teachers within the apartheid education system were not encouraged to be creative, imaginative and lead curriculum development and design. They were controlled followers and were forced to practise through prescription. As a consequence, many teachers were not participants in the exciting process of curriculum development.

The development of these Guidelines was rooted within the framework of the Revised National Curriculum Statement Grades R-9 (Schools). Therefore, it is expected that these Guidelines should be read within a sound understanding of the Revised National Curriculum Statement Grades R-9 (Schools).

Teachers, schools management teams, departmental officials, teacher unions, non-governmental organisations, community-based organisations and service providers are invited to use these Guidelines not as a doctrine but as an enabling mechanism that will contribute to the delivery of quality, life-long learning.

T.D. Mseleku
Director-General: Education

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SECTION 1
GUIDELINES FOR THE DEVELOPMENT OF LEARNING PROGRAMMES

1.1 INTRODUCTION

Curriculum and teacher development theories and practices in recent times have focused on the role of teachers and specialists in the development and implementation of effective teaching, learning and assessment practices and materials. In the Revised National Curriculum Statement Grades R-9 (Schools) (RNCS), mention was made of policy guidelines for Learning Programmes (RNCS, Overview, p.16). It has been agreed that these will now be called Teacher's Guide for the Development of Learning Programmes. As stated in the RNCS, the curriculum is to be implemented in schools by means of Learning Programmes. Teachers are encouraged to develop and implement their own Learning Programmes, and this should happen within the policy framework provided in the RNCS. This Teacher's Guide for the Development of Learning Programmes (hereafter called 'these Guidelines') have been developed to support teachers to do so.

Although this document is primarily written for **teachers** who have to develop their own Learning Programmes, cognisance is taken of the fact that other Learning Programme developers will also use these Guidelines.

1.2 PURPOSE OF THE TEACHER'S GUIDE FOR THE DEVELOPMENT OF LEARNING PROGRAMMES

These policy Guidelines have been developed at national level (with provincial participation) to assure that teaching, learning and assessment practices are developed effectively so that learners can achieve the Learning Outcomes as set out in the RNCS.

The purposes of these Guidelines are to guide teachers in the development of a Learning programme by:

- providing Guidelines to teachers on *how to* develop a Learning Programme;
- providing the ***essential features and underlying principles*** of a Learning Programme;
- promoting and encouraging adherence to the RNCS and support for its implementation; and
- providing a framework for teacher development and training.

These Guidelines are intended to be implemented in conjunction with other policies that promote and support education transformation so that the Critical and Developmental Outcomes, which underpin teaching and learning across the South African school curriculum, are attained. For example, the *White Paper 6: Special Needs Education – Building an Inclusive Education and Training System* needs to be read to provide background information on issues related to barriers to learning, as these have crucial impact on what happens in the classroom. The *Assessment Guidelines for Inclusive Education* document stresses the need for alternative teaching and assessment strategies, and provides recommendations on how to overcome barriers to learning. Addressing barriers to learning is an important responsibility of teachers when developing Learning Programmes.

These Guidelines also need to be read together with the RNCS. The RNCS contains Learning Area Statements for each Learning Area that spell out the Learning Outcomes (LOs) and Assessment Standards (AS) per grade and the Overview.

1.3 DEFINITIONS

The RNCS indicates that LEARNING PROGRAMMES should be organised as follows:

- Planning for the whole phase. This is called a **Learning Programme.**
- Planning for a year and grade within a phase. This is called a **Work Schedule.**
- Planning for groups of linked activities or single activities. These are called **Lesson Plans.**

1.3.1 Learning Programme

A **Learning Programm**e is a ***phase-long plan*** that provides a framework for planning, organising and managing classroom practice for each phase. It specifies the scope for teaching, learning and assessment for the phase and is a "structured and systematic arrangement of activites that promote the attainment of Learning Outcomes and Assessment Standards for the Phase" (RNCS Overview, 2002). A Learning Programme is a tool for ensuring that the Learning Outcomes for each Learning Area are effectively and comprehensively attended to in a sequential and balanced way across the phase.

The Learning Programme thus interprets and sequences the Learning Outcomes and Assessment Standards as spelt out in the RNCS into planned teaching, learning and assessment activities for a phase. It spells out what core knowledge and concepts will be used in attaining the Learning Outcomes for the phase. It plans for how different contexts and local realities, like the needs of the community, school and learners, will be considered.

The Learning Programme also considers how integration within and across Learning Areas will happen, as well as what resources are available and needed to deliver teaching and learning activities.

A Learning Programme will in turn, be translated into yearlong, grade specific ***Work Schedules*** and shorter activity-long ***Lesson Plans.***

1.3.2 Work Schedule

A **Work Schedule** is a ***yearlong programme*** that shows how teaching, learning and assessment will be sequenced and paced in a *particular grade.* It is a delivery tool, a means of working towards the achievement of the Learning Outcomes specified in the Learning Programme, and incorporates the Assessment Standards that will be achieved in that grade.

1.3.3 Lesson Plan

A **Lesson Plan** is the next level of planning and is drawn directly from the Work Schedule. It describes concretely and in detail teaching, learning and assessment activities that are "to be implemented in any given period[of time]" (RNCS Overview, 2002). A Lesson Plan could range

in duration from a single activity to a term's teaching, learning and assessment and, in terms of actual time, may last from a day to a week or a month. It includes *HOW* (i.e. teaching style, approach and methodology) teaching, learning and assessment activities are to be managed in the classroom.

1.4 THE PURPOSE OF A LEARNING PROGRAMME, WORK SCHEDULE AND LESSON PLAN

Learning Programmes, Work Schedules and Lesson Plans represent different stages of planning. While the team of teachers that teach in a phase develops a Learning Programme, the teachers of a particular grade within a phase develop a Work Schedule from the Learning Programme. The class/Learning Area teacher, in turn, develops the Lesson Plans for his/her class. At each level of planning more detail is added to that of the previous level as is described below. Quite apart from the detail shown at each stage, the whole process is informed (at each level) by the same and very important factors described in 1.5.

1.4.1 From the RNCS to the Learning Programme

A Learning Programme translates the RNCS into phase-long plans that detail (at a minimum):

- The sequencing of Learning Outcomes and Assessment Standards across the phase to ensure a coherent teaching, learning and assessment programme;
- The core knowledge and concepts or knowledge foci selected to be used to attain the Learning Outcomes;
- The context that ensures that teaching and learning is appropriate to the needs that exist in the community, school and classroom; and
- The time allocation and weighting given to the different Learning Outcomes and Assessment standards in the phase.

When developing the Learning Programme teachers also need to ***consider***:

- how integration within and across the Learning Areas will happen;
- the resources needed and those to be used when determining the teaching, learning and assessment activities; and
- any special or national events likely to be included in the school calendar.

These considerations are taken to more depth and given much more detail when planning the Work Schedule and Lesson Plans.

A team planning approach will promote coherence, integration and cohesion in the Learning Programme for the phase. Such an approach also provides for a framework for the development and effective use of Learning and Teaching Support Materials.

1.4.2 From the Learning Programme to the Work Schedule

A Work Schedule provides the teachers in a grade with a yearlong programme based on the Learning Programme. It develops on the sequencing, context, and core knowledge and concepts choices made at Learning Programme level. The teachers responsible for the Learning Programme for a particular grade within a phase will produce the Work Schedule for their grade

group by drawing on the Learning Programme for that phase.

In addition to the detail already provided in the Learning Programme, teachers will in developing the Work Schedule, plan:

- The assessment programme for the year. They will need to ensure a spread of different assessment forms across the year in keeping with the assessment guidelines for each Learning Area;
- The use of resources needed; and
- Integration within and across Learning Areas.

1.4.3 From the Work Schedule to the Lesson Plan

The Lesson Plan provides detailed structure for teaching, learning and assessment activities. It could range from a single lesson to a few months of activities. It provides the day-to-day details for teaching, learning and assessment. It also enables, for example, events of major importance internationally, nationally or locally, to be incorporated in the curriculum in a structured, yet flexible way. The World Summit on Sustainable Development held in Johannesburg in 2002, national commemoration and holidays, and other examples are opportunities around which a Lesson Plan could be built. The Lesson Plans are designed to ensure opportunities for learners to achieve the Learning Outcomes and Assessment Standards of that Learning Area.

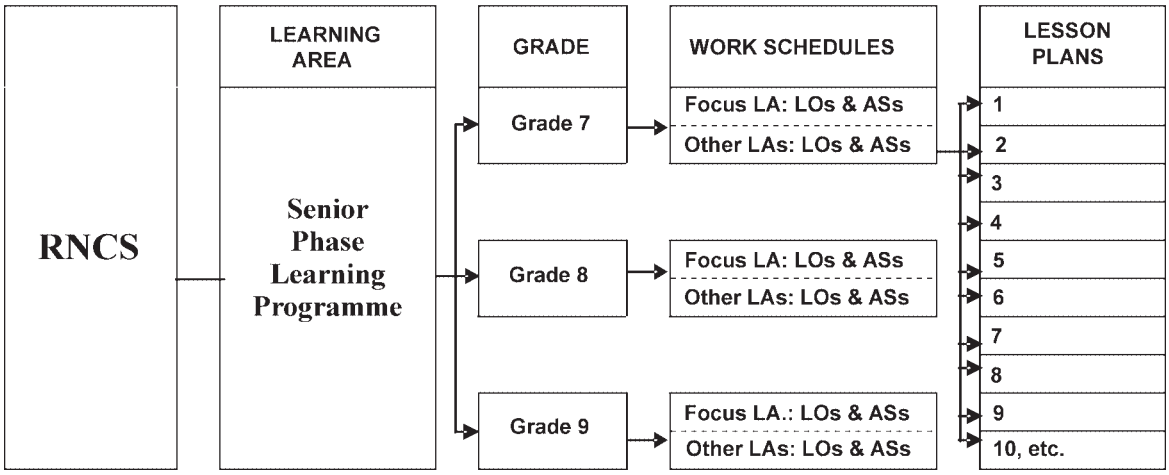
The following elements should be contained in the Lesson Plan:

- Those elements already determined in the Learning Programme and Work Schedule, namely:
  - The Learning Outcomes and Assessment Standards,
  - The context and/or core knowledge and concepts selections for the lesson,
  - The assessment tasks to be used in the lesson,
  - The resources needed for the lessons, and
  - Integration opportunities;
- The actual dates over which the Lesson Plan will stretch;
- Conceptual links to previous and future Lesson Plans;
- Details and sequencing of the teaching, learning and assessment activities that will make up the Lesson Plan;
- Any particular teaching approach and method to be used; and
- Special and important notes regarding the needs of the learners in the class for whom the teacher is preparing the Lesson Plan.

Individual teachers will prepare their own Lesson Plans to support teaching, learning and assessment in their particular classrooms.

The figure below indicates the relationship among the three different stages of planning.

Figure 1: Relationship among the three different stages of planning.



NOTE: *In the above diagram Lesson Plans are only indicated for Grade 7, but would also appear alongside Grades 8 and 9 in the final column when the Learning Programme has been planned in its entirety.*

1.5 ISSUES TO BE CONSIDERED WHEN DEVELOPING LEARNING PROGRAMMES, WORK SCHEDULES AND LESSON PLANS

The aim of a Learning Programme is to design and sequence teaching, learning and assessment activities that will result in meaningful and relevant learning. Teachers need to find ways of making the planning process a manageable one, so that the process of planning is facilitative rather than being a tedious task. For example, there is not much point in rewriting Learning Outcomes and Assessment Standards each time an activity is developed. Numbering the Assessment Standards and then referring to the numbered Assessment Standards may be easier.

To achieve the aim of Learning Programmes, Work Schedules and Lesson Plans, the following aspects have to be considered during planning:

1.5.1 Philosophy and Policy

- The RNCS is an embodiment of the nation's social values, and its expectations of roles, rights and responsibilities of the democratic South African citizen as expressed in the Constitution. Full discussion on this section is not included here as it is required that teachers read the RNCS for the discussion and detail on the philosophy and policy underpinning the RNCS.
- Outcomes-based education (OBE) philosophy and practice with the Critical and Developmental Outcomes is the underlying educational philosophy.
- Other national and local policies also impact on effective delivery.

1.5.2 Principles Underpinning the Curriculum

The RNCS is underpinned by principles that are crucial for working towards the aims of the education system. These are, amongst others:

- Social Justice
- a Healthy Environment
- Human Rights
- Inclusivity

In simple terms **social justice** refers to one's responsibility to care for others to the common good of society. Social justice serves to remind all humanity (government and civil society) that the needs of all individuals and societies should be met within the constraints imposed by the biosphere, and that all should have equal opportunity to improve their living conditions.

A **healthy environment** cannot be attained independent of people, their lifestyles and choices, their rights and social justice. Environment includes the social, political, economic and biophysical dimensions of all life and life-support systems (air, water and soil).

Human rights and their infringement are grounded in the daily experiences of people within their local environments. They are an inextricable part of our lives – so much so that we often take for granted the protection they offer us.

Inclusivity deals with a number of social justice and human rights issues, and at the same time taps into the rich diversity of our learners and communities for effective and meaningful decision-making and functioning for a healthy environment. Schools are encouraged to create cultures and practices that ensure the full participation of all learners irrespective of their cultures, race, language, economic background and ability. All learners come with their own experiences, interests, strengths and barriers to learning which need to be accommodated.

In developing Learning Programmes, educators and other curriculum developers will need to pay attention to these principles and to find ways of developing teaching, learning and assessment activities and providing Learning and Teaching Support Materials that offer learners opportunities to explore these principles.

1.5.3. Time Allocation and Weighting

- The RNCS overview document details the time allocated to each Learning Area in both the Intermediate and Senior phases, and to Learning Programmes in the Foundation Phase.
- These Guidelines also make recommendations with respect to how Learning Outcomes should be weighted with respect to each other.

To be able to develop Learning Programmes, teachers need to be aware of these allocations and weightings, as well as how these translate into hours and periods in the school(s) for which they are developing the Learning Programme.

1.5.4 Integration

Integrated learning is central to outcomes-based education. The historically fragmented nature of knowledge can be overcome if attention is paid to relevant integration both within Learning Areas, and across Learning Areas.

Teachers need to have a clear understanding of the role of integration within their Learning Programmes. The key, however, is the balance to be struck between integration and conceptual progression. That is, integration must support conceptual development rather than being introduced for its own sake. Teachers must therefore be aware of and look for opportunities for integration both within and across Learning Areas.

1.5.5 Resources

Different Learning Areas, and in turn different Learning Programmes, will rely on different resources for their success. Teachers will have to be familiar with the resources needed and the resources available as they develop their programmes. Care should be taken not to develop Learning Programmes where lack of access to resources will discriminate against learners. Teachers must also be sensitive to the limitations of learners who experience barriers to learning and how their progress may be affected by availability of resources.

1.5.6 Inclusivity and Barriers to Learning

The RNCS assumes an inclusive approach to teaching, learning and assessment. Learning Programmes need to address any barriers that learners for whom the programme is being developed may experience. Teachers need to be aware of the social, emotional, physical and other needs of the learners as they develop their Learning Programmes. For ensuring that matters of Inclusivity are addressed, teachers need to consider any particular barriers to learning and/or assessment that exist in different Learning Areas and make provision for these when developing Learning Programmes.

1.5.7 Differences between Learning Areas and Learning Area Statements

While each of the Learning Area Statements has been developed according to the same framework and philosophy, careful examination will show that subtle differences exist between them. These differences are a natural consequence of the peculiarities of each of the Learning Areas. The implication of the differences between Learning Areas and Learning Area Statements for Learning Programme, Work Schedule and Lesson Plan development is that such development in each Learning Area will have to take note of these peculiarities. Furthermore, as teachers in one Learning Area look for integration opportunities with other Learning Areas, they should be aware of the peculiarities of those other Learning Areas.

Some of the most striking differences are the following:

Natural Sciences has a separate chapter (chapter 5) in the Learning Area Statement that lists "Core Knowledge and Concepts" – these provide the context in which at least 70% of teaching, learning and assessment should take place, the other 30% can come from local contexts. The Core Knowledge and Concepts are presented by phase and organised into four main content areas or knowledge strands:

- *Life and Living*
  - Living Processes and Healthy Living
  - Interactions in Environments
  - Biodiversity, Change and Continuity
- *Energy and Change*
  - Energy Transfers and Systems
  - Energy and Development in South Africa

- *Planet Earth and Beyond*
  - Our Place in Space
  - Atmosphere and Weather
  - The Changing Earth
- *Matter and Materials*
  - Properties and Uses of Materials
  - Structures, Reactions and Changes of Materials

Technology does not have a separate chapter listing knowledge focus or contexts, but Learning Outcome 2 (Technological Knowledge and Understanding) identifies three core knowledge areas for the Learning Area and organises the Assessment Standards for the Learning Outcome accordingly:

- *Structures*
- *Processing*
- *Systems and Control*

It should also be noted that **Natural Sciences** and **Technology** have the same Learning Outcome 3 (Technology: Technology, Society and the Environment, and Natural Sciences: Science, Society and the Environment). This is a deliberate design feature of these two Learning Areas intended to facilitate integration between the Learning Areas, both short-term integration as well as the combining of the Learning Areas into one Learning Programme in the Intermediate Phase.

Social Sciences has a separate chapter (chapter 5) in the Learning Area Statement that lists the "Knowledge Focus Framework." This is grade-by-grade specific and provides knowledge/topics for both History and Geography.

While **Arts and Culture** also does not have a separate chapter on knowledge, the Assessment Standards for each Learning Outcome are classified under the following "art forms":

- *Dance*
- *Drama*
- *Music*
- *Visual Arts*
- *Composite*—only for some Learning Outcomes and only in some Grades

The Arts and Culture Learning Area Statement lists, furthermore, on pages 7 and 8 organising principles for each grade in each phase and for each Learning Outcome in each grade, a further organising principle for the Assessment Standards.

Languages do not have a list of knowledge contexts in the same way that some of the Learning Areas already mentioned do. However, lists of *recommended texts* are provided by grade in Chapters 2, 3 and 4 of the Learning Area Statement.

1.5.8 Clustering of Assessment Standards

Teachers, when planning assessment activities, recording learner performance and reporting on learner progress will look to the Assessment Standards for descriptions of the level at which learners should demonstrate their achievement of the various Learning Outcomes. Having selected the Learning Outcomes and when planning teaching, learning and assessment, teachers may find that certain Assessment Standards can be grouped or **clustered** together quite naturally.

In **some Learning Area**s (certainly not all), it would not be practical to teach to each and every Assessment Standard for each Learning Outcome. Firstly, the Assessment Standards in those Learning Areas do not stand alone, and secondly, there are simply too many Assessment Standards per Learning Outcome for the teacher to be able to deal with them individually. In such cases, the teacher on examining the Assessment Standards, may realise that they group quite naturally into **clusters** of Assessment Standards. These clusters can in turn be used for planning.

For example, in Mathematics in the Intermediate Phase, there are some eleven Assessment Standards for Learning Outcome 1 (Numbers, Operations and Relationships). An examination of these Assessment Standards suggests that they can quite naturally be organised into the following Assessment Standards clusters:

- Recognising, classifying and representing numbers
- Applications of numbers to problems
- Calculation types involving numbers
- Properties of numbers

The Mathematics Learning Area statement neither clusters nor suggests clustering. While the Mathematics Guideline does suggest clustering and even recommends possible clusters, it is up to the teacher to decide whether or not to cluster the Assessment Standards.

While the clustering of Assessment Standards is something that teachers may choose to do, the following should be noted when clustering Assessment Standards:

- Clustering of Assessment Standards should not occur across Learning Outcomes. Recording and reporting needs to be against Learning Outcomes and the selected Assessment Standards. Clustering Assessment Standards across Learning Outcomes would make reporting and recording impossible.
- Learning Outcomes are never clustered. While we may develop Lesson Plans with more than one Learning Outcome, we would consider this to be an example of integration and not clustering.
- When clustering Assessment Standards, it is not allowed that *new* Assessment Standards are written as a result of the clustering.
- While clustering of Assessment Standards is possible for planning the teaching, learning and assessment activities, teachers record learner performance against the individual Assessment Standards in that cluster.

Guidelines on how to deal with the Learning Outcomes and Assessment Standards of each Learning Area are provided in the Learning Area specific section of each Learning Area's Guideline.

1.6 DEVELOPMENT PROCESS

While the development process suggested in this document may appear tightly sequenced and ordered, teachers will, in practice, find themselves going back and forth between steps.

1.6.1 Developing a Learning Programme

Once teachers have taken all the philosophy, policy and other issues already described into account, the following steps are suggested as a more detailed guide for this task:

- *Select the Learning Outcomes*
  The Learning Outcomes (and how they are attended to) are what drive the development process. It is important that teachers decide which Learning Outcomes are to be focused on at a particular time and how they are packaged together. The Learning Area specific section that follows will indicate how Learning Outcomes can be packaged or explored.

- *Identify Assessment Standards*
  Teachers need to identify the Assessment Standards (or at least clusters of standards) for each Learning Outcome that will be targeted at a particular time within the Learning Programme. Assessment is planned to ensure that evidence is provided of how learners are performing against the Assessment Standards. When *recording* learner performance, teachers will show how each learner is meeting the Assessment Standard(s) and at what level the Learning Outcomes are being attained. Teachers will then *report* on every learner's performance and progress against the Learning Outcomes.

  More detail on the assessment programme, forms of assessment, and recording and reporting processes for each Learning Area is provided in the Assessment Guidelines for the different Learning Areas.

- *Determine the teaching, learning and assessment context(s) and/or core knowledge and concepts*
  Two main kinds of contexts have been identified for inclusion in Learning Programme development, and where appropriate teachers need to be explicit about these.

  One level is the broad consideration of the social, economic, cultural and environmental contexts of the learners. This can also include the local needs of the learners, of the school and the surrounding community.

  The other level is the Learning Area with contexts unique to the Learning Area and the specifics required by the Learning Area (see 1.5.7 above). Such contexts are reflected in the kinds of examples used, the types of projects given, the language used, the barriers being addressed, and the teaching, learning and assessment activities. Context must make specific provision for learners with disabilities.

When dealing with core knowledge and concepts, teachers must select core knowledge and concepts that address the identified Learning Outcomes and Assessment Standards. In Learning Areas where this information is not provided, teachers need to determine their own.

- *Allocate time*
  Teachers need to allocate appropriate weighting and allocation of time to each Learning Outcome and its associated Assessment Standards – as per the weightings discussed in the Learning Area specific sections of the document. It is also important to check that the time allocated to the Learning Programme is consistent with the time allocations of each Learning Area within the phase.

  After this process, it is recommended that teachers should stand back and examine the Learning Programmes in terms of the various features discussed in this chapter. It is also important to analyse all the Learning Programmes for a phase so that implications of one programme on another in terms of learner work load can be resolved. In this way, it is imagined that the time allocation for each programme will be modified and finalised through continued reflection and refinement.

  Learners who experience barriers to learning must be accommodated through flexibility in terms of time allocated to complete activities. Additional time may be given or alternatively learners may be allowed to complete their tasks at a later stage. There must be recognition of the fact that completing only part of the task also has value. These arrangements are planned as part of the individual support for each learner who has a barrier to learning.

- *Integration and resources*
  Integration and the selection and use of resources have already been discussed in detail in 1.5.4 and 1.5.5 above. Teachers will also need to consider integration and resourcing when planning a Learning Programme. While they may only show the details regarding resources and integration in the Work Schedules, they must apply their minds to these issues at the time of Learning Programme development.

1.6.2 Developing a Work Schedule

A Work Schedule must be developed for each year in the Learning Programme. A Work Schedule gives a greater level of detail for each aspect or element of the Learning Programme and adds further detail with respect to other aspects.

It should be emphasized that the process of developing a Work Schedule should not be seen as a process that occurs in a linear way, but as a holistic and integrated process. The following should be considered when developing a Work Schedule:

- *Details from the Learning Programme*
  In developing the Learning Programme decisions have already been taken about the sequencing of Lesson Plans, the Learning Outcomes and Assessment Standards that will be focused on by each Lesson Plan, the selection of contexts and/or knowledge and the time allocation to the Lesson Plans. If necessary the teacher(s) developing the Work Schedule may want to amplify these details.

- *Assessment tasks*
  The Department of Education has developed Assessment Guidelines for each Learning Area. Among other details, these documents spell out the forms of assessment to be completed by each learner in each grade. At the time of planning the Work Schedule, the teacher(s) should decide when to use each of the assessment forms to ensure both their most appropriate application and to spread the assessment demands on the learners evenly across the year.

- *Resources required*
  In developing the Work Schedules, teachers will need to consider in detail the resources that will be required for each Lesson Plan and may need to re-sequence units according to the availability of the resources.

- *Integration*
  In developing the Work Schedule, teachers will have to consider in greater detail, matters of integration. In the case of integration across Learning Areas, this may include meeting with the teachers from the other Learning Area(s) to ensure that the anticipated integration is workable in terms of their respective Work Schedules.

1.6.3 Developing a Lesson Plan

Lesson Plans are developed from the yearlong Work Schedule by individual teachers. A Lesson Plan is assumed to be a complete and coherent series of teaching, learning and assessment activities. It can consist of a single activity or several activities spread over a few days or a number of weeks.

In as much as Learning Programme and Work Schedule design is influenced by philosophy, policy and several other factors already discussed in 1.5, Lesson Plan development is further informed by the classroom realities of the teacher's class.

Realities of the classroom that have an impact on planning a Lesson Plan include:

- *Learning styles*
  Since different learners have particular and preferred learning styles, every class is certain to contain groups of learners who assimilate information and develop understanding in different ways. Before a teacher is able to develop a Lesson Plan s/he must have a clear sense of the different learning styles of the learners in the class. S/he must also have a sense of those activities that are likely to succeed with particular individuals or groups and those that are unlikely to, and must plan to accommodate all learners in the class.

- *Teaching approach and methodology*
  Teachers must decide how they will approach their teaching and what methods they will use. The nature of the Learning Area often determines what approach and which methods will best support the teaching, learning and assessment activities in the particular Learning Area.

- *Barriers to learning*
  While it is possible to list many different types of barriers to learning in general, not all of these will apply in every class. Similarly there may be barriers to learning that are particular

to individual learners only. When developing a Lesson Plan the teachers must have a clear sense of barriers to learning that exist in the class so that they can overcome these through the way in which they structure activities and also through the activities that they select.

- *Resources available to the school and class*
  Different schools have access to different types of resources, and so while a particular Lesson Plan may work well in one school, it may fail in another because of a difference in the available resources — both types and quantity — available to teachers and their classes.

- *What learners already know*
  It is important to be aware of the prior learning that is both required for different Lesson Plans and the levels of this prior learning present in the class for whom the teacher is developing a Lesson Plan. Learners could demonstrate different levels of knowledge and concept development from the same learning experience. What learners already know becomes an important point of departure for planning what will happen next in an activity.

  At times teachers may wish to perform some form of baseline assessment to be able to establish the level of prior learning and accordingly plan appropriate support for the learners.

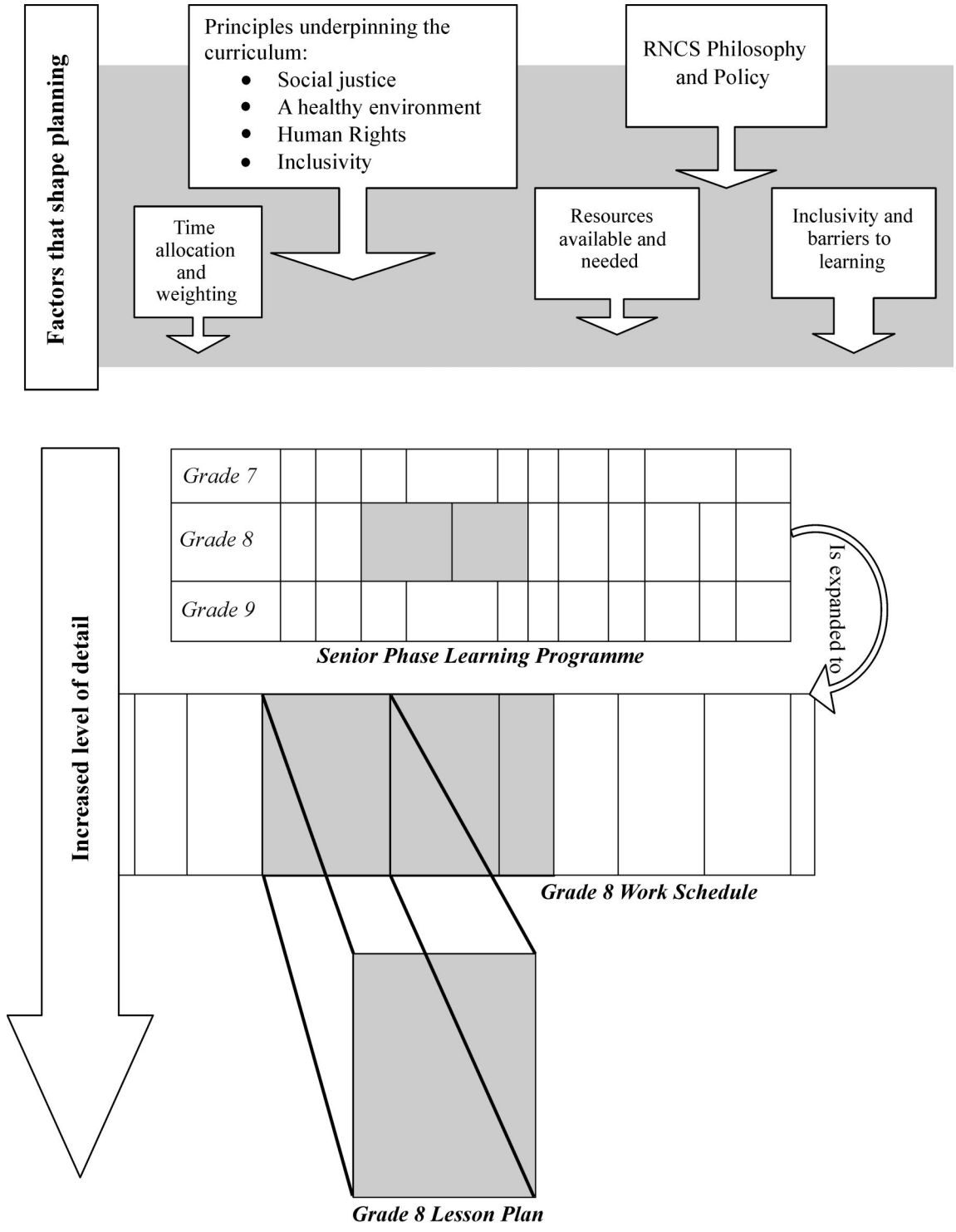
- *School policies*
  In the same way that national education policy will impact on Learning Programme design, so too will the policies of the school impact on both the design of the Lesson Plan and its execution.

  When the above issues have been considered, the teacher is finally ready to develop the Lesson Plan in detail. Within the planning, the teacher has to:
  - Develop and/or source teaching, learning and assessment activities;
  - Identify the role of outcomes and concepts from other Learning Areas;
  - Decide on assessment strategies and select or develop instruments to be used; and
  - Plan how to support learners who experience barriers to learning.

  After a Lesson Plan has been developed, the execution remains. In the execution of a Lesson Plan the teacher will become aware of issues that may not have been anticipated. These will need to be incorporated and should, in turn, be considered when planning the next Lesson Plan(s). Like Learning Programme and Work Schedule development, Lesson Plan development is not a linear process, but rather one of continual modification, reflection, revision and refinement.

The figure below indicates the factors that inform the development of Learning Programmes, Work Schedules and Lesson Plans. It also shows how the levels of planning in a Learning Programme proceed from the RNCS to the Learning Programme to the Work Schedule to the Lesson Plan.

Figure 2: The planning process and factors taken into account when developing Learning Programmes.



1.7 ASSESSMENT

1.7.1 Nature of Assessment

The assessment requirements of the curriculum policy have presented strong challenges to most educators. This section is therefore provided to support the implementation of sound assessment practices.

The assessment practices that are encouraged through the RNCS for Grades R-9 (Schools) are continuous, planned and integrated processes of gathering information about the performance of learners measured against the Learning Outcomes. The level at which the learner is to be assessed is provided by the Assessment Standards which are progressive from grade to grade. A Learning Programme, Work Schedule and Lesson Plan design should ensure that assessment is an integral part of teaching, learning and assessment.

Planning assessment to include the assessment of learners who experience barriers to learning is important. It is likely that in every classroom there would be some learners who experience barriers to learning. However, these barriers will not always be the same and could be situated in the learning context, i.e. inflexible methodology, lack of resources or in the learners themselves, i.e. sensory, physical, intellectual disabilities or disease/illness. They can also arise from the social context, i.e. poverty, violence or difficult home conditions. When planning an assessment activity, the teacher should have a clear sense of the wide range of barriers that may inhibit learning and the achievement of the Learning Outcomes and how to address them. The key is to determine what exactly is being assessed, (i.e. concepts, application, skill) and to develop assessment tasks in such a way that learners have a variety of options to demonstrate their learning with respect to the Learning Outcomes and Assessment Standards as outlined in the RNCS. (For more details on alternative methods of assessment, please refer to *Curriculum 2005: Assessment Guidelines for Inclusion, May 2002.)*

Assessment should:

- enhance individual growth and development, monitor the progress of learners and facilitate learning;
- find out what a learner knows, understands and/or can do;
- make judgements based on valid and appropriate evidence – these judgements should then enable us to make well informed decisions about what a learner needs to learn next;
- give an indication of the success of the programme of learning including how appropriate resources have been;
- include a variety of techniques;
- encourage learners to go beyond simple recall of data or facts;
- close the gap between the classroom and the real world;
- include opportunities for learners to perform tasks and solve problems; and
- make provision for adaptive methods of assessment.

1.7.2 Planning for Assessment

Assessment cannot be neutral with respect to what is taught and learned. Any assessment is an expression of values on teaching, learning and assessment. We need to view assessment as a critical and integrated part of the teaching-learning process. As planning for teaching, learning and assessment activities begins with a Learning Programme, planning for assessment should also be integrated in these plans.

When planning for assessment the following documents should provide the framework for planning:

- The Assessment Policy for the General Education and Training Band, Grades R-9 and ABET (December 1998);
- The RNCS (The Overview and the Learning Area Statements);
- Assessment Guidelines for each Learning Area; and
- Assessment Guidelines for Inclusion.

The planning for assessment in the Learning Programme should give schools an indication of resources and time needed for assessment in that phase. To do this teachers need to know what knowledge, skills, attitudes and values the learners are expected to possess so that they are able to integrate the assessment programme within teaching and learning activities.

In a ***Learning Programme*** teachers need to:

- Mention all the **possible forms of assessment** they are likely to use in determining the achievement of the Learning Outcomes. In doing this also take the Assessment Standards into consideration;
- Mention the **resources** they are likely to need (including assistive devices);
- Take the **context and core knowledge and concepts** into consideration; and
- Indicate the **time** that will be needed.

In the ***Work Schedule*** planning for assessment focuses on a grade. When planning a Work Schedule considerations should be given to the following:

- Learning Outcomes give guidance by indicating **what** should be assessed;
- Assessment Standards indicate the **level** at which the Learning Outcome should be assessed;
- Indicate the **assessment strategies** or different forms of assessment teachers plan to use;
- Indicate the **resources** teachers will use; and
- Take into consideration the **diverse needs** of the learners.

In a ***Lesson Plan*** teachers should:

- Indicate **how** the Learning Outcomes would be assessed;
- Consider the **level** at which the Learning Outcomes would be assessed using the Assessment Standards;
- Also consider the **context,** the availability of **resources** and the **diverse needs** of learners; and
- Give a detailed description of how they plan to use the various **assessment strategy(ies)** and/or different form(s) of assessment, how these will be integrated within teaching and learning, and what will be recorded.

For each level of planning in the Learning Programme, the Work Schedule and the Lesson Plan, teachers need to describe the following clearly:

- **When** they are going to assess;
- **How** they are going to assess;
- What **resources** they are going to use; and
- How they are going to support the **diverse needs** of learners.

1.7.3 Assessment Strategies

A wide range of assessment strategies may be used to measure learner performance. Teachers can select these depending on the purpose of assessment. These will also depend on a specific Learning Area. The forms/types chosen must provide a range of opportunities for learners to demonstrate attainment of knowledge, skills, values and attitudes. The following are some of the various forms/types of assessment that could be used by the teachers to assess learner achievement:

a) Tests
b) Performance-based assessment
c) Interviews
d) Questionnaires
e) Structured questions
f) Assignments
g) Case studies
h) Practical exercises/demonstrations
i) Projects
j) Role-plays
k) Simulations
l) Aural/Oral Questions
m) Observations
n) Self-report assessment

These assessment strategies and the different forms of assessment for each of the Learning Areas are discussed at length in the Assessment Guidelines for each Learning Area.


TIRISANO
WORKING TOGETHER

SECTION 2
THE NATURAL SCIENCES LEARNING PROGRAMME

2.1 SYNOPSIS

What is today known as "Science" has roots in African, Arabic, Asian, American and European cultures. It has been shaped by the search to understand the natural world through observation, codifying and testing ideas, and has evolved to become part of the cultural heritage of all nations. It is usually "characterized by the possibility of making precise statements which are susceptible of some sort of check or proof" (McGraw-Hill Concise Encyclopaedia of Science and Technology, 2nd Edition, p.1647).

To be accepted as science, certain methods of inquiry are generally used. In addition to promoting reproducibility and attempts at objectivity, these methods also promote a systematic approach to scientific inquiry. These methods include formulating hypotheses, designing and carrying out experiments to test the hypotheses. Repeated investigations are undertaken, and methods and results obtained are carefully examined and debated before they are accepted as 'valid'. Knowledge production in science is an ongoing process that usually happens gradually, but occasionally knowledge leaps forward as a new theory replaces the dominant view. As with all other knowledge, scientific knowledge changes over time as people acquire new information and change their ways of viewing the world.

2.1.1 Description of the Learning Area in the South African Context

In recognition of the power of the Natural Sciences in interpreting the world in which we live and in economic development, the Learning Area Statement has been written in such a way that it ensures the promotion of scientific literacy amongst all learners and provides access to science education for all. In this way, the imbalances of the past are redressed.

The main features of the Learning Area Statement are the Learning Outcomes, the Assessment Standards that embody the knowledge, skills, values and attitudes required to achieve the Learning Outcomes and the "statements" of Core Knowledge and Concepts.

2.1.2 The Natural Sciences Learning Area Contexts

The three Learning Outcomes for the Natural Sciences Learning Area are as follows :

- 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
- Learning Outcome 2 (Constructing Science Knowledge): The learner will know and be able to interpret and apply scientific, technological and environmental knowledge
- Learning Outcome 3 (Science, Society and the Environment): The learner will be able to demonstrate an understanding of the interrelationships between science and technology, society and the environment.

2.2 RELATIONSHIP BETWEEN THE LEARNING OUTCOMES

2.2.1 Weighting of the Learning Outcomes

The Natural Sciences Learning Area Statement describes the Learning Outcomes separately, so as to enable them to be assessed separately. In many activities, especially in extended tasks, all three Learning Outcomes can be intertwined, but there are also opportunities when the outcomes are dealt with individually.

All three Learning Outcomes are equally important. This does not mean that in each and every activity all three Learning Outcomes must be given equal emphasis: some activities might focus on Learning Outcome 1, another on Learning Outcome 2 or 3 etc. Over the entire phase (3 years) adequate opportunities must be provided for learners to attain equal success in all three Learning Outcomes. This does not necessarily mean that the **same number** of opportunities or the same time should be provided for the development of all three Learning Outcomes. It might mean that, based on feedback from learners indicating how quickly or how slowly a particular Learning Outcome is being attained, that more or less opportunities may have to be provided for a particular Learning Outcome.

2.2.2 Process Skills across the Three Learning Outcomes

"Process skills", which refer to the learner's cognitive activity of creating meaning and structure in new information and experiences, are applicable to all three Learning Outcomes, and do not refer only to investigative activities as in Learning Outcome 1.

From the teaching point of view, process skills can be seen as building blocks from which suitable science tasks are constructed. A framework of process skills enables teachers to design questions that promote the kinds of thinking required by the Learning Outcomes. It would also be valuable to teachers in assessment, when designing rubrics, rating-scales, marking memos and instruments to record day-to-day participation of learners.

One possible list of process skills that are essential in outcomes-based tasks:

- Observing and comparing
- Measuring
- Recording information
- Sorting and classifying
- Interpreting information
- Predicting
- Hypothesizing
- Raising questions about a situation
- Planning science investigations
- Conducting investigations
- Communicating science information

These process skills are discussed in more detail on pages 13 and 14 of the Learning Area Statement.

2.3 ASSESSMENT STANDARDS

The **Learning Outcomes** are statements of what the learners should know, demonstrate and be able to do. The Natural Sciences Learning Outcomes speak of learners' competence in choosing relevant knowledge and skills and making choices about how to produce something which is appropriate to the situation or task they have. We see the Learning Outcome in the learners' ability to "put it all together." In this sense, the Learning Outcomes are not simple, but compound performances because they integrate several responses by the learner. We can use an analogy of simple and compound leaves: a **simple** leaf has just one blade, while a **compound** leaf has a number of leaflets arranged on the same axis. So a Learning Outcome is not seen in correct answers to single, separate questions or in completion of single, separate activities. This is the reason why, in outcomes-based education, teachers often include projects or extended investigations for learners – in tasks of this sort, learners can show competence as they make choices about what they will put together, what they will produce and how they will present it.

To assess what the learners produce and do, we need to look at various aspects of the competence and that is where the Assessment Standards come in. The Assessment Standards enable us to see particular aspects of the compound competence that the Learning Outcome is describing. The Assessment Standards describe the level at which learners should demonstrate their achievement of the Learning Outcomes and the ways of demonstrating their achievement.

In other words the Assessment Standards are statements that give detail to the Learning Outcomes and they describe criteria by which to judge how well learners are able to achieve the Natural Sciences Learning Outcomes.

The table below shows the Assessment Standards and the Learning Outcomes from which they originate.

Learning Outcome 1 (Scientific Investigations)	**Learning Outcome 2 (Constructing Science Knowledge)**	**Learning Outcome 3 (Science Society and the Environment)**	
		Intermediate Phase	**Senior Phase**
Planning investigations	Recalling meaningful information when needed	Understanding science and technology in the context of history and indigenous knowledge	Understanding science as a human endeavour in cultural contexts
Conducting investigations and collecting data	Categorising information to reduce complexity and look for patterns	Understanding the impact of science and technology on the environment and on people's lives	Understanding sustainable use of the Earth's resources
Evaluating data and communicating findings	Interpreting information	Recognising bias in science and technology which impacts on people's lives	
	Applying knowledge to problems that are not taught explicitly		

The Assessment Standards for Learning Outcome 3 are written differently for the Intermediate and Senior Phases. This was done so as to align the Intermediate Phase Assessment Standards with those of the Technology Learning Area, in anticipation of the possibility that, in some schools, Natural Sciences and Technology may be combined into one Learning Programme in the Intermediate Phase.

2.3.1 Interpreting the Assessment Standards

The Natural Sciences Learning Outcomes call for compound, integrated products from learners. As with the Critical Outcomes, learners can grow in competence in an outcome, without reaching an end-point.

To understand this, teaching could be taken as an example: the competence of teaching calls for a complex product or performance in which you integrate many skills and much knowledge, and what you do will depend on the kind of problems you encounter. Teaching is a competence in which you may get better and better over the years yet never say, "Now I have arrived!" Therefore you might not accept being assessed on the basis of "Can teach/can't teach". But you could accept an assessment of whether you have got better at teaching in the past year, and you know that you may get still better as the years pass. It is an illustration of how competence can grow, without reaching an end-point.

In a similar way, let us take Learning Outcome 1 ("The learners will be able to act confidently on curiosity … and to investigate relationships and solve problems …"). Young children may show curiosity and investigate a natural phenomenon, like seeds germinating. They would do this at quite a simple level. In Grade 12 these learners may investigate the same phenomenon at more advanced levels, with carefully controlled experiments. Some of these learners might leave school and become research scientists, investigating the same phenomenon at university level in collaboration with scientists in other countries, and setting up plant growth experiments that are carried out in the international space station.

We can see that Learning Outcome 1 is never finally "achieved", but a learner can grow better and better at doing it. The same thing is true of the other outcomes, because they are compound performances, not single acts. So we must assess the learners in terms of levels of being good at doing the Outcomes. (However, at a finer level of detail, such as the skill of measuring with a ruler, we can assess in terms of "Can do/Can't yet do" and we can say that a particular skill has been achieved. We will look at this issue later).

Please refer to Appendix 1, at the back of this document. The Assessment Standards are written in a set of levels, called Grade Level 4, Grade Level 5, and Grade Level 6 and so on. As a learner shows work of higher and higher quality in a particular Learning Outcome, we will record progress in terms of these Levels.

The **horizontal grey bars** in the progression tables indicate the Assessment Standards as aspects of the outcome on which learners must progress. For example, for Learning Outcome 1, the Assessment Standards are "Planning investigations", "Conducting investigations and collecting data" and "Evaluating data and communicating findings."

Under each grey bar there are descriptors of how that Assessment Standard might be demonstrated, at increasing levels of sophistication.

The descriptors, going from left to right across Grade Levels, are very condensed statements and by themselves they can give a reader only a limited sense of level. Therefore, in the Learning Areas Statement (p.32-59), the Assessment Standards and are supported by illustrative examples of what learners might be doing if they are at this or that level. These illustrative examples strengthen the description of the level, and allow a teacher to distinguish more clearly between one level and another. The illustrative examples are headed by the phrase "Achievement is evident when the learner, for example..."

2.4 CORE KNOWLEDGE AND CONCEPTS FOR THE NATURAL SCIENCES

The Natural Sciences Learning Area comprises a wide variety of fields of inquiry. Because of this diversity, it is not possible to list all science knowledge under one heading. Therefore, the fields which scientists study have been grouped into four strands or Core knowledge and Concepts areas viz. *Life and Living, Energy and Change, Planet Earth and Beyond and Matter and Materials*. Each of these strands have been refined into sub-strands, each of which is summarised by a general proposition or unifying statement. The table below reflects the four main strands, their sub-strands, as well as the unifying statements:

Strand	Sub-strand	Unifying Statement
Life and Living	*Life Processes and Healthy Living*	Living things, including humans and invisibly small organisms, can be understood in terms of life processes, functional units and systems.
	Interactions in Environments	Organisms in ecosystems are dependent for their survival on the presence of abiotic factors and their relationship with other organisms.
	Biodiversity, Change and Continuity	The huge diversity of forms of life can be understood in terms of a history of change in environments and in characteristics of plants and animals throughout the world over millions of years
Energy and Change	*Energy Transfers and Systems*	Energy is transferred through biological or physical systems, from energy sources. With each transfer, some of the energy becomes less available for use, and therefore we need to know how to control energy transfers
	Energy and Development in South Africa	Energy is available from a limited number of sources, and the sustainable development of countries in our region depends on the wise use of energy resources.
Planet Earth and Beyond	*Our Place in Space*	Our planet is a small part of a vast solar system in an immense galaxy.
	Atmosphere and Weather	The atmosphere is a system which interacts with the land, lakes and oceans and which transfers energy and water from place to place
	The Changing Earth	The Earth is composed of materials which are continually being changed by forces on and under the surface.
Matter and Materials	*Properties and Uses of Materials*	We can classify materials by their properties, in order to establish types and patterns. Properties determine the selection of materials for particular uses.
	Structure, Reactions and Changes of Materials	We can modify materials in ways we choose, through our understanding of their sub-structure

The Learning Outcomes describe what learners must be able to do with a certain range of scientific knowledge. The Assessment Standards define the levels at which learners should demonstrate their achievement of a Learning Outcome. The core knowledge and concepts are neither Learning Outcomes nor Assessment Standards. They serve as the vehicle for delivery of the outcomes.

Furthermore, the core knowledge and concepts for the Intermediate and Senior Phase represent about 70% of the time in a Phase's Learning Programme. The other 30% of the time should be used **to extend** these minimum knowledge statements; alternatively, science Core knowledge and Concepts from contexts that are significant to the learners and the local community may be used. These contexts, for example, may be economic, environmental, social or health matters.

2.5 ASSESSMENT IN NATURAL SCIENCES

The assessment process is an effective way of communicating the expectations of the Natural Sciences Learning Area and measuring what learners do and know in the Sciences.

Assessment provides learners with feedback on how well they are meeting the expectations as described in the Learning Outcomes and Assessment Standards. Feedback leads to changes in the teaching and learning of the Natural Sciences and encourages learners to improve their understanding of Sciences. How Natural Sciences knowledge, skills, values and attitudes are assessed is then important. Certain forms of assessment best fit the nature of this Learning Area. Teachers should refer to the Assessment Guidelines for the forms of assessment that have been recommended.

Teachers are encouraged to provide learners with opportunities for authentic assessment. Authentic assessment tasks require learners to apply scientific knowledge and reasoning to situations similar to those they will encounter in the world outside the classroom, as well as to situations that represent near enough how scientists do their work. Assessment tasks must be developmentally appropriate, must be set in contexts that are familiar to the learners, must not require reading skills or vocabulary that are inappropriate to the learners' grade level, and must be as free from bias as possible. For this reason the development of assessment tasks are to be guided by the Assessment Standards and the Core Knowledge and Concepts framework. Teachers must ensure that assessment tasks are developed for all the strands and should use the indigenous knowledge learners have already been exposed to.

The myth that the Natural Sciences is only for certain learners must be dispelled. How well learners perform will encourage them to continue learning in Natural Sciences. Assessment tasks must be appropriately modified to accommodate the needs of all learners, to include those who experience barriers to learning, or who have limited resources.

2.6 TEACHING AND LEARNING IN NATURAL SCIENCES

The Learning Area Statement for the Natural Sciences is much more than a catalogue of facts to be taught, learned and assessed. It is a Curriculum Statement organised around a society in transition while at the same time taking into account that South African learners should be given every opportunity to become leaders in a global playing field. Thus the Learning Area Statement focuses on scientific literacy and access to science education for all.

2.6.1 Promotion of Scientific Literacy

The Natural Sciences Learning Area deals with the promotion of scientific literacy by:

- the development and use of science process skills in a variety of settings
- the development and application of scientific knowledge and understanding
- appreciation of the relationships and responsibilities between science, society and the environment.

2.6.2 The Development and Use of Science Process Skills

The teaching and learning of science involves the development of a range of process skills that may be used in everyday life, in the community and in the workplace. Learners can gain these skills in an environment that supports creativity, responsibility and growing confidence. Learners develop the ability to think objectively and use a variety of forms of reasoning, while they use process skills to investigate, reflect, analyse, synthesise and communicate.

2.6.3 Development of and Application of Scientific Knowledge and Understanding

Scientific knowledge and understanding is a cultural heritage that can be used to:

- answer questions about the nature of the physical world
- prepare learners for economic activity and self expression
- lay the basis for further studies in science
- prepare learners for active participation in a democratic society that values human rights and promotes environmental responsibility

2.6.4 Science and Society

Science and technology have made a major impact, both positive and negative, on our world. Careful selection of scientific Core knowledge and Concepts, and use of a variety of ways of teaching and learning science should promote understanding of:

- science as a human activity
- the history of science
- the relationship between science and other Learning Areas
- the contribution of science to social justice and societal development
- responsibility to ourselves, society and the environment
- the consequences of decisions that involve ethical issues.

2.6.5 Access to Science Education for All

The Natural Sciences Learning Area envisages a teaching/learning environment that recognises that the people of South Africa operate with a variety of learning styles as well as with culturally influenced perspectives. It starts from the premise that all learners should have access to a meaningful science education, and that arbitrary selection and rejection processes based on various kinds of biases should be avoided. Meaningful education has to be learning-centred and help learners to understand not only the scientific knowledge and how it is produced but also the environmental and global issues that are intertwined within the Learning Area. The Natural

Sciences Learning Area must be able to provide a foundation on which learners can build throughout life.

Any Learning Programme for the Natural Sciences or for Science and Technology designed on the basis of this guideline should …

- organise the Learning Outcomes, their associated Assessment Standards and the Core Knowledge and Concepts from the Learning Area Statement into coherent units within the Work Schedules which hang together to form a three-year long Learning Programme
- focus on the development of all Learning Outcomes
- focus on the development of the Natural Sciences process skills
- place investigations at the centre of all classroom activities
- place a high priority on the development of scientific literacy in all sectors of the population
- promote the development of the Core Knowledge and Concepts in Science and the development of skills that can enable the learner to take this knowledge further
- take due cognisance of the impact of Science and Technology on people's lives and on the environment
- use examples and activities in the teaching and learning of the Natural Sciences to promote human rights and issues of social justice
- include indigenous knowledge systems as a means of understanding science as a human endeavour within cultural contexts
- provide opportunities for the participation of all learners, including those who may have been previously denied on the basis of race, gender, poverty, physical and/or psychological disability, and those living with such challenges as HIV/AIDS

In order to ensure attainment, or at the very least, attempt attainment of the main goals mentioned above, there needs to be a shift in the approaches to science teaching, learning and assessment. This shift should be characterised by:

- investigations being placed at the centre of all classroom activities
- providing adequate opportunities to build, interpret and apply scientific, technological and environmental knowledge
- providing opportunities for debate and discussion of, amongst others, ethical alternatives to current ways of solving problems of a scientific, technological and/or environmental nature

i. Investigations at the centre of classroom activities

Learners should be given every opportunity to carry out investigations. It should be noted that investigations are not limited to experimental work carried out in laboratories (or within classrooms for that matter) to resolve practical problems. Investigations include opportunities to: identify problem; seek information from books and resource people; generate products, questionnaires, collections of data and collections of materials from nature or industry; create testable questions, fair tests and reports explaining their conclusions.

With regard to practical problems, learners need to be given opportunities to put their minds to different kinds of problems such as the following:

- problems of making
- problems of observing, surveying and measuring

- problems of comparing
- problems of determining the effect of certain factors

Examples of **problems of making** include: "How can we make a very sensitive thermometer?", "How can we make our own magnetic compass?", "How can we make a system that will give water to plants automatically?", or "How can we make a solar-energy oven ?"

Problems of observing, surveying and measuring include: "How can we find out what nocturnal animals do at night?" , "How can we find out what kinds of fuel people in this area use?", "What do successful gardeners do to get a good crop?", "How can we measure the volume of a drop of water?", " How much water does a plant lose in a day" and "How can we show the change in position of Venus each morning?".

Problems of comparing include: "Which liquid soap is the best?", "Which cloth will keep you warmest on a cold day?", "Which glue is the strongest?" and "Which batteries are the most economical?"

Examples of **problems of determining the effect of certain factors** are "What is the effect of increased dropping height, on how a ball bounces?", "What is the effect of making the water hotter, when you dissolve sugar?" , "Which conditions make seeds germinate faster?" and "Do seedlings grow downwards because the water is down below?"

The four kinds of problems listed above overlap, of course. For example, to determine the effect of changing one factor, the learners need to set up a fair way of comparing the effects as that factor is varied.

ii. *Opportunities to build, interpret and apply scientific, technological and environmental knowledge*

Learners need opportunities to collect or extract information from various sources and then organize and analyse this information. While doing so they are building their frameworks of knowledge by using science concepts repeatedly, in a widening range of situations. They see the usefulness of concepts that explain a range of phenomena and link a range of ideas.

Building this competence involves process skills such as interpreting information by interrogating pictures and diagrams, transforming information from one form to another (such as from prose to a graph or vice versa), looking for patterns in data, or expressing a relationship between two variables.

At the simplest, but nevertheless essential level, learners need to **recall meaningful information** when needed. This does not imply that learners must memorise material that has no meaning for them; rather it recognizes that the ability to retrieve connected ideas is still a valuable intellectual skill.

At the next level is **categorisation** that is used extensively in science because it is an effective tool for reducing the great complexity which scientists find in nature. Categorisation is a general term for the more well-known terms sorting, grouping and classifying.

A more advanced ability is comprehension, shown in the **interpretation of information**. Here, the learner must be able to change the information from one form to another (e.g. from words to numbers or graphs), explain it in his/her own words, find appropriate examples of it, make inferences and predictions from it and relate it to other information.

At the next level is the **application of knowledge**, which refers to the ability to select and use knowledge in somewhat new and unfamiliar situations. This often means selecting and using concepts, rules, methods, formulae and theories correctly to produce an answer or product.

These are minimum expectations, of course. Teachers can call for higher levels of understanding, such as analysis, synthesis and evaluation, at any grade.

iii. Opportunities for debate and discussion

The learning and teaching of science must provide opportunities for debate and discussion. Examples of such opportunities include:

- the ways in which scientific knowledge changes gradually over time; atomic theory, evolution and our understanding of biochemical pathways are good illustrations.
- the doubt component normally associated with new breakthroughs in science; this is often represented by words such as "perhaps", "maybe", "possibly", "in certain circumstances", "it would appear that" in scientific reports; the success and/or failure of various treatments for HIV/AIDS provides a useful context for such debates and discussions
- attempts to retrieve and understand knowledge that has become fragmented and/or lost over the ages; indigenous knowledge and traditional technologies may provide useful contexts.
- the values of different groups of people and how they choose to deal with their problems i.e problems associated with the environment and sustainable development
- the different world-views within which people operate and how people cross-over from the culture of home to the culture of science and back again
- the biases and prejudices surrounding the accessibility and usage of resources in the South African context.

2.7 OVERCOMING BARRIERS TO TEACHING, LEARNING AND ASSESSMENT

In addition to the many general barriers that hinder the development of all learners to their full potential, the following factors have been identified as examples of issues that may become barriers to effective teaching, learning and assessment in the Natural Sciences:

- language
- inadequate prior knowledge
- teachers' not realising that learners may hold different world-views
- lack of school laboratories and equipment
- public perceptions of the Natural Sciences and social stereotypes
- inflexible curriculum

2.7.1 Language

For many learners, the Language of Learning and Teaching (LOLT) is not their home language. This places them at a considerable disadvantage. The problem is intensified for those learners who are deaf or whose hearing has been impaired.

In the Natural Sciences, the problem is often compounded by the special terminology used and by the very specific language style demanded of report writing in the Learning Area.

The following strategies are recommended to make the Learning Area accessible to a greater number of learners:

- The Learning Area Statement should be "versioned" for use among the hearing impaired and the deaf. Alongside this "versioning", augmentative and alternative communication (AAC) strategies, such as alternative communication systems, supplements to vocal communication and communication through facilitators, should be developed.
- Acceptance by teachers, especially by those in the Foundation and Intermediate Phases, of responses by learners in their most fluent language. This has obvious implications for the teacher's language ability.
- Acceptance of a less rigid style of reporting of scientific investigations. For example, "I put a teaspoon of sugar in a glass of water and stirred it" should be equally acceptable to the more conventional "A spatula of sugar was placed in a beaker of water and stirred".
- Frequent use and acceptance of mind maps, flow charts, spider-grams, annotated drawings and the like instead of descriptions in words.
- An understanding by teachers that the loose use of English words might not reflect lack of conceptual understanding; instead it might indicate that the English word does not have an exact translation in the home language of the learner. For example, in the Life Sciences to say that a blood vessel is wider than another one is very different from saying that it is bigger; yet "bigger" and "wider" translate to the exact same word in isiZulu. So when an isiZulu speaking learner reads/hears the word "wider", translates it into the mother tongue (as "bigger") and re-translates it to English in response to a question, it comes out as "bigger", which might suggest a lack of conceptual understanding.
- While the use of scientific terminology in the teaching and learning of the Natural Sciences cannot be avoided altogether, efforts must be made to show the derivation of the terms so that learners can work out the meaning of similar terms for themselves later on. For example, if "arthropoda" can be shown to come from the two words arthros (= jointed) and poda (= feet) it should become much easier to understand the term "Decapoda" and "millipede". Furthermore, words which may have a slightly different meaning in science and in everyday life need to be clearly explained in order to avoid misconceptions i.e "battery", "community".

2.7.2 Inadequate Prior Knowledge

The fragmented and unequal educational practices of the past has led to a situation where a large percentage of learners find themselves in a situation where their knowledge, skills, attitudes and values are not yet at the grade level indicated by the different Assessment Standards. Thus, in any one grade-level, it is possible that some learners may be functioning at one or more levels

below the expected grade level, while others may be functioning at levels beyond the expected grade level.

It is important, therefore, for the teacher to take into account such differences when planning activities within the Learning Programme, or else one group of learners will struggle with the work, while another may become bored. Core knowledge and Concepts selection must take into account the prior knowledge, experience and skills of all the learners within the class. Frequent and regular adjustments need to be made to the activities, based on feedback back of the extent to which learners are coping with the original tasks planned.

The Assessment Standards are written in a continuum which assists in this type of situation. Teachers can report any progress a learner makes from level to level, even if that learner is not performing at the minimum standard for the grade. The teacher can meaningfully say, for example, that a learner. Grade 6 "works mostly at Grade 4 on Learning Outcome 1" and the teacher can then give the learner a description of what she must do to get up to Grade 5 and then to Grade 6 level. This continuum also allows teachers to recognise and report on learners' work which may be beyond the Grade level.

2.7.3 Not Realising that Learners may hold Different World-views

Most learners within South African classrooms think in terms of more than one world-view. The existence of these different world-views may not in itself be a barrier towards effective teaching and learning in the Natural Sciences. In fact, it is a powerful motivation for the inclusion of Indigenous Knowledge Systems (IKS). However, ignoring these different world-views and the challenges they bring with them, would probably make science teaching and learning more difficult than it should be.

2.7.4 Lack of School Laboratories and Equipment

The absence of proper school science laboratories, laboratory apparatus equipment is oft-cited reasons for the poor performance of learners in the Natural Sciences. Water, electricity and a gas supply are the very basic services required in every school laboratory. While Provincial Education Departments attempt to speed up the provision of these essential services, as well as other simple equipment and apparatus, the myth that the teaching of the Natural Sciences cannot be taught in schools without fully-fledged laboratories with expensive and sophisticated equipment needs to be done away with. Every investigation does not necessarily demand experimental investigation in a laboratory. For example an audit of water-use in sections of the community (Grade 9) taken from the Revised Learning Area Statement may be undertaken without sophisticated laboratory equipment whatsoever. Besides, many investigations can, and should be, carried out with the use of improvised equipment.

2.7.5 Public Perceptions of the Natural Sciences and Social Stereotypes

The public perception of the Natural Sciences is that it is difficult and reserved for the select few who may have been gifted with superior intellects. This ignorance, coupled with prejudice and social stereotyping creates a negative attitude towards the Learning Area. The fact that only a

small percentage of practicing scientists are black or female reinforces the stereotype that blacks and females are not meant to do the Natural Sciences. Expectations of these learners in the Natural Sciences (and their concomitant performances) drop more especially since jobs in this Learning Area are stereotypically undertaken by males and by other race groups.

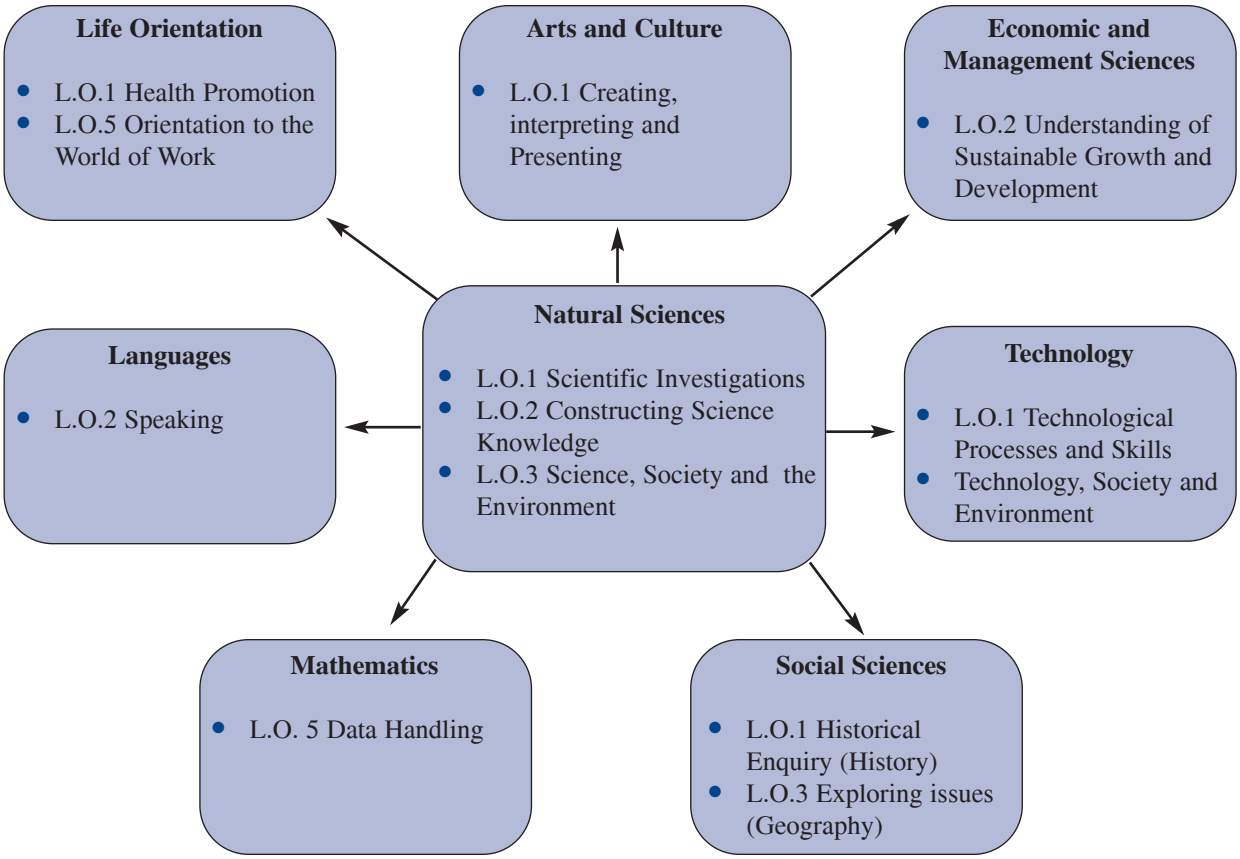
It becomes the responsibility of the teacher of the Natural Sciences to ensure that the Learning Programmes and the tasks within them do not carry this stereotyping further; activities selected must be of interest to all learners and opportunities must be provided for all learners to succeed. Furthermore, reporting to parents should focus on the extent to which the learner has progressed over the year or term.

2.8 ISSUES IN DESIGNING A LEARNING PROGRAMME, WORK SCHEDULE AND LESSON PLANS FOR NATURAL SCIENCES

Since the Learning Outcomes for all the Learning Area Statements have been derived from the Critical and Developmental Outcomes, a natural link exists amongst almost all of the Learning Outcomes of the different Learning Areas. Some links are shown in the diagram below.

When looking for links in the development of Learning Programmes, it is important to go beyond the level of Learning Outcomes. The Assessment must also be scrutinised. Such an approach will ensure that the process of integration between Learning Areas is a natural one based on authentic links.

This linking of Learning Outcomes make the integration of Learning Programmes possible. This is what a map showing the linking of some of the Learning Outcomes across Learning Areas may look like.



- The Learning Programme should not attempt to cover a lot of ground superficially, but rather look at the depth to which Learning Outcomes are attained and the relevance of the knowledge and skills learners are acquiring. The reason for this suggestion is that in order to meet the Learning Outcomes, learners need time to do in-depth investigations and projects.
- Since the three Learning Outcomes are intertwined, invariably all Learning Outcomes will be addressed in the Learning Programmes repeatedly. This will also allow for many more learning opportunities for learners to demonstrate achievement of Learning Outcomes.
- Selection of context and Core knowledge and Concepts from those listed in Appendix 2 will depend on various factors such as local relevance/interest. For example, in some areas of the country, it might be mining. In such a case it will be necessary to look through all the statements of Core Knowledge and Concepts, in all four strands (Life and Living, Planet Earth and Beyond, Energy and Change, and Matter and Materials), and select those that might contribute to development of this context. Other contexts of global, national and local interest will be planned in the same way.
- There should be a balance of all four Core Kowledge and Concept strands within the Learning Programme.
- Remember also that it is suggested that 70% of the time be spent on the Core Knowledge and Concepts statements. The other 30% of the time may be used to extend these statements, or to select material significant to the learners and the local community. These may include economic, environmental, social or health matters.
- Bear in mind that the time available for the teaching, learning and assessment of the Natural Sciences is 13% of the time available. Where schools exercise the option of developing a combined Natural Sciences and Technology Learning Programme, the total time available will be 21%.


TIRISANO
WORKING TOGETHER

SECTION 3
INTERMEDIATE PHASE

3.1 THE INTERMEDIATE PHASE LEARNER

The Intermediate Phase is important in that it provides for a specific group of learners in the approximate age group 8-14 in grades 4-6. In this phase, learners are:

- Becoming more sensitive to how their actions affect others;
- Beginning to consider the needs, desires and points of view of others;
- Able to function co-operatively in the completion of group tasks with increasing ease;
- Enjoying the challenge of tackling independent tasks;
- Beginning to reveal the desire to take control of their own learning;
- Attempting to satisfy their curiosity about the world around them through active participation and critical enquiry in the learning process;
- Beginning to seek more order; while still manifesting spontaneity and creativity;
- Becoming more deliberate and methodical in their approach;
- Increasingly able to apply acquired methods in new contexts;
- Increasingly able to access, record and manipulate information; and
- Increasingly able to investigate, compare and assess critically.

How this is important for the Natural Sciences

Learners in the Intermediate Phase begin a major advance in their thinking, compared to their thought as it was in the Foundation Phase: the advance is in their increasing ability to do things in thought before doing them in action. They can think through a series of steps in their minds and thus they are better able to plan a procedure for an investigation. Their growing ability to consider a connected series of events allows them to see and describe simple associations between the events, provided that the task involves materials or events they have worked with or experienced. Grade 4 learners typically find it hard to remember events in sequence – they can recall the first and last things that happened, but often they cannot recall the events in-between. By Grade 6, however, they can recall the steps that occur when a situation changes: for example, a learner can reconstruct, using memory and reasoning, the way shadows will change length and direction, between sunrise and sunset.

They have an improved command of the language and can use it more accurately, which allows greater refinement of concepts. For example, Intermediate Phase learners probably have the words to distinguish between "**melting**" and "**dissolving**", or between a towel "**getting dry**" and the water "**evaporating**." This language ability indicates greater mastery of the concepts.

They are more able to think in terms of how others might see things or experience situations and thus are better able to deal with issues of bias and the impact of technology on peoples' lives.

3.2 LEARNING PROGRAMME OPTIONS IN THE INTERMEDIATE PHASE

This section provides guidelines for the development of Learning Programmes in the Intermediate Phase.

Three options on how to develop a Learning Programme are discussed in this section. When designing a Learning Programme, Work Schedule or Lesson Plan, it is important to remember that assessment tasks and the recording of learner performance are planned together as part of the activities being developed.

Even though guidelines are provided by the Department of Education at a national level, provinces will develop further guidelines where necessary in order to accommodate diversity. Schools could propose the number and nature of the integrated Learning Programmes based on their own school contexts. These integrated Learning Programmes must ensure that the prescribed outcomes for each Learning Area are dealt with effectively and comprehensively.

The purpose of developing integrated Learning Programmes is to address the following:

- Even though there are eight Learning Areas, with their own knowledge domains, it is important to remember that knowledge does not exist in isolation. There are natural connections between and across Learning Areas, and knowledge in one Learning Area is relevant and can be used to achieve outcomes in another Learning Area.
- When planning, it is useful to consider using the Learning Outcomes in one Learning Area to enrich another Learning Area. The linkage though should reflect a natural connectedness, and should not be a forced link for the sake of linking with another Learning Area.
- Using the option for integration, allows for effective management of available staff and issues of overload in the diverse school contexts that exist. At Intermediate Phase, it may be that the following situations prevail:
  - 1 teacher is responsible for teaching all Learning Areas in a grade
  - 1 teacher is responsible for teaching more than one Learning Area in different grades
  - 1 teacher teaches across Learning Areas and across grades
    (There may be other arrangements in different schools.)

The options presented are meant to address these situations especially as teachers will develop the Learning Programmes themselves.

It is understood that eight Learning Areas MUST be implemented in the Intermediate Phase. Furthermore Languages and Mathematics will be distinct Learning Programmes. This is important for reporting and recording purposes. Irrespective of how Learning Areas are integrated, reporting is done against the Learning Outcomes of each of the Learning Areas. Teachers will record learner performance against the Learning Outcomes and Assessment Standards selected for developing an activity.

3.2.1 What the Integration of Learning Areas means

Integrating Learning Areas should enhance the knowledge, skills, attitude and values embedded in the Learning Outcomes of each Learning Area. Learning Outcomes have associated Assessment Standards specific to each grade and although planning starts with Learning Outcomes, it is how Assessment Standards are integrated that is important. Some Assessment Standards can stand alone while others may be clustered with Assessment Standards from other Learning Areas.

The Learning Area Core knowledge and Concepts, concepts or themes are NOT the starting point when planning integration. However, they are important vehicles for achieving the outcomes and are to be considered as part of the planning. Each Learning Area has its own concepts and

knowledge domain, but achieving knowledge on its own without developing appropriate skills is not what we strive for in an outcomes-based curriculum.

The integration of Learning Areas into Learning Programmes will have implications for planning.

3.2.2 Implications for Planning

When planning it is important to take into consideration:

- How well the teacher knows the other Learning Areas in order to be able to integrate and assess effectively
- The integrity of the Learning Areas must be maintained and learning in each Learning Area must not be compromised
- Coverage of all Learning Outcomes and Assessment Standards in each Learning Area must be ensured.
- That planning for assessment is done as part of the planning for activities. This is important when integrating across Learning Areas as well as when integrating within a Learning Area. It is also important for avoiding overload in teaching and learning, and teachers feeling that they are doing "too much" assessment.
- That the planning needs to involve all teachers for a phase and/or at a grade level
- That the time utilization must be in line with national policy
- Different approaches to teaching and learning can be used to support classroom practice. For example, the investigative and practical approach to teaching Natural Sciences will best suit the Learning Outcomes.
- That the effective use of available resources must be planned, and that resources that are not available but needed must be identified and provided.

3.2.3 Options to be Considered

The following options are suggested for integrating (or combining) Learning Areas into Learning Programmes, remembering that Languages and Mathematics are distinct Learning Programmes. Planning an integrated Learning Programme always starts with identifying and combining the relevant Learning Outcomes of those Learning Areas being integrated. Even when planning from a Learning Programme to a Lesson Plan, teachers start with integrating the Learning Outcomes and Assessment Standards.

Option 1: Learning Programmes are derived directly from Learning Areas

This implies that the Learning Areas themselves are the Learning Programmes.

This does not mean there are not opportunities within the Learning Programme to integrate, especially if it is to enrich teaching, learning and assessment. In this option teachers may want to cluster Learning Outcomes and Assessment Standards within the Learning Area.

Teachers assess learner performance in line with the Assessment Standards and report against the Learning Outcomes.

Option 2: One Learning Area is integrated with another Learning Area

For example:

- Natural Sciences and Technology, or
- Economics Management Sciences and Technology, or
- Economics Management Sciences and Social Sciences, or
- Life Orientation and Arts & Culture, or any other combination of Learning Areas.

In this option, match the Learning Outcomes of both Learning Areas, and cluster the appropriate Assessment Standards. There are instances within an integrated Learning Programme where some Learning Outcomes can be dealt with separately.

Teachers are **NOT** to write new Learning Outcomes or new Assessment Standards. They assess against **the clusters** of Assessment Standards and record against these Assessment Standards as defined in the activity or task. They report against Learning Outcomes.

Option 3: Short-term integration with other Learning Areas

In this option there is short-term integration across Learning Areas for enrichment where natural connections with other Learning Outcomes and Assessment Standards are established.

For example:

- LO with SS and A&C
- EMS with TECH and LO
- NS with SS (Geography)
- Tech with A&C
  (or any other combinations)

Teachers assess and record against the Learning Outcomes and Assessment Standards of each of the Learning Areas that have been integrated. Reporting is done against the Learning Outcomes.

The illustrations that follow provide examples of how these options are planned in the different Learning Areas.

3.3 ILLUSTRATIONS OF LEARNING PROGRAMMES

3.3.1 An Illustration of a Natural Sciences Learning Programme in the Intermediate Phase

What follows is a guideline for the development of a Natural Sciences Learning Programme for the Intermediate Phase. Yearlong Work Schedules can, in turn be derived from such a Learning Programme. Although steps are suggested, the process is not linear but a reiterative one.

- Organise the Learning Programme on a flip chart or large sheet of paper, or in such a way that all those involved in the development process can contribute to the planning of the Learning Programme.

The following grid shows what aspects of planning will be unpacked in the Phase-long plan, but when developing the actual programme teachers will fill in the detail. Also no process for arriving at the detail is shown here but as a team you will find a process (i.e a mind mapping process or brainstorm) to arrive at the detail.

Phase-long Learning Programme Plan							
Grade 4	*LO and AS* Context Core knowledge and Concepts Resources		*LO and AS* Context Core knowledge and Concepts Resources	*LO and AS* Context Core knowledge and Concepts Links with other LA Resources	etc.		
Grade 5	*LO and AS* Context Core knowledge and Concepts Resources	*LO and AS* Context Core knowledge and Concepts Resources	*LO and AS* Context Core knowledge and Concepts Links with other LA Resources		etc.		
Grade 6	*LO and AS* Context Core knowledge and Concepts Resources	*LO and AS* Context Core knowledge and Concepts Resources	*LO and AS* Context Core knowledge and Concepts Resources	*LO and AS* Context Core knowledge and Concepts Links with other LA Resources	etc.		

The entire structure represents a three-year Learning Programme and any one horizontal row represents a yearlong Work Schedule. The Learning Programme will show a plan of how Learning Outcomes and Assessment Standards are organized or "packaged" and sequenced, and what context and Core knowledge and Concepts is to be used.

- We indicated earlier that the Learning Outcomes are intertwined and that all three of them need to be addressed in each Lesson Plan. This implies that within each cell, *all three Learning Outcomes and Assessment Standards* associated with each need to be written within the cell.

[Since this information will be repeated in each and every cell, you might decide not to write the Learning Outcomes and Assessment Standards fully, as long as you remember that **it is the Learning Outcomes that drive the teaching, learning and assessment in each level of planning**].

Even before you think about **how** (i.e. Core knowledge and Concepts and context) you will attain outcomes, you will know **what** (Learning Outcomes and Assessment Standards) and to **what depth** of attainment you want to focus on. Remember it is the Assessment Standard that describe the level at which learners should demonstrate the achievement of the Learning Outcome.

- When selecting a context and the Core Knowledge and Concepts that will be used to attain

the Learning Outcomes and Assessment Standards, the following ways can be considered:

(a) Select a context that is of interest or local relevance. For example, in some areas of the country, it might be the range of plants and animals along the seashore, in others it may be plants found in semi-arid regions. Look through all the statements of Core Knowledge and Concepts (Appendix 2) and select those that might contribute to this Work Schedule for the grade being considered (say grade 4). (Note that the statements in Appendix 2 have been numbered for convenience). Possible links include food chains, ecosystems and the role of water in ecosystems (Life and Living), the energy of falling water (Energy and Change), the water cycle and the quality of water resources (Planet Earth and Beyond), properties of water and change of phase (Matter and Materials). Note that we have selected Core knowledge and Concepts from across all four main knowledge areas. While this might not always be possible, we should strive towards this.

Other possible contexts for the Intermediate Phase include the following:

(Note that this is not meant to be an exhaustive list – in the classroom teachers should be able to come up with a lot more on their own.)

- natural disasters
- sports
- food and cooking
- transportation
- diseases
- tourism
- mining

Some teachers might prefer to work with broader categories in which some of the above contexts (including others) might be clustered. Examples of such categories, with closely linked contexts within each of them, are as follows:

Sustainable Living

- water is life
- energy for all
- air
- diversity

Our Changing World

- natural disasters
- the soil story
- mining
- materials in the environment

Healthy Living

- sport
- diseases

Food and Shelter for Survival

Transport

- transport in society
- transport in the body

(b) Look through all the statements of core knowledge and concepts, select those that fit together and put them all in the same cell. Also think up a context or topic that embraces all the selected statements. For example, the context "energy flow" might be useful to hold together the following: food production by plants, food consumption by animals (Life and Living), energy sources and energy transfers (Energy and Change), fossil fuels (Planet Earth and Beyond), change in phase during heat gain or heat loss (Matter and Materials).

(c) Some Work Schedules within the Learning Programme and the subsequent Lesson Plans may be developed entirely around the 30% unspecified knowledge and concepts. This allows space for the teacher to select knowledge and concepts that are relevant to the treatment of local issues, problems and interests of learners.

- Consider how much time each unit of the Learning Programme is likely to take and write this down within the cell.
- Follow the same way of considering what you want to plan for each cell in the horizontal row representing a grade
- Make certain that there is conceptual link from one cell to the next.
- Do this for the two horizontal rows representing grades 5 and 6, and complete the outline of the Learning Programme for the Intermediate Phase.
- The actual number of units that make up the Learning Programme is not fixed. It depends on the amount of time taken for each unit of the Learning Programme. (Remember that the time allocation for Natural Sciences is 13% of a 26.5 hour week; if there are approximately 38 weeks of teaching time in the year, this works out to a total of approximately 130 hours for science in the year). However, it is suggested that when deciding on the number of units in the Learning Programme(for example, not more than 10) to be planned for the year, you do so as to allow time for the learners to do in-depth investigations and projects and thereby meet the Learning Outcomes and their Assessment standards.
- The planning of a Learning Programme will take some time. As the cells in the Programme begin to fill up, frequent re-arrangements may be necessary. As you contemplate how to meet the Learning Outcomes in each of the units in the Learning Programme, new ideas will result in re-thinking the Core knowledge and Concepts choice for other units in that Learning Programme. The planning of a Learning Programme is thus a reiterative, and not linear, process.

The following is an example of a part of a Learning Programme for the Natural Sciences in the Intermediate Phase. Note the following with regard to the example:

- there are only 2 units in the Work Schedule per grade shown since this is an example of only a **part** of a Learning Programme; in practice, there will be many more units in that Work Schedule to take up the entire 130 hours available per year per grade
- we understand that all Learning Outcomes are important and it is encouraged that as far as possible all three Learning Outcomes are used, but there will be instances when

one Learning Outcome is emphasised and the others are used to support that Learning Outcome. It is also not necessary to rewrite the Learning Outcomes and Assessment Standards out in full every time you plan – use, for example, Learning Outcome 1 and Assesment Standard 2 or Learning Outcome 3, Assessment Standard 1, etc

- in selecting statements of Core Knowledge and Concepts we have used option 3.3.3(a) as described on the previous page; it is possible to use options 3.3.3(b) and 3.3.3 (c) as well
- the actual time that teachers might want to allocate per unit will depend on the depth and breadth with which they wish to treat the unit
- there is conceptual progression from grade to grade, and within each grade the units in the Work Schedule are linked together
- the format shown in the example is not meant to be prescriptive. Schools, or teachers, may decide on their own formats as long as the essential elements or information i.e. resources, time, Learning Outcomes, Assessment Standards, etc, are shown in the formats used
- when integration with other Learning Areas is planned, the Learning Outcomes and Assessment Standards used must be indicated. Integration with other Learning Areas need not happen in every Lesson Plan.

Part of Natural Sciences Learning Programme for the Intermediate Phase

Grade	Learning Outcomes & Assessment Standards	LO 1 AS 1; AS 2 LO 2 AS 1; AS 2 (Gr6) LO 3 AS 2		LO 1 AS 1; AS 2; AS 3 LO 2 AS 1 LO 3 AS 1 AS 2	
	Integration	LANG LO 1; AS 1		SS LO 1; AS 2; TECH LO 2 AS 1 LO LO 2 AS 2;	
	Strand	**Context** Food and Cooking	**Resources**	**Context** Sport	**Resources**
4	Life and Living Energy and Change Matter and Materials Earth and Beyond	Sources of energy and energy transfer How green plants obtain energy Requirements and sources of the requirements for food manufacture in plants How energy is transferred to animals Time : 10 hours	Green Plants Magazines etc (*broad description of resources needed*)	Seasonal weather changes and significance for the different codes of sport Requirements for high performance in sports : healthy living, high energy levels, training, mental attitude, genetic constitution (a simple explanation, in outline only) Energy for movement, growth and repair of damaged cells and tissues Sources of energy for sports Time : 20 hours	Magazines Slides of different cells and tissues (*here teachers provide broad description of resources needed*)
5	Life and Living Energy and Change Matter and Materials Earth and Beyond	Why animals need food Need for a balanced diet Why food needs to be cooked Variety of ways of cooking food Properties of matter and changes and physical changes that food undergoes during cooking Individual and cultural preferences for different types of food Time : 20 hours	Magazines Models Diagrams etc (*broad description of resources needed*)	Energy and other requirements for the different codes of sport Availability of above requirements from different food groups Balanced diet Cooking and its effect on the nutrients in food Properties of materials used in sport equipment and clothing e.g. flexibility, retention of heat etc Time : 20 hours	Magazines Samples of materials used (*here teachers provide broad description of resources needed*)
6	Life and Living Energy and Change Matter and Materials Earth and Beyond	The requirements and products of photosynthesis Sources of the requirements, including the water cycle, and brief explanation of carbon cycle The process of photosynthesis in broad outline The digestive system and process of digestion Diseases associated with nutrition Time : 25 hours	Diagrams Models etc (*broad description of resources needed*)	The need for water (dehydration in sports) Food and chemicals as systems that can store energy How energy becomes available from muscles in broad outline (digestion, transport and breakdown in cells) Sexual reproduction and inheritance (including the inheritance of sporting talent) Skeletal system, muscles and movement Time : 25 hours	Models Diagrams (*broad description of resources needed*)

IMPORTANT: *The above format may be changed to best suite of the planning needs of the school and teachers, but the essential features for planning* ***must*** *be included.*

3.3.2 Developing an Integrated Learning Programme for Natural Sciences and Technology

As shown in the previous section, one of a number of options can be used in Learning Programme development in the Intermediate Phase. Schools, with the approval of their Provincial Education Department, have the option of for example combining the Natural Sciences and Technology Learning Areas into one Learning Programme. In order to do this, a clear understanding of the similarities and differences between the Learning Outcomes and Assessment Standards of both Learning Areas is essential, as shown below:

	Natural Sciences	Technology
Learning Outcome 1	***Scientific Investigations:*** 3.3 Planning investigations 3.4 Conducting investigations and collecting data 3.5 Evaluating data and communicating findings	***Technological Processes and Skills*** 3.3 Investigates 3.4 Designs 3.5 Makes 3.6 Evaluates 3.7 Communicates
Learning Outcome 2	***Constructing Science Knowledge*** 3.6 Recalling meaningful information when needed 3.7 Categorizing information 3.8 Interpreting information 3.9 Applying knowledge	***Technological Knowledge and Understanding*** 3.8 Structures 3.9 Processing 3.10 Systems and control
Learning Outcome 3	***Science, Society and the Environment*** ***Technology, Society and the Environment*** 3.3 understanding science and technological knowledge in the context of history and indigenous knowledge 3.4 understanding the impact of science and technology on the environment and on people's lives 3.5 recognising bias in science and technology which impacts on people's lives	

Learning Outcomes for a combined Learning Programme

What follows is an elaboration of the table above to illustrate how the Learning Outcomes may be combined for a Natural Sciences and Technology Learning Programme.

Learning Outcome 1: Technology

The learner will be able to apply technological processes and skills ethically and responsibly using appropriate Information and Communication Technologies.

The Assessment Standards in this outcome are organised under five **technological skills**, namely **Investigates** (4 Assessment Standards but see note below on Investigating in Natural Sciences Learning Outcome 1), **Designs** (4 Assessment Standards), **Makes** (3 Assessment Standards), **Evaluates** (2 Assessment Standards) and **Communicates** (2 Assessment Standards).

(You will find these 15 Assessment Standards in the Technology Learning Area Statement)

Learning Outcome 1: Natural Sciences

The learner will be able to act confidently on curiosity about natural phenomena; and to investigate relationships and solve problems in Scientific, Technological and environment contexts.

The Assessment Standards for this outcome are **Planning investigations**, **Conducting investigations** and **collecting data**, and **Evaluating data** and **communicating findings**.

Note on integration: The two Learning Outcomes Technology Learning Outcome 1 and Natural Sciences Learning Outcome 1, above, have been written in such a way that Learning Outcome 1 (Natural Sciences) can be done as investigation on its own, or Learning Outcome 1 (Natural Sciences) can be done as the **Investigates** skill of Learning Outcome 1 (Technology). When the second option applies, the Lesson Plan also include Designs, Makes, Evaluates and Communicates.

Learning Outcome 2: Technology

The learner will be able to understand and apply relevant technological knowledge ethically and responsibly.

The Assessment Standards for Learning Outcome 2 (Technological Knowledge and Understanding) are organised under three Core knowledge and Concepts areas, **Structures**, (1 Assessment Standard), **Processing** (1 assessment Standard) and **Systems and Control**, (2 Assessment Standards, Mechanical systems and Electrical/ electronic systems). You will find the wording of the Assessment Standards in the Technology Learning Area Statement.

Learning Outcome 2: Natural Sciences

Learners will know and be able to interpret and apply scientific, technological and environmental knowledge

This outcome is assessed on four Assessment Standards, namely **Recalling meaningful information when needed, Categorising information to reduce complexity and look for patterns, Interpreting information** and **Applying knowledge to problems that are not taught explicitly.**

Note on integration: The Natural Sciences Learning Area Statement has Section 4 on Core Knowledge and Concepts, organised in four strands (Life and Living, Energy and Change, Planet Earth and Beyond, Matter and Materials) and there are several overlaps between these strands and the Technology Learning Outcome 2 Assessment Standards.

Learning Outcome 3: Natural Sciences and Technology

Learners will be able to demonstrate an understanding of the interrelationships between Science and Technology, society and the environment.

This Learning Outcome is written in the same words for the Intermediate Phase in the Natural

Sciences and Technology Learning Area Statements. The Assessment Standards for the outcome are also the same, namely **Understanding science and technology knowledge in the context of history and indigenous knowledge, Understanding the impact of science and technology on the environment and on people's lives,** and **Recognising bias in science and technology which impacts on people's lives.**

Note on integration: When learners produce work showing progress in this outcome, you may record their progress in both Technology and Natural Sciences Assessment Standards.

The principles that guide the development of Learning Programmes for the Natural Sciences, described on pages 45 to 50 also apply here to the development of a combined Learning Programme for Natural Sciences and Technology. However, a few additional factors must be considered, such as time allocation, attending to Learning Outcomes from both Learning Areas, Assessment, use of Core Knowledge and Concepts in the Natural Sciences.

Time allocation

The time allocations for the separate Technology and Natural Sciences Learning Areas in the Intermediate Phase are 8% for Technology and 13% for Natural Sciences giving us a total time of approximately 210 hours for each year. Teachers can use their discretion in the actual time spent on each Learning Area. Good planning of Work Schedules and Lesson Plans should create extra time for the learners to do practical work in both Technology and Natural Sciences

Learning Outcomes

- All the learning outcomes must be targeted each term, preferably in each Lesson Plan.
- Not all Lesson Plans will require a complete Technology project. A Technology project means that the learners do all the technological skills (in Learning Outcome 1, these are Investigates, Designs, Makes, Evaluates and Communicates) using Core knowledge and Concepts chosen from the Learning Outcome 2 Assessment Standards and targeting Learning Outcome 3 through the Learning Outcome 1 Assessment Standards.
- In doing, for example, three Technology projects, the learners will do three investigations and you will be able to record progress in Natural Sciences Learning Outcome 1 at the same time. However, some of the Core Knowledge and Concpets in Natural Sciences might not be dealt with in the Technology projects and so the learners should do an extra investigation using Core Knowledge and Concepts not covered in Technology. This will then mean a total of FOUR investigations in a year.

Assessment

- Assessment strategies/techniques must be developed together with the activities. Where possible, develop the assessment tools with the learners to ensure clarity of focus. This needs to be a part of the teaching and learning process and not an after-thought.
- At least one reliable judgement of level or progress on each Learning Outcome should be made for each learner during each term. Some Learning Outcomes have few Assessment Standards while others have many. In a term it is not always possible to collect evidence on all Assessment Standards. For example, for Learning Outcome 1 (Technology) in the Intermediate Phase there are 15 Assessment Standards but not all might generate useful

evidence of learners' progress in a term. However, over the year, the teacher should have **at least** one reliable judgement of level for **each** Assessment Standard, backed by evidence of some kind. This means that ALL Learning Outcomes must be addressed through all its Assessment Standards over the year, for purposes of reporting.

Core Knowledge and Concepts in Technology and Natural Sciences

- The Core Knowledge and Concepts to be used for the delivery of the Learning Outcomes is described in Learning Outcome 2 (Technology) above and Section 4 (Intermediate Phase) of the Natural Sciences Learning Area Statement.

  Keep in mind the following principle: The knowledge focus as mapped out in the Natural Sciences (Chapter 5 of the RNCS and Appendix 2 in this booklet) and Technology Learning Outcome 2 should **not be all** that you use. The principle is that you should make learning relevant to learners' lives and therefore use knowledge drawn from local context and issues, current affairs and learners' interests. Think of this knowledge as being allocated 30% of the time you spend on this combined Learning Programme. In some schools teachers might spend 30% of the time on in-depth work on compulsory Core Knowledge and Concepts that is interesting or relevant to the learners' lives.
- To ensure that the Technological Knowledge and Understanding (Learning Outcome 2) and each of the four strands in the Natural Sciences Core Knowledge and Concepts receives a balanced treatment over a **phase and a year**, modules should integrate relevant topics within and across the various strands with the Technological Knowledge and Understanding topics.

Learning Outcome	Assessment Standards	Core knowledge and concepts/Context	Integra-tion	Resources
Tech LO1	Investigates Finds out about the background context when given a problem, need or opportunity, and lists the advantages and disadvantages that a technological solution might bring to people and the environment Finds out about existing product and relevant to a problem need or opportunity, and identifies and compares their design aspects (i.e. who is it for what is it for, what it looks like, what it is made of, how well it works, whether it will affect the environment)	Selection of products made from different materials. For example, different products made from paper, plastic, leather or other material, etc and what they are used for. Plan an investigation by setting up focused questions on the materials and products selected Having selected a product, comment on their value, purpose, environ-mental friendliness, the texture, of the material	Mathematics EMS SS	Different objects made from the materials selected, i.e. a paper plate, a plastic bag, a leather /plastic shoe. Plastic of different shapes and sizes, etc
NS LO1	Plans investigation: helps to clarify focus questions for investigation and describes the kind of information, which would be needed to answer the question. Conduct investigations and collects data: conduct simple tests or surveys and records observation or responses Evaluates data and communicates findings: relates observations and responses to the focus question	Data capturing and analysis of data using information collected by the learners Critical analysis of ancient and modern products Elaborate on their differences and Level of importance, and why		
NS LO2	Recalls meaningful information: at the minimum, describe the features which distinguish one category of thing from another Categories information: categorises objects and organisms by two variables		Mathematics EMS	
Tech LO 2	*Structures* Demonstrates knowledge and understanding of materials suitable for supporting loads, how structures can be made stable and how they could be reinforced *Processing* Demonstrates knowledge and understanding of the reasons different materials deteriorate and ways of preserving them.	Use of materials for various purposes i.e. strength and support What constitutes the quality of materials? Sustainability of the materials Society and the product Use and adaptation of the product by various societies		
Tech LO 3	Indigenous Technology and culture Describes similarities in problems and solutions in own and other societies -past present and future		Social Sciences	

Learning Outcome	Assessment Standards	Core knowledge and concepts/Context	Integra-tion	Resources
NS LO 3	Understands science and technology in the context of history and indigenous knowledge: Describes the similarities in problems and solutions in own and other societies in the present, past and the future Understands the impact of science and technology: Suggest ways to improve technological products or process and to minimise negative effects on the environment Recognises bias in science and technology: Suggests how technological products and services can be made accessible to those presently excluded	The impact modern technology on the product(s) the people and environment both, economically, socially, politically culturally and traditional practice and human resource development How modern technology has position itself in the promotion and protection of human rights, gender sensitivity, equitable access to technological products and health	EMS Social Sciences Life Orientation Life Orientation	
Tech LO1	*Designs* Writes or communicates a design brief for the development of a product related to a given problem, need or opportunity that clarifies the technological purposes of the solutions Suggests and records at least two alternative solutions to the problem, need or opportunity that link clearly to the design brief and to given specification and constraints (people, environment, safety and impact)	Designing of the solution Development of the solution using the best option	Mathematics EMS Language	
Tech LO 1	*Designs* Writes or communicates a design brief for the development of a product related to a given problem, need or opportunity that clarifies the technological purpose of the solutions. Suggests and records at least two alternative solutions to the problem, need or opportunity that clearly link to the design brief and to give specifications and constraints (people, environment, safety and impacts)	Understand the impact of science and technology. Suggest ways to improve technological products or process and to minimise negative effects on the environment Processing Demonstrate knowledge and understanding of the reasons different materials deteriorate and ways of preserving them	Mathematics Mathematics Life Orientation Languages	

3.4. ILLUSTRATIONS OF WORK SCHEDULES

3.4.1 An illustration of a Natural Sciences Work Schedule

In the Work Schedules, the cells representing all the Lesson Plans in the Learning Programme for any particular grade are fleshed out in more detail than in the Learning Programme. For example, for Grade 5, a part of a Work Schedule might look like this:

Work Schedule: Natural Sciences **Year:** 2004

Teaching time available (in hours): ……

Learners' needs:

Generic: ……

Specific: ……

Week	Unit	Learning Outcome	Assessment Standard(s)	Integration	Core knowledge and concepts/Context	Learning Activities	Assessment form	Resources
1	1	LO 1 LO 2 LO 3	AS 1 AS 2 AS 1 AS 2 AS 3 AS 4 AS 1 AS 2	None for this unit of the Work Schedule	Strands: Energy and Change, Matter and Material, Life and Living Food and Cooking Properties of matter and changes resulting from cooking Individual and cultural choices for different types of food	• research diet and ways of cooking in the past • investigate nutritional value of various food types i.e. breakfast cereals, hamburgers etc • investigate changes that take place when an egg is fried • research preferences for different food types in school	Investigation Written work Questionnaires	Food samples Apparatus for practical work
2								
3								
4								

Work Schedule: Natural Sciences **Grade:** 6

Teaching time available: ….....

Learners' needs:

Generic: .....**Specific:** .....

Week	1	2	3	4	5	6	7	8
LO	Tech LO 1, NS LO 1 and LO 2		Tech LO 1		NS LO 3, Tech LO 2		Tech LO 1, LO 3	
ASS	Finds out about the background context when given a problem, need or opportunity, and lists the advantages and disadvantages that a technological solution might bring to people and the environment Finds out about existing products relevant to a problem need or opportunity, and identifies and compares their design aspects (i.e. who is it for what is it for, what it looks like, what it is made of, how well it works, whether it will affect the environment) Plans investigations: Helps to clarify focus questions for investigation and describes the kind of information which would be needed to answer the question. Conducts investigations and collects data: Conducts the simple tests or surveys and records observations or responses Evaluates data and communicates findings: Relates observations and responses to the focus question Recalls meaningful information: At the minimum, describes the features which distinguish one category of thing from another Categorises information: Categorises objects and organisms by two variables *Designs* Writes or communicates a design brief for the development of a product related to a given problem, needs or opportunity that clarifies the technological purposes of the solution. Suggests and records at least two alternative solutions to the problem, need or opportunity that link clearly to the design brief specifications and a constraints (people, safety environmental and impact, appearance)				Understand the impact of the science and technology. Suggest ways to improve technological products or process and to minimise negative effects on the environment. *Processing* Demonstrate knowledge and understanding of the reasons different materials deteriorate and ways of preserving them		Develop plans that detail the making steps including drawings and sketches that help to clarify the plans Choose and use suitable tools to make the product by measuring marking out cutting or separating shaping or forming, joining or combining and finishing the chosen material Works efficiently and safely Understand science and technology in the context of history and indigenous knowledge	

Week	1	2	3	4	5	6	7	8
LO	**Tech LO 1, NS LO 1 and LO 2**		**Tech LO 1**		**NS LO 3, Tech LO2**		**Tech LO 1, LO 3**	
Integration	**Language, Mathematics** Mathematics, Language				Social Sciences		Mathematics, Social Sciences	
Core knowledge and Concepts	**Manufacturing/tech and science processes**		Manufacturing		Manufacturing		Manufacturing	
Activities	Learners collect different samples of materials Learners compare the different collection of materials and what products are made from them Learners verify what those products were used for		Learners study the various types of materials (leather, plastic/paper.) Learners design their choice of products for a material. Learners suggest and write down reasons for their choice		Learners investigate the substances/chemicals used to process and manufacture the product. Learners name those substances or products Learners investigate the substance/harmlessness or harmfulness to the environment Learners suggest ways and means of improving the product without causing harm to the environment		Learners develop the product following the technological steps Learners use their skills correctly to develop the product. Skill s such, joining. Combining and cutting Learners use their science and technological knowledge to compare the product with the indigenous product	
Assessment	Development of questionnaire Development of a sheet capturing all necessary items, comparing those items Report on the findings		Questionnaire Written down reasons for the suggested design		Verbal and written report on the kinds of substances used. Report on the relationships between the substances and nature. Report on how the product could be improved		Assessment of the completed product Observation of learners when the product is developed and noting the skills applied Report on how the modern product differ with the primitive product	
Resources	Old and unused products like shoes or plastic bags Library Paper cuttings		Paper Pencil Rubber Ruler		Writing materials		Tools Plastic papers Glue Pen hammer Scissors etc	

NOTE: *In this illustration the time has been indicated in* ***weeks.***

3.5 ILLUSTRATIONS OF LESSON PLANS

3.5.1 Lesson Plan for the Natural Sciences

The following is an example of a Lesson Plan for Grade 5 learners, which extends the Learning Programme and the Work Schedule. In developing a Lesson Plan, the teacher increases the level of detail still further and decides on how to select and sequence teaching, learning and assessment activities.

Table 3.5.1 is meant to indicate the kind of thinking that will happen when preparing a Lesson Plan. Teachers will consider which Learning Outcomes they want to use and ways in which the Learning Outcomes and Assessment Standards can be measured, concepts and core knowledge relevant, as well as some of the activities or Lesson Plans that can be planned.

Teachers will also indicate any particular needs of the learners and the local needs that may influence teaching and learning in this Lesson Plan.

Context : Food and Cooking

Core Core knowledge and Concepts Statements

- Living things need food for energy, to move, grow and repair damage to their bodies.
- Humans need a balanced diet from certain groups of food to be healthy
- Animals, including humans, have digestive systems for getting nutrients from food.
- Humans, including animals, get energy from eating plants and from eating animals that ate plants.
- Substances change when they receive or lose energy as heat. Some changes to materials are temporary but other changes are permanent

Core knowledge and Concepts from the unspecified 30%

- preferences for and/or abstinence from particular types of food because of personal, religious and cultural reasons

Activities for learning, teaching and assessment

- research diet and ways of cooking in the past
- investigate nutritional value of various food types i.e. breakfast cereals, hamburgers etc
- investigate changes that take place when an egg is fried

Ways in which the learning outcomes will be met:

Learning Outcome 1: Plans investigations (AS1), conducts investigations (AS2), evaluates and communicates findings with regard to the following:

- nutritional value of various food types
- changes that take place when an egg is fried
- preferences for different food types by learners at school

Learning Outcome 2: Recalls meaningful information AS1); Categorises information (AS2)

- explanation of need for balanced diet and the need for food (AS1)
- comparing nutritional value of different types of food (AS2)
- grouping learners according to food preferences (AS2)
- interpreting results of the investigations (AS3)
- applying information from one strand into another (AS4)

Learning Outcome 3: Identifies positive and negative effects of scientific developments (AS2)

- research diet and ways of cooking in the past (AS1)
- research preferences for different food types (AS1)
- investigate nutritional value of different types of foods (AS2)
- research preferences for different food types in school

This information can be organised using the Lesson Plan template as indicated below so that planning starts with the identification of the Learning Outcomes and Assessment Standards and then considers how the context will be used :

<table>
<tr><th colspan="3">LESSON PLAN</th></tr>
<tr><td colspan="2">Learning Area: Natural Sciences</td><td>Grade: 5</td></tr>
<tr><td colspan="2">Duration: 2 hours</td><td>Date/Week: 1</td></tr>
<tr><td>Learning Outcome:
LO 1

LO 2</td><td>Assessment Standards:
AS 1, AS 2

AS 1, AS 2, AS 3</td><td>Integration:
None for this unit of the Lesson Plan or activity</td></tr>
<tr><td colspan="2">Looking backward at:
Kinds of energy</td><td>Looking forward to:
Design of other sources of energy</td></tr>
<tr><td colspan="3">Core knowledge and Concepts/Context:
Food and Cooking
Strands: Life and living, Energy and Change
• Living things need food for energy, to move, grow and repair damage to their bodies.
• Humans need a balanced diet from certain groups of food to be healthy
• Animals, including humans, have digestive systems for getting nutrients from food.
• Humans, including animals, get energy from eating plants and from eating animals that ate plants.
• Substances change when they receive or lose energy as heat. Some changes to materials are temporary but other changes are permanent</td></tr>
<tr><td colspan="3">Learning activities and assessment
• research diet and ways of cooking in the past
• investigate nutritional value of various food types e.g. breakfast cereals, hamburgers etc
• investigate changes that take place when an egg is fried
Ways in which LOs will be met:

Learning Outcome 1: Plans investigations (AS 1), conducts investigations (AS 2), evaluates and communicates findings with regard to the following:
• nutritional value of various food types
• changes that take place when an egg is fried
• preferences for different food types by learners at school

Learning Outcome 2: Recalls meaningful information AS 1); Categorises information (AS 2)
• explanation of need for balanced diet and the need for food (AS 1)
• comparing nutritional value of different types of food (AS 2)
• grouping learners according to food preferences (AS 2)
• interpreting results of the investigations (AS 3)
• applying information from one strand into another (AS 4)</td></tr>
</table>

<table>
<tr><td colspan="2">Learning Outcome 3: Identifies positive and negative effects of scientific developments (AS 2)
• research diet and ways of cooking in the past (AS 1)
• research preferences for different food types (AS 1)
• investigate nutritional value of different types of foods (AS 2)
research preferences for different food types in school</td></tr>
<tr><td>Planned assessment (recording):
Written work
Investigations</td><td>Resources:
Model of digestive system
Magazines
Foods samples
Heating apparatus
Internet; Resource books</td></tr>
<tr><td>Expanded opportunities:
Research ways in which World Health Organisations are trying to combat diseases caused by malnutrition</td><td>Teacher reflection:
Teachers will note
• how the Lesson Plan could have been presented differently
• what impacted on experiments done
• other examples that may have been used
• what was good/weak about he LU
• Concepts that have not been dealt with effectively</td></tr>
</table>

NOTE: *The Lesson Plan itself can be broken up into individual activities or may be dealt with as a series of activities within which the learning, teaching and assessment described above need to be worked out in detail.*

3.5.2 Lesson Plan showing Integration of Natural Sciences with Technology

The following is an example of a Lesson Plan that can be used for a combined Natural Sciences and Technology Programme for Grade 6 learners. Again, table 3.5.2 shows some considerations teachers make for planning the integrated Lesson Plan.

Table 3.5.2

Context: Health – The role of water in sustaining life and socio-economic development

Core Core knowledge and Concepts statements: (processing/life and living/matter and material)

- Water plays an important role in the ecosystem, sustaining both plant and animal life.
- Modern and ancient methods of water purification and their impacts on health and the environment.
- Benefits of the properties of materials and how materials can be processed/recycled/reused.
- Modern and ancient uses of water
- Designing skills and communication of ideas/intentions of designs
- Uses of water- domestically and industrial/agricultural

Core knowledge and Concepts statements from other strands/Learning Area/s:

- Water as a source of energy
- Water cycle

Ways in which the learning outcomes will be met:

Learning Outcome 1 (Science) AS1: clarify focus questions for investigation to:

- Show that plants need water to survive
- Compare methods of purification
- Explore sources of water and their use: domestic, industrial, agricultural.

Learning Outcome 1 (Technology) AS 2,3,4,5: clarify the designing aspect of a proposed solution:

- Suggest/draws at least two alternative designs for a water purifier
- Chooses a design and gives a reason for choice
- Develops a drawing for manufacture/making that shows a sectional view (cut away). This drawing will include notes, labels and dimensions (measurements)
- Details the steps (stages) that will be followed to make the purifier.
- Evaluates the purifier by testing it and reports on the findings.

Learning Outcome 2 (Science) AS3; **Learning Outcome 3** (Science) AS2, 3; **Learning Outcome 2** (Technology) AS2:

- Conduct investigation and surveys and as per LO1 AS1 above
- Relate observations and responses to focus questions (LO1 AS1 above)
- Test materials / containers for suitability to be used for the solution.
- Interpret information from their investigations

Learning Outcome 3 (Science/Technology) AS1, 2,3; LO1 (Science) AS3:

- Describe similarities and differences in problems and solutions in ancient and modern societies with regard to the role of water in sustaining life and socio-economic development
- Suggest ways to improve technological methods of purifying water and to minimise their negative effects on health and the environment
- Suggest ways of improving access to clean water for all

As indicated previously, the individual lessons, within which the teaching, learning and assessment activities described above are described in detail, need to be planned. Below find an example of the Lesson Plan plan. This information can be organised using the Lesson Plan template as indicated below so that planning **starts** with the identification of the Learning Outcomes and Assessment Standards and then considers how the context will be used :

LESSON PLAN

Learning Area: Natural Sciences and Technology **Grade:** 6

Duration: 4 hours **Date/Week:** 2 and 3

Learning Outcome:	Assessment Standards:	Integration:
NS LO 1 TECH LO 1	AS 1, AS 2, AS 3 AS 2, 3, 4, AND 5	None with other Learning Areas for this Lesson Plan
NS LO 2 TECH LO 2	AS 3 AS 2	
NS AND TECH LO 3	AS 1, 2 AND 3	

Looking backward at:	Looking forward to:
Different eco-systems and its dependence on growth and reproduction of plants	Industrial and agricultural impact on quality of water

Core knowledge and Concepts/Context:
Water: The role of water in sustaining life and socio-economic development
Strands: Life and Living; Matter & Material, Energy and Change
Core knowledge and Concepts statements: (*processing/life and living/matter and material*)

- Water plays an important role in the ecosystem, sustaining both plant and animal life.
- Modern and ancient methods of water purification and their impacts on health and the environment.
- Benefits of the properties of materials and how materials can be processed/recycled/reused.
- Modern and ancient uses of water
- Designing skills and communication of ideas/intentions of designs
- Uses of water – domestically and industrial/agricultural

Learning activities and assessment:

- Conduct investigation on purification methods
- Testing of materials for their properties
- Research ways in which materials can be processed/recycled/re-used
- Design of simple water purification system

Ways in which the Learning Outcomes will be met:

LO 1 (Science) AS 1: clarify focus questions for investigation to:

- Show that plants need water to survive
- Compare methods of purification
- Explore sources of water and their use: domestic, industrial, agricultural.

LO 1 (Technology) AS 2,3,4,5: clarify the designing aspect of a proposed solution:

- Suggest/draws at least two alternative designs for a water purifier
- Chooses a design and gives a reason for choice
- Develops a drawing for manufacture/making that shows a sectional view (cut away). This drawing will include notes, labels and dimensions (measurements)

Learning activities and assessment (continued):

- Details the steps (stages) that will be followed to make the purifier.
- Evaluates the purifier by testing it and reports on the findings.

LO 2 (Science) AS 3; LO 1 (Science) AS 2, 3; LO 2 (Technology) AS 2:

- Conduct investigation and surveys and as per LO1 AS1 above
- Relate observations and responses to focus questions (LO1 AS1 above)
- Test materials/containers for suitability to be used for the solution.
- Interpret information from their investigations

LO 3 (Science/Technology) AS 1, 2, 3; LO 1 (Science) AS 3:

- Describe similarities and differences in problems and solutions in ancient and modern societies with regard to the role of water in sustaining life and socio-economic development
- Suggest ways to improve technological methods of purifying water and to minimise their negative effects on health and the environment
- Suggest ways of improving access to clean water for all

Planned assessment (recording):	**Resources:**
Written work Investigations - focused questions Test	Experiment apparatus Plants Water Drawing equipment Research notes on modern and ancient purification methods
Expanded opportunities	**Teacher reflection**
Design purification system for your school and present this as a plan to your School *Governing Body*	*Teachers will note* • *how the Lesson Plan could have been presented differently* • *what impacted on experiments done* • *other examples that may have been used* • *what was good/weak about he LU* • *Concepts that have not been dealt with effectively*

SECTION 4
SENIOR PHASE

4.1 THE SENIOR PHASE LEARNER

In this phase learners should be provided with opportunities to acquire, develop and apply a range of more advanced knowledge, understanding and skills. Breadth, depth, access and entitlement are particularly important to ensure that learners are given a sound basis from which to take advantage of choices at the FET phase. Learners should know enough about the nature of the options to ensure their decisions about future choices are informed ones.

The focus of the curriculum at the Senior Phase is transitional, to inform choice and to enable independence on the part of the learner. The Senior Phase is there to bridge the gap between consolidation and extension at the Intermediate Phase and choice at the Further Education and Training (FET) Phase. In this phase, it is important to remember that:

- Learners are becoming more independent.
- They are becoming clearer about own interests.
- They mature physically and sexually.
- They mature cognitively and socially and use lateral reasoning.
- They have some understanding of probability, correlation, combinations, prepositional reasoning and other higher level cognitive skills.
- They have the ability to perform controlled experimentation, keeping all but one factor constant.
- They have the ability to hypothesise variables before experimentation to reverse direction between reality and possibility.
- They can also use inter-propositional operations, combining propositions by conjunction, disjunction, negation and implication.
- They continually anticipate the reactions of others to their appearance and behaviour.
- Peer influence plays a major role in their social development.
- They believe that one must be sensitive about infringing on the right of others and always avoid violating rules made by their peers.
- They respect ideas and values of others, but rely on their own intellect and values in making personal decisions.
- Learners further develop abstract thought. They concentrate on thinking in abstract terms and hypothesise and use lateral reasoning. At this level sophistication of thought processes really begins and with appropriate support, the learner can analyse events and have some understanding of probability, correlations, combinations, prepositional reasoning and other higher-level cognitive skills.
- The learners also become aware of new aspects about themselves which have an influence on the development of the concept of self. The adolescent is continually anticipating the reactions of others to their appearance and behaviour. Peer influence plays a major role in their social development. The development of a positive self regard (self worth) is paramount during this stage.
- Their capability for abstract thinking influences moral judgement and decisions. They still concentrate on social responsibilities, but are moving towards independent morality.

It is important during this phase to get them focused on critical and creative thinking skills, attitude development and the understanding of their role in society.

Its importance for the Natural Sciences

They can think through more complex problems without actually doing them, provided they have pictures or models to work with. When doing investigations, they are interested in the question, does it happen in other instances, and does it always happen? Is there a pattern? They are interested in making and checking cause-and-effect predictions.

Their language has developed so that they can use or understand an increasing number of relational concepts, which enables them to learn about structure and function, adaptation, and energy transfers by conduction and convection, for example. Examples of these relational concepts are *All animals have structures which enable them to take in the food they need,* and *Different substances conduct heat at different rates.* They can now use language to make finer distinctions, which demonstrate their grasp of reality. For example, they can distinguish *"air"* from *"steam"*, and *"steam"* from *"smoke"*, and *"water vapour"* from *"air."* They can explain how the concepts *"air"* and *"the atmosphere"* relate to each other.

Many older Senior Phase learners enjoy considering issues of authority and ethics, and their curriculum should provide them with opportunities to examine and debate these issues in the science, technology and environment context.

4.2 DEVELOPING A LEARNING PROGRAMME AND WORK SCHEDULE IN THE SENIOR PHASE

The principles and procedures for the development of Learning Programmes, Work Schedules and Lesson Plans for the Natural Sciences in the Senior Phase are the same as those for the Intermediate Phase (as described in pages 58 to 64). Note, however, that while the time allocation for grade 7 is exactly the same as that for Intermediate Phase learners (13% of a 26.5 hour week), for grades 8 and 9 the time allocated is 13% of a 27.5 hour week. This works out to approximately 140 hours per year per grade.

As indicated in section 3.3.3, there are three possible options for selecting statements of core knowledge and concepts to complete the cells that represent Lesson Plans within a Learning Programme. In the Intermediate Phase example provided, we indicated how various contexts may be used to select the Core Knowledge and Concepts statements i.e. option (a). The example further showed what detail will be included when doing a Work Schedule and how the detail is further described when doing a Lesson Plan. The same can be done for the Senior Phase when developing a Learning Programme, Work Schedule or Lesson Plan.

The following becomes important:

- Identify and sequence the Learning Outcomes and Assessment Standards to be attained at the end of the Learning Programme.
- Select relevant and appropriate contexts that consider the needs of learners, the school and the community.
- Remember also that the selection of contexts will always **ensure that the four strands are included**, and that the assessment standards are used appropriately at the different grade levels.

- The **resources** used are described for the Learning Programme, Work Schedule and Lesson Plan, but the level of detail and specificity will be different.
- **What learners already know** becomes important when developing the Lesson Plans. At Work Schedule level, teachers will have a broad indication of what their learners know from the evidence of learner performance presented by the previous grade teacher in the learners' portfolios. This evidence is pegged against the Assessment Standards for the particular grade (to give an indication of at which level the majority of the learners are performing). Planning for learners with any barriers to learning is then purposefully planned for even before the Lesson Plans are developed. In the Lesson Plans specific approaches, resources and support is qualified for all learners.

4.3 ILLUSTRATION OF A LESSON PLAN

For the purpose of illustration, in the Lesson Plan described below, we have used option (b) i.e. selecting and putting together closely related statements of core knowledge and concepts that naturally fit together. It is important to remember that this is just an example. Teachers may continue to use option (a) (using contexts to hold Core knowledge and Concepts together) in the Senior Phase, or use option (c) (using Core knowledge and Concepts not specified in the statements of core knowledge and concepts). This is what will be considered when planning a Lesson Plan:

Context : Acids and Bases in the Environment

Core Core knowledge and Concepts Statements

- Many household substances are acidic or basic
- Indicators are substances that react with acids and soluble bases to produce products that have distinctive colours
- Acids and bases neutralise one another to form salts
- Acids have characteristic reactions with metals, metal oxides, hydroxides and carbonates

Core knowledge and Concepts from the unspecified 30%

- problems that acids in the environment can cause

Ways in which the learning outcomes will be met:

Learning Outcome 1: Plans investigations (AS1), conducts investigations (AS2), evaluates and communicates findings with regard to the following :

- areas of the tongue which are best for the identification of sweet, salty, sour and bitter tastes
- making home made indicators with substances such as tea, turmeric, red cabbage, beetroot and flower petals
- the properties of acids (vinegar, lemon juice) and bases (washing powder solution, ammonia)
- the neutralization of acids

Learning Outcome 2: Recalls meaningful information AS1); Categorises information (AS2)

- explanation of the problems that acids in the environment could cause(AS1)
- categorization of common household substances in as many ways as possible (AS2)
- comparison of the effectiveness of three different antacids (AS3)
- applying information to test the pH of local soils(AS4)

Learning Outcome 3: Understands sustainable use of earth's resources

- investigate the issue of acids in the environment (AS2)

Activities for learning, teaching and assessment

- categorization of common household substances in as many ways as possible
- investigation of specific areas of the tongue for the tastes sweet, sour, salty and bitter
- investigation of the properties of acids
- measurement of the pH of common household liquids using Universal Indicator
- making indicators from substances such as tea, turmeric, petals etc.
- investigation of acid-base reactions such as egg-shell in vinegar
- investigation of the effectiveness of three different antacid tablets
- investigation of the problem of acids in the environment (acid-rain, sinkhole formation, pH of rain water, streams, dams and soils

This information can be organised using the Lesson Plan template as indicated below so that planning **starts** with the identification of the Learning Outcomes and Assessment Standards and then considers how the context will be used:

<table>
<tr><th colspan="3">LESSON PLAN</th></tr>
<tr><td colspan="2">Learning Area: Natural Sciences</td><td>Grade: 7</td></tr>
<tr><td colspan="2">Duration: 5-6 hours</td><td>Date/Week: 2 – 4</td></tr>
<tr><td>Learning Outcome:
LO 1

LO 2

LO 3</td><td>Assessment Standards:
AS 1, AS 2

AS 1, AS 2, AS 3, AS 4

AS 2</td><td>Integration:
None with other Learning Areas for this Lesson Plan</td></tr>
<tr><td colspan="2">Looking backward at:
Phases of matter and changes of state</td><td>Looking forward to:
Use of acid reactions in Industry</td></tr>
<tr><td colspan="3">Core knowledge and Concepts/Context:
Acids and Bases in the Environment
Strands: Matter & Material, Energy and Change

Core Knowledge and Concepts statements:
• Many household substances are acidic or basic
• Indicators are substances that react with acids and soluble bases to produce products that have distinctive colours
• Acids and bases neutralise one another to form salts
• Acids have characteristic reactions with metals, metal oxides, hydroxides and carbonates

Core Knowledge and Concepts from the unspecified 30%
• Problems that acids in the environment can cause</td></tr>
<tr><td colspan="3">Learning activities and assessment:
• categorization of common household substances in as many ways as possible
• investigation of specific areas of the tongue for the tastes sweet, sour, salty and bitter
• investigation of the properties of acids
• measurement of the pH of common household liquids using Universal Indicator
• making indicators from substances such as tea, turmeric, petals etc.
• investigation of acid-base reactions such as egg-shell in vinegar
• investigation of the effectiveness of three different antacid tablets
investigation of the problem of acids in the environment (acid-rain, sinkhole formation, pH of rain water, streams, dams and soils</td></tr>
</table>

Ways in which the learning outcomes will be met:

Learning Outcome 1: Plans investigations (AS 1), conducts investigations (AS 2), evaluates and communicates findings with regard to the following:

- areas of the tongue which are best for the identification of sweet, salty, sour and bitter tastes
- making home made indicators with substances such as tea, turmeric, red cabbage, beetroot and flower petals
- the properties of acids (vinegar, lemon juice) and bases (washing powder solution, ammonia)
- the neutralization of acids

Learning Outcome 2: Recalls meaningful information (AS 1); Categorises information (AS 2)

- explanation of the problems that acids in the environment could cause(AS 1)
- categorization of common household substances in as many ways as possible (AS 2)
- comparison of the effectiveness of three different antacids (AS 3)
- applying information to test the pH of local soils(AS 4)

Learning Outcome 3: Understands use of earth's resources

- Investigate the issue of acids in the environment (AS 2)

Planned assessment (recording):	**Resources:**
Investigations Written work Research	Apparatus for investigations/practical work Household materials for indicators Soil samples Examples of metals, metal oxides. Hydroxides, carbonates
Expanded opportunities Conduct an investigation on the safety of storage facilities in your home, and recommend how chemicals in your home can be stored differently	**Teacher reflection** *Teachers will note* • *how the Lesson Plan could have been presented differently* • *what impacted on experiments done* • *other examples that may have been used* • *what was good/weak about the Lesson Plan* • *Concepts that have not been dealt with effectively*


TIRISANO
WORKING TOGETHER

SECTION 5
LEARNING AND TEACHING SUPPORT MATERIALS (LTSMs)

The role of the teacher in developing Learning and Teaching Support Materials is an important one, and one that will receive much emphasis in teacher development programmes. The importance of teachers developing their own support materials is emphasised in that:

- Classroom-based activities are supported by relevant and appropriate Learning and Teaching Support Materials generated by the teacher.
- The development of Learning and Teaching Support Materials by teachers for specific activity outcomes will ensure that the direct needs of a particular learner or group of learners are considered.
- Learner-centredness as a core principle of OBE will be reinforced right through to materials development.
- Expanded opportunities for enrichment and remediation can be included, and alternative opportunities for can be included.
- Whilst provinces are ensuring that schools are resourced, the lack of adequate resources will not impede teaching and learning.

Teacher-generated Learning and Teaching Support Materials are not the only Learning and Teaching Support Materials than can be used effectively in a classroom. Many publishers of Learning and Teaching Support Materials are likely to use this document to produce a large variety of Learning and Teaching Support Materials. It is also important that teachers are able to select and use existing materials effectively.

Most Provincial Education Departments have developed systems through which these commercially available publications are screened according to set criteria. Those publications which meet the criteria are then put on a catalogue from which schools may select and purchase for their learners. It should be noted that the criteria for screening publications to place on such catalogues are very general so as to include publications suitable for schools situated within a wide variety of contextual factors. What this simply means is that not all publications placed on a catalogue are necessarily suitable for your specific school with its own peculiar set of contextual factors. The responsibility of selecting one or more publications for your school rests with the teacher who has to ensure that those purchased are suitable for the learners within the school and for the context within which they will be learning.

Two categories of Learning and Teaching Support Materials require special mention; firstly that of the needs of practical work in the teaching and learning of science and secondly, the needs of learners experiencing barriers to learning.

The absence of proper school science laboratories, laboratory apparatus, materials (chemicals and biological specimens) and equipment are oft-cited reasons for the poor performance of learners in the Natural Sciences. Water, electricity and a gas supply are the very basic services required in every school laboratory. While Provincial Education Departments attempt to speed up the provision of these essential services, as well as other simple equipment and apparatus, the myth that the teaching of the Natural Sciences cannot be conducted in schools without fully-fledged laboratories with expensive and sophisticated equipment needs to be exploded. Every investigation does not necessarily demand experimental investigation in a laboratory. For example an audit of water-use in sections of the

community (grade 9) taken from the Revised Learning Area Statement may be undertaken without sophisticated laboratory equipment whatsoever. Besides, many investigations can, and should be, carried out with the use of improvised equipment.

Every effort needs to be made to ensure that learners are able to access the entire Natural Sciences Learning Area Statement through all its activities. This might mean the improvement of physical access to specialised areas such as science rooms and laboratories and the re-structuring of such facilities, and the provision of assistive devices such as specialised audio equipment and Braille facilities.

Finally, it is important to note that the provision of a supply of suitable Learning and Teaching Support Materials will not automatically lead to an improvement in the teaching and learning of the Natural Sciences. The teacher needs to devise and implement a system of the effective use of these support materials.

APPENDICES

APPENDIX 1
The Assessment Standards

APPENDIX 2
Statements of Core Knowledge and Concepts

APPENDIX 1

THE ASSESSMENT STANDARDS

Learning Outcome 1: Learners act confidently on their curiosity about natural phenomena as they investigate relationships and solve problems in science, technology and environmental contexts

Grade 4	Grade 5	Grade 6
Planning investigations		
Learner contributes to group discussion of familiar situations, needs or materials, and identifies interesting aspects which could lead to investigations	Learner lists, with support, what is known about familiar situations and materials, and suggests questions for investigation	Learner helps to clarify focus questions for investigation and describes the kind of information which would be needed to answer the question
Conducting investigations and collecting data		
Learner explores the possibilities in available materials, finding out how they can be used	Learner carries out instructions and procedures involving a small number of steps	Learner conducts simple tests or surveys and records observations or responses
Evaluating data and communicating findings		
Learner talks about observations and suggests possible connections to other situations	Learner reports on the group's procedure and the results obtained	Learner relates observations and responses to the focus question

Learning Outcome 2: Learners know, categorise, interpret and apply scientific, technological and environmental knowledge

Learners recall meaningful information when needed		
Learner, at the minimum, uses his/her most fluent language to name and describe objects, materials and organisms	Learner, at the minimum, uses his/her most fluent language to name and describe features and properties of objects, materials and organisms	Learner, at the minimum, describes the features which distinguish one category of thing from another
Learners categorise information to reduce complexity and look for patterns		
Learner sorts objects and organisms by a visible property	Learner creates his/her own categories of objects and organisms, and explains his/her rule for categorising	Learner categorises objects and organisms by two variables

Grade 7	Grade 8	Grade 9
Planning investigations		
Learner plans simple tests and comparisons, and considers how to make them fair	Learner identifies factors to be considered in investigations and plans ways to collect data on them, across a range of values	Learner plans a procedure to test predictions or hypotheses, with control of an interfering variable
Conducting investigations and collecting data		
Learner organises and uses equipment or sources to gather and record information	Learner collects and records information as accurately as equipment permits and investigation purposes require	Learner contributes to systematic data collection, with regard to accuracy, reliability and the need to control a variable
Evaluating data and communicating findings		
Learner generalises in terms of a relevant aspect and describes how the data supports the generalisation	Learner considers the extent to which the conclusions reached are reasonable answers to the focus question of the investigation	Learner seeks patterns and trends in the data collected and generalises in terms of simple principles
Learners recall meaningful information when needed		
Learner, at the minimum, recalls definitions and complex facts	Learner, at the minimum, recalls procedures, processes and complex facts	Learner, at the minimum, recalls principles, processes and models
Learners categorise information to reduce complexity and look for patterns		
Learner compares features of different categories of objects, organisms and events	Learner applies classification systems to familiar and unfamiliar objects/ events/organisms/materials	Learner applies multiple classifications to familiar and unfamiliar objects/ events/organisms/materials

Learning Outcome 2 (continued)

Grade 4	Grade 5	Grade 6
Learners interpret information		
Not applicable as a minimum standard at this Grade	Not applicable as a minimum standard at this Grade	Learner, at the minimum, interprets information by using alternative forms of the same information
Application of knowledge at Grade 4 to Grade 6 levels is seen in the actions of learners		
Not applicable as a minimum standard at this Grade	Not applicable as a minimum standard at this Grade	Not applicable as a minimum standard at this Grade

Learning Outcome 3: The learner is able to demonstrate an understanding of the inter-relationships between science and technology, society and the environment

Understanding science & technology in the context of history and indigenous knowledge		
Learner describes how local indigenous cultures have used scientific principles and technological products for specific purposes	Learner identifies ways that products and technologies have been adapted from other times and cultures	Learner describes similarities in problems and solutions in their own society and other societies present, past and possible future
Understanding impacts of science & technology on the environment and on people's lives		
Learner identifies features of technological devices around him/her and tells about their purpose and usefulness	Learner identifies the positive and negative effects of scientific developments or technological products on the quality of people's lives and/or the environment	Learner suggests ways to improve technological products or processes and to minimise negative effects on the environment

Grade 7	Grade 8	GRADE 9
Learners interpret information		
Learner interprets information by identifying key ideas in text, finding patterns in recorded data, and making inferences from information in various forms such as pictures, diagrams and text.	Not applicable as a minimum standard at this Grade Learner interprets information by translating tabulated data into graphs, reads data off graphs, makes predictions from patterns,	Learner interprets information by translating line graphs into text descriptions and vice versa, extrapolates from patterns in tables and graphs to predict how one variable will change, identifies relationships between variables from tables and graphs of data, hypothesises possible relationships between variables
Learners apply knowledge to problems that are not taught explicitly		
Learner applies conceptual knowledge by linking a taught concept to a variation of a familiar situation	Learner applies conceptual knowledge to somewhat unfamiliar situations by referring to appropriate concepts and processes	Learner applies principles and links relevant concepts to generate solutions to somewhat unfamiliar problems

Learning Outcome 3 (continued)

Grade 4	Grade 5	Grade 6
Recognising bias in science & technology which impacts on people's lives		
Learner identifies difficulties some people may have in using technological devices	Learner describes the impact that lack of access to technological products and services has on people	Learner suggests how technological products and services can be made accessible to those presently excluded

Grade 7	Grade 8	Grade 9
Understanding science as a human endeavour in cultural contexts		
Learner compares differing interpretations of events	Learner identifies ways in which people build confidence in their knowledge systems	Learner recognises differences in explanations offered by Natural Sciences and other systems of explanation
Understanding sustainable use of Earth resources		
Learner analyses information about sustainable and unsustainable use of resources	Learner identifies information required to make a judgement about resource use	Learner responds appropriately to knowledge about use of resources and environmental impacts

APPENDIX 2

STATEMENTS OF CORE KNOWLEDGE AND CONCEPTS

- **Core knowledge and concepts in Life and Living.**

Life processes and healthy living	Interactions in environments	Biodiversity, change and continuity
Unifying statement: *Living things, including humans and invisibly small organisms, can be understood in terms of life processes, functional units and systems.*	***Unifying statement:*** *Organisms in ecosystems are dependent for their survival on the presence of abiotic factors and on their relationship with other organisms.*	***Unifying statement:*** *The huge diversity of forms of life can be understood in terms of a history of change in environments and in characteristics of plants and animals throughout the world over millions of years*
Foundation Phase		
Foundation Phase 1 Many of our body parts correspond to parts of animals, such as limbs, heads, eyes, ears, feet, and in many cases they use them for the same purposes we do. **FdnPh 2.** Animals and plants have needs similar needs to ours, for food, water and air.	**FdnPh 3.** We depend on plants and animals for food, and we breed certain animals and grow certain plants as crops. **FdnPh 4.** We see cultural diversity in the kinds of food people like to eat. **FdnPh 5.** Some animals, like flies and ticks, carry germs which can make people sick.	**FdnPh 6.** There is a large variety of plants and animals, which have interesting visible differences but also similarities, and they can be grouped by their similarities. **FdnPh 7.** Plants and animals change as they grow and as the years pass, and as the seasons change.
Intermediate Phase		
Intermediate Phase 1 Green plants produce their own food and grow by using water and substances from the air and soil. Energy from light is needed to change these simple substances into food and plant material. Green plants are the only organisms that can produce food in their own bodies. **IntPh 2.** Living things need food for energy, to move, grow and to repair damage to their bodies ("tissues"). Animals including humans have digestive systems for getting nutrients from food. Humans need a balanced diet from certain groups of food, to be healthy. **IntPh 3.** All living things can respond to their	**IntPh 5.** Animals cannot make their own food, and so some animals eat plants for food while some animals eat other animals. All animals ultimately depend on green plants for their food. **IntPh 6.** Ecosystems are self-contained areas where a wide variety of plant and animal species live and reproduce. They depend on each other and on the non-living environment. The life and reproduction of all the organisms in an ecosystem depend on the continuing growth and reproduction of plants. **IntPh 7.** Organisms' habitats are the places where they feed, hide, produce young and, in many cases, shelter the young until the young have	**IntPh 10.** New plants can grow from certain parts of a parent plant. This is called vegetative reproduction and does not need seeds. The new plants have all the characteristics of the parent plant. **IntPh 11.** Sexual reproduction is the process by which two individual plants or animals produce another generation of individuals. The next generation's individuals look like the parents but always have slight differences ("variation") from their parents and from each other. **IntPh 12.** SA has a rich fossil record of animals and plants which lived many millions of years ago.

Life processes and healthy living	Interactions in environments	Biodiversity, change and continuity
environment in various ways; animals, including humans, have specialised sense organs. **IntPh 4.** Living things can move themselves; animals, including humans, can move themselves from place to place. Many species of animals move themselves by means of muscles attached to some kind of skeleton, which is either inside or on the surface of the body.	a better chance of survival. Animal species live in their habitats in a variety of social patterns (such as being solitary, pairing for life, or living in packs, prides, herds, troops or colonies). **IntPh 8.** Ecosystems depend on soil. Soil forms by natural processes from rock and dead plant and animal material, but it takes an extremely long time to form. Substances which plants take from the soil must be replaced to maintain fertility of the soil. (Link this with Planet Earth **IntPh11**) **IntPh 9.** Water plays an important role in ecosystems, sustaining both plant and animal life. Industrial, agricultural and domestic activities may have a serious impact on the quality and quantity of water available in an area. (Link this with Planet Earth **IntPh13**)	Many of those animals and plants were different from the ones we see nowadays. Some plants and animals nowadays have strong similarities to fossils of ancient plants and animals. We infer from the fossil record and other geological observations that the diversity of living things, natural environments and climates were different in those long-ago times. (Link this with Planet Earth **IntPh12**)
Senior Phase		
Senior Phase 1 Humans go through physical changes as they age; puberty means that the body is ready for sexual reproduction. **SenPh 2.** Human reproduction begins with the fusion of sex cells from mother and father, carrying the patterns for some characteristics of each. **SenPh 2.** Conception is followed by a sequence of changes in the mother's body, and during this period the future health of the unborn child can be affected **SenPh 3.** Knowledge of how to prevent the transmission of	**SenPh 9.** Human reproduction is more than conception and birth; it involves adults raising children, which requires judgement and values and usually depends on the behaviour of other people in a community and environment. **SenPh 10.** Each species of animal has characteristic behaviours which enable it to feed, find a mate, breed, raise young, live in a population of the same species, or escape threats in its particular environment. These behaviours have arisen over long periods of	**SenPh 15.** Offspring of organisms differ in small ways from their parents and generally from each other. This is called variation in a species. **SenPh 16.** selection kills those individuals of a species which lack the characteristics that would have enabled them to survive and reproduce successfully in their environment. Individuals which have characteristics suited to the environment reproduce successfully and some of their offspring carry the successful

Life processes and healthy living	Interactions in environments	Biodiversity, change and continuity
sexually transmitted diseases, including HIVirus, must be followed by behaviour choices. **SenPh 4.** Green plants use energy from the sun, water and carbon dioxide from the air to make food by photosynthesis. This chemical reaction is central to the survival of all organisms living on earth. **SenPh 5.** Animals, including humans, require protein, fat, carbohydrates, minerals, vitamins and water. Food taken in is absorbed into the body via the intestine. Surplus food is stored as fat or carbohydrate **SenPh 6.** Animals including humans have a circulatory system which includes the heart, veins, arteries and capillaries and which carries nutrients and oxygen to all parts of the body, and removes waste products. Oxygen, which is provided by the breathing system, reacts with food substances to release energy. (Link with Energy & Change **SenPh 1-3**) **SenPh 7.** All living things, including humans, have means of eliminating waste products which are produced during life processes. Water plays an important role in this process. **SenPh 8.** Water makes up a large proportion of all living things, and their health depends on water passing through them in various ways, using structures (such as kidneys, skin or	time that the species population has been living in the same environment. **SenPh 11.** All organisms have adaptations for survival in their habitats (such as adaptations for maintaining their water balance, obtaining and eating the kind of food they need, reproduction, protection or escape from predators). **SenPh 12.** An ecosystem maintains numerous food webs and competition for food among different individuals and populations. South Africa has certain ecosystems which have exceptional biodiversity. All uses of these areas must be based on principles of sustainable development **SenPh 13.** Pollution interferes with natural processes that maintain the inter-dependencies and diversity of an ecosystem **SenPh 14.** Many biological changes, including decomposition and recycling of matter in ecosystems, and human diseases, are caused by invisibly small, quickly-reproducing organisms.	characteristics. Natural selection is accelerated when the environment changes, and this can lead to the extinction of species. **SenPh 17.** Variations in human biological characteristics such as skin colour, height etc. have been used to categorise groups of people. These biological differences do not indicate differences in innate abilities of the groups concerned. Therefore, such categorisation of groups by biological differences is neither scientifically valid nor exact; it is a social construct. **SenPh 18.** Biodiversity enables ecosystems to sustain life and recover from changes to environment. Loss of biodiversity seriously affects the capacity of ecosystems and the earth, to sustain life. Classification is a means to organise the great diversity of organisms and make them easier to study. The two main categories of animals are the vertebrates and invertebrates, and among vertebrates the five classes are amphibians, birds, fish, reptiles and mammals. **SenPh 19.** Human activities, such as the introduction of alien species, habitat destruction, population growth, pollution and over-consumption result in the loss of biodiversity, which becomes evident when more species become endangered, or, ultimately, extinct.

Life processes and healthy living	Interactions in environments	Biodiversity, change and continuity
stomata) which can fulfil this function.		**SenPh 20.** Extinctions also occur through natural events. Mass extinctions have occurred in the past, suggesting that huge changes to environments have occurred. However, these changes occurred very slowly, compared to the fast rate at which humans can destroy plant and animal species. (Link with Planet Earth **SenPh14**) **SenPh 21.** The cell is the basic unit of most living things, and an organism may be formed from one or many cells. Cells themselves carry on life processes such as nutrition, respiration, excretion and reproduction, which sustain the life of the organism as a whole.

- **Core knowledge and concepts in Energy and Change.**

Energy transfers and systems	Energy and development in South Africa
Unifying statement: *Energy is transferred through biological or physical systems, from energy sources. With each energy transfer, some of the energy becomes less available for our use, and therefore we need to know how to control energy transfers.*	***Unifying statement:*** *Energy is available from a limited number of sources, and the sustainable development of countries in our region depends on the wise use of energy sources.*
Foundation Phase	
Foundation Phase 1 When we say we feel "full of energy", we mean we feel ready to move fast or do a lot of work.	**FdnPh 2.** People who do not have enough food or the right kind food to eat, feel tired and lack energy.
Intermediate Phase	
Intermediate Phase 1 There are sources of energy in nature which can be used for doing useful work; examples are wind, the Sun, fire, animals' muscles and falling water. Energy sources can be dangerous but can also be used in systems which people design, such as boats,	**IntPh 7.** Humans and animals get energy from eating plants and from eating animals that ate plants. The Sun

Energy transfers and systems	Energy and development in South Africa
windmills, carts, cookers and turbines. **IntPh 2.** A system is made of two or more parts that work together or affect each other. Systems may be as simple as two grindstones that crush grain between them, or have several parts, like an electrical circuit, or have many parts, like an ecosystem. Systems transfer energy from one part of the system to other parts. **IntPh 3.** We can design and make systems which store energy. Electric cells, stretched springs, food and chemicals which can react are examples of such systems. **IntPh 4.** An electrical circuit is a system. It is a path of electrical components and conductors with no breaks in it, and an energy source to make electric charges flow around the conducting path. The energy source may be cells or the "mains" electricity supply. The circuit transfers energy from the source to resistors such as bulbs, heating-wires, solenoids or motors in the circuit. (Link with Technology Learning Area) **IntPh 5.** Whenever a substance changes by expanding, contracting, melting evaporating, condensing or solidifying, it means that the substance has gained or given away some energy. (Link with Matter and Materials **IntPh5**) **IntPh 6.** Sound transfers energy from a vibrating body to our ears. Vibrations travel through a medium, which may be a solid, a liquid or a gas. We hear a change in the rate of vibration as a change in pitch.	provides energy for plants to grow and produce food. (Link with Life & Living **IntPh1 and 5**) **IntPh 8.** Energy from electrical sources can be dangerous and so we need safety rules for using electricity.
Senior Phase	
Senior Phase 1 Energy can be stored in a system as potential energy, either by the positions of the bulk parts of the system or by its particles (atoms and molecules) which have the potential to react with each other and release energy. Examples of potential energy are the stored energy of a compressed spring or the stored energy of particles which could react in a fuel-and-air mixture, or in the food and body of a living thing. **SenPh 2.** Stored energy can be released as kinetic energy in the motion of parts of the system, either in the motion of bulk parts of the system or in the motion of particles of the system. Examples of the release of kinetic energy are the motion of a released spring or the faster motion of the particles of hot gases when a fuel-air mixture burns, or the body movement of humans and animals. Kinetic energy is transferred to parts within the system and energy is also transferred to the system's surroundings. When energy is transferred, it causes changes in the system and the system's surroundings. **SenPh 3.** There is an unlimited number of systems which can be made to store or transfer energy. The possible systems include electrical, mechanical (including spring and friction systems), chemical, gravitational, nuclear, solar, biomass, optical (light), acoustical (sound) and thermal (heat) systems as well as human bodies and ecosystems. **SenPh 4.** All physical systems that people use (for example, appliances, vehicles and human bodies) waste some of the energy they receive,	**SenPh 9.** Energy sources such as wind, sun, and water in high dams are renewable. Fuels such as coal, gas and oil are not renewable energy sources, because they cannot be replaced (Link with Planet Earth **SenPh 15**) **SenPh 10.** Development and relief of poverty depends on energy supplies, particularly electrical energy, and the systems to deliver the energy to where it is needed. **SenPh 11.** Large-scale electricity supply depends on generation systems which use a few energy sources such as burning coal, nuclear reactions, burning gas and falling water. Use of any of these sources has

Energy transfers and systems	Energy and development in South Africa
and the wasted energy goes to heat up the surroundings. When the energy has gone into heating the surroundings, we can no longer use that energy to do work for us. **SenPh 5.** Hot objects transfer energy to colder objects, until the objects reach the same temperature. Hot objects transfer their energy, as heat, in three ways: by conduction, by convection and by radiation. These transfers may be useful or wasteful. Wasteful heat transfer can be controlled by reducing conduction, convection and radiation in a system. Similarly, useful heat transfer can be increased by improving conduction, convection and radiation in a system. **SenPh 6.** All organisms in an ecosystem need energy from other parts of the ecosystem. Energy is transferred from part to part of an ecosystem and each part retains only a fraction of the energy it received. (Link with Life & Living **SenPh13**). **SenPh 7.** Light travels away from a light-giving body until it strikes an object. The object may then absorb the light, or refract it or reflect it. Light transfers energy to other objects. (Link with Life & Living **SenPh5**) **SenPh 8.** Objects can exert forces on each other, thereby forming a system which can store or transfer energy. They may do so by physical contact or by forces which act through a field. Field forces are the magnetic, electric and gravitational forces. All forces act in pairs, so that if body A exerts a force on body B, B exerts an equal and opposite force on A.	environmental implications. For example, when coal is burned to generate electricity, gases are produced that affect the atmosphere and local and global environments. (Link with Planet Earth **SenPh 15** and **16**) **SenPh 12.** Other electricity-generation systems have smaller environmental impact but may cost more in the short term. Better design of buildings and appliances, and better practices in using energy, can save costs to consumers and lessen the environmental impact of exploiting energy sources **SenPh 13**. Many people in SA use wood for heating and cooking. Plants such as trees can be a renewable energy source if more trees are planted and the soil is managed well. (Link with Planet Earth **SenPh 15**)

- **Core knowledge and concepts in The Planet Earth and Beyond.**

Our Place in Space	Atmosphere and Weather	The Changing Earth
Unifying statement: *Our planet is a small part of a vast solar system in an immense galaxy.*	***Unifying statement:*** *The atmosphere is a system which interacts with the land, lakes and oceans and which transfers energy and water from place to place*	***Unifying statement:*** *The Earth is composed o materials which are continually being changed by forces on and under the surface*
Foundation Phase		
Foundation Phase 1 Many different objects can be observed in the sky. Examples are birds, clouds, aeroplanes, the Sun, stars, Moon, planets and satellites. All these objects have properties, locations and	**FdnPh 2.** Weather changes from day to day in ways that can be recorded and sometimes predicted. There are occasional unusual weather events like storms, floods or tornados which have impacts on people's lives.	**FdnPh 3.** Soil and rocks vary in appearance and texture from place to place. By investigation, learners can find out that some soils erode more easily than others do while some soil types support plant life better than others. They

Our Place in Space	Atmosphere and Weather	The Changing Earth
movements that can be investigated with a view to determining patterns, relationships and trends.		could investigate what some of the factors involved might be.
Intermediate Phase		
Intermediate Phase 1 Day and night may be explained by the rotation of the Earth on its own axis as it circles the Sun. **IntPh 2.** The Moon's apparent shape changes in a predictable way and these changes may be explained by its motion relative to the Earth and Sun. Many cultural traditions and special occasions are related to the shape or position of the Moon. **IntPh 3.** The stars' apparent positions in relation to each other do not change, but the nightly position of the star pattern as a whole changes slowly over the course of a year. Many cultures recognise and name particular star patterns, and have used them for navigation or calendars.	**IntPh 4.** Weather may change from day to day. Weather can be described by measurable quantities, such as temperature, wind direction and speed, and precipitation. **IntPh 5.** Other changes take longer to occur. An example of this type of medium term change is annual seasonal changes, which may be described in terms of changes in rainfall, average wind direction, length of day or night and average maximum and minimum temperatures. **IntPh 6.** Water changes its form as it moves in a cycle between the hydrosphere, atmosphere and lithosphere in what is known as the "water cycle." **IntPh 7.** Most of planet Earth is covered by water in the oceans. A small portion of the planet is covered by land that is separated into continents. At the poles there are ice caps. Only a small amount of the water is available for living things on land to use and only a small portion of the land is easily habitable by humans.	**IntPh 8.** Earth materials are solid rocks and soils, water, and the gases of the atmosphere. **IntPh 9.** Erosion of the land creates the landforms that we see and also results in the deposition of rock particles that may be lithified to form sedimentary rocks. Erosion and deposition can be very slow and gradual or it can occur in short catastrophic events like floods. **IntPh 10.** Rocks may be classified into igneous, sedimentary and metamorphic types. This classification is based on the origins and history of the rocks. **IntPh 11.** Soil consists of weathered rocks and decomposed organic material from dead plants, animals, and bacteria. Soil forms by natural processes, but it takes an extremely long time to form. Soils have properties of colour and texture, capacity to retain water, and ability to support the growth of many kinds of plants, including those in our food supply. (Link with Life & Living **IntPh 8**) **IntPh 12.** Fossils are the remains of life forms that have been preserved in stone. Fossils are evidence that life, climates and environments in the past were very different from that of today. (Link with Life &

Our Place in Space	Atmosphere and Weather	The Changing Earth
		Living **IntPh12**) **SenPh13.** The quality of water resources is determined by the quality of the catchment area. Proper care and management of catchment areas and water resources is essential, and factors affecting the quality of water resources and catchment areas may be investigated. (Link with Life & Living **IntPh9**)
Senior Phase		
Senior Phase 1 The Earth is the third planet from the Sun in a system that includes the Moon, the Sun, eight other planets and their Moons, and smaller objects, such as asteroids and comets. The Sun, an average star, is the central and largest body in the solar system. **SenPh 2.** Most objects in the solar system are in regular and predictable motion. The motions of the Earth and Moon explain such phenomena as the day, the year, phases of the Moon, and eclipses. **SenPh 3.** Gravity is the force that keeps planets in orbit around the Sun and governs the rest of the motion in the solar system. Gravity alone holds us to the Earth's surface. **SenPh 4.** The Sun is the major source of energy for phenomena on the Earth's surface, such as growth of plants, winds, ocean currents, and the water cycle. **SenPh 5.** Space exploration programmes involve international collaboration in the use of Earth-based	**SenPh 6.** The outer layers of the Earth are the atmosphere, hydrosphere and the lithosphere. We live in the biosphere, which is where all these layers interact to support life. **SenPh 7.** Climate varies in different parts of the globe. It tends to be cold in the Polar Regions and hot in the tropics. Different types of plants and animals are adapted to living in different climatic regions. (Link with Life & Living **SenPh12**) **SenPh 8.** The atmosphere is a mixture of nitrogen and oxygen in fairly constant proportions, and small quantities of other gases that include water vapour. The atmosphere has different properties at different elevations. **SenPh 9.** The atmosphere protects the Earth from harmful radiation and from most objects from outer space that would strike the Earth's surface. The atmosphere is the most important factor in keeping the Earth's surface temperature from falling	**SenPh 11.** The planet Earth has a layered structure, with a lithosphere, a hot, convecting mantle and a dense, metallic core. **SenPh 12.** Lithospheric plates larger than some continents constantly move at rates of centimetres per year, in response to movements in the mantle. Major geological events, such as Earthquakes, volcanic eruptions, and mountain building, result from these plate motions. **SenPh 13.** Land forms are the result of a combination of constructive and destructive forces. Constructive forces include crustal deformation, volcanic eruption, and deposition of sediment, while destructive forces include weathering and erosion. **SenPh 14.** Many of the organisms in SA's fossil record cannot be easily classified into groups of organisms alive today, and some are found in places where present-day conditions would not be suitable for them. This is evidence that life and

Our Place in Space	Atmosphere and Weather	The Changing Earth
telescopes (such as SALT in South Africa) and telescopes in orbit. Robotic space-craft travel long distances to send back data about the planets and other bodies in our solar system, and research is being done on ways to send people to investigate the planet Mars.	too low or rising too high to sustain life. **SenPh 10.** Human activities and natural events can slightly change the composition and temperature of the atmosphere. Some effects of these small changes may be changes in annual weather patterns and long-term changes in rainfall and climate	conditions on the surface of Earth have changed through time. (Link with Life & Living **SenPh21**) **SenPh 15.** Fossil fuels such as coal, gas and oil are the remains of plants and animals that were buried and fossilised at high pressures. These fuels are not renewable in our lifetimes. (Link with Energy and Change **SenPh9**) **SenPh 16.** Mining is a major industry in South Africa, with local examples in all the nine provinces. It is important in terms of the supply of coal for energy, essential raw materials for other industries, employment and earnings for the country. A great number of other industries depend on the mining industry. Legislation controls mining, with regard to safety and environmental effects.

- **Core knowledge and concepts in Matter and Materials.**

Properties and uses of materials	Structure, reactions and changes of materials
Unifying statement: *We can classify materials by their properties, in order to establish types and patterns. Properties determine the selection of materials for particular uses.*	***Unifying statement:*** *We can modify materials in ways we choose, through our understanding of their sub-structure.*
Foundation Phase	
Foundation Phase 1 Materials have different properties such as texture, colour, strength and heaviness, and can be classified by these properties. We make things with materials which have the properties we want.	**FdnPh 2.** Substances can be mixed and sometimes changes can be seen, such as the dissolving of a solid or new colours when food colourings/paints are mixed

Properties and uses of materials	Structure, reactions and changes of materials
Intermediate Phase	
Intermediate Phase 1 Pure substances have melting temperatures and boiling temperatures which are characteristic for each substance, and help us to identify the substance. **IntPh 2.** Materials are evaluated and classified by their properties (such as hardness, flexibility, thermal conductivity or insulation, electrical conductivity or insulation, and whether they can be magnetised) and properties such as solubility and rusting. **IntPh 3.** Major classes of materials are metals, ceramics (including glasses) and polymers (including plastics and fibres). Composite materials combine the properties of two or more materials.	**IntPh 4.** Some changes to materials are temporary but other changes are permanent. **IntPh 5.** Substances change when they receive or lose energy as heat. These changes include contraction and expansion, melting, evaporation, condensation and solidification. (Link with Energy and Change **IntPh 5**) **IntPh 6.** The dissolving of a substance in a solvent depends on variables which affect the rate of dissolving.
Senior Phase	
Senior Phase 1 Substances in different states ("phases") have distinct properties such as crystalline structures, or compressibility/ incompressibility or tendency to diffuse. **SenPh 2.** Dark-coloured surfaces get hotter than light-coloured surfaces when exposed to radiating sources of energy like the Sun. Dark-coloured objects radiate their energy as heat more readily than shiny light-coloured objects. (Link with Energy & Change **SenPh5 and 7**) **SenPh 3.** Some materials are magnetised by electric currents or magnets. Some materials can be electrically charged by rubbing them with a different material. (Link with Energy & Change **SenPh8**) **SenPh 4.** Some conductors and circuit components reduce the current in an electric circuit to a significant extent and are called resistors. Resistors can be selected or designed to control currents. **SenPh 5.** A pure substance cannot be separated into different substances, while a mixture can be separated, usually by physical means. Differences in properties can be used to separate mixtures of different substances (by methods such as filtration, distillation, evaporation, chromatography or magnetism). (Link with Matter & materials **SenPh7** below) **SenPh 6.** Specific gases may be separated from the air or produced in reactions, and have many uses in industry and other sectors of the economy. Oxygen, hydrogen and carbon dioxide have characteristic properties and reactions by which we can identify them. **SenPh 7.** Extracting useful materials from raw materials depends on chemical reactions and methods of separation **SenPh 8.** Raw materials, from which processed materials are made, must be mined, grown or imported from other countries Raw materials that are mined are non-renewable and mining has environmental costs. Growing raw materials involves choices about the use of arable land and water catchment areas.	**SenPh 9.** A particle model of matter can explain physical changes of substances such as melting, evaporation, condensation, solidification, diffusion and heating by conduction. **SenPh 10.** Many household substances are acidic or basic. Indicators are substances that react with acids and soluble bases to produce products that have distinctive colours. Acids and bases neutralise one another to form salts. Acids have characteristic reactions with metals, metal oxides, hydroxides and carbonates. **SenPh 11.** Many chemical reactions need some energy to get started; many chemical reactions give off energy as they happen. **SenPh 12.** Elements are made of just one kind of atom, whereas compounds are made of two or more kinds of atoms in fixed proportions.

Properties and uses of materials	Structure, reactions and changes of materials
	Elements may react to form compounds, and compounds may be decomposed into their elements. Energy input is needed to break a compound into its elements, whereas energy is given out when elements react to form a compound. **SenPh 13.** Oxygen has characteristic reactions with metals and non-metals, forming oxides. Some of these oxides dissolve in water to form acidic or alkaline solutions. Some metals react more readily with oxygen than other metals. Corrosion of iron is an economically important reaction which can be prevented through an understanding of the reactions between iron, water and oxygen. **SenPh 14.** The reaction of oxygen with food releases energy in the cells of living things. (Link with Life & Living **SenPh7**)