education

Department:
Education
REPUBLIC OF SOUTH AFRICA

NATIONAL CURRICULUM STATEMENT GRADES 10-12 (GENERAL)

SUBJECT ASSESSMENT GUIDELINES

LIFE SCIENCES

JANUARY 2008

PREFACE TO SUBJECT ASSESSMENT GUIDELINES

The Department of Education has developed and published Subject Assessment Guidelines for all 29 subjects of the National Curriculum Statement (NCS). These Assessment Guidelines should be read in conjunction with the relevant Subject Statements and Learning Programme Guidelines.

Writing Teams established from nominees of the nine provincial education departments and the teacher unions formulated the Subject Assessment Guidelines. The draft copies of the Subject Assessment Guidelines developed by the Writing Teams were sent to a wide range of readers, whose advice and suggestions were considered in refining these Guidelines. In addition, the Department of Education field-tested the Subject Assessment Guidelines in 2006 and asked for the comments and advice of teachers and subject specialists.

The Subject Assessment Guidelines are intended to provide clear guidance on assessment in Grades 10 to 12 from 2008.

The Department of Education wishes you success in the teaching of the National Curriculum Statement.

CONTENTS

1. PURPOSE OF THE SUBJECT ASSESSMENT GUIDELINES

This document provides guidelines for assessment in the National Curriculum Statement Grades 10 - 12 (General). The guidelines must be read in conjunction with *The National Senior Certificate: A Qualification at Level 4 on the National Qualifications Framework (NQF)* and the relevant Subject Statements. The Subject Assessment Guidelines will be applicable for Grades 10 to 12 from 2008.

The Department of Education encourages teachers to use these guidelines as they prepare to teach the National Curriculum Statement. Teachers should also use every available opportunity to hone their assessment skills. These skills relate both to the setting and marking of assessment tasks.

2. ASSESSMENT IN THE NATIONAL CURRICULUM STATEMENT

2.1 Introduction

Assessment in the National Curriculum Statement is an integral part of teaching and learning. For this reason, assessment should be part of every lesson and teachers should plan assessment activities to complement learning activities. In addition, teachers should plan a formal year-long Programme of Assessment. Together the informal daily assessment and the formal Programme of Assessment should be used to monitor learner progress through the school year.

Continuous assessment through informal daily assessment and the formal Programme of Assessment should be used to:

- develop learners' knowledge, skills and values
- assess learners' strengths and weaknesses
- provide additional support to learners
- revisit or revise certain sections of the curriculum and
- motivate and encourage learners.

In Grades 10 and 11 all assessment of the National Curriculum Statement is internal. In Grade 12 the formal Programme of Assessment which counts 25% is internally set and marked and externally moderated. The remaining 75% of the final mark for certification in Grade 12 is externally set, marked and moderated. In Life Orientation however, all assessment is internal and makes up 100% of the final mark for promotion and certification.

2.2 Continuous assessment

Continuous assessment involves assessment activities that are undertaken throughout the year, using various assessment forms, methods and tools. In Grades 10-12 continuous assessment comprises two different but related activities: informal daily assessment and a formal Programme of Assessment.

2.2.1 Daily assessment

The daily assessment tasks are the planned teaching and learning activities that take place in the subject classroom. Learner progress should be monitored during learning activities. This informal daily monitoring of progress can be done through question and answer sessions; short assessment tasks completed during the lesson by individuals, pairs or groups or homework exercises.

Individual learners, groups of learners or teachers can mark these assessment tasks. Self-assessment, peer assessment and group assessment actively involves learners in assessment. This is important as it allows learners to learn from and reflect on their own performance.

The results of the informal daily assessment tasks are not formally recorded unless the teacher wishes to do so. In such instances, a simple checklist may be used to record this assessment. However, teachers may use the learners' performance in these assessment tasks to provide verbal or written feedback to learners, the School Management Team and parents. This is particularly important if barriers to learning or poor levels of participation are encountered.

The results of these assessment tasks are not taken into account for promotion and certification purposes.

2.2.2 Programme of Assessment

In addition to daily assessment, teachers should develop a year-long formal Programme of Assessment for each subject and grade. In Grades 10 and 11 the Programme of Assessment consists of tasks undertaken during the school year and an end-of-year examination. The marks allocated to assessment tasks completed during the school year will be 25%, and the end-of-year examination mark will be 75% of the total mark. This excludes Life Orientation.

In Grade 12, the Programme of Assessment consists of tasks undertaken during the school year and counts 25% of the final Grade 12 mark. The other 75% is made up of externally set assessment tasks. This excludes Life Orientation where the internal assessment component counts 100% of the final assessment mark.

The marks achieved in each assessment task in the formal Programme of Assessment must be recorded and included in formal reports to parents and School Management Teams. These marks will determine if the learners in Grades 10 and 11 are promoted. In Grade 12, these marks will be submitted as the internal continuous assessment mark. Section 3 of this document provides details on the weighting of the tasks for promotion purposes.

2.2.2.1 Number and forms of assessment required for Programmes of Assessment in Grades 10 and 11

The requirements for the formal Programme of Assessment for Grades 10 and 11 are summarised in Table 2.1. The teacher must provide the Programme of Assessment to the subject head and School Management Team before the start of the school year. This will be used to draw up a school assessment plan for each of the subjects in each grade. The proposed school assessment plan should be provided to learners and parents in the first week of the first term.

Table 2.1: Number of assessment tasks which make up the Programme of Assessment by subject in Grades 10 and 11

SUBJECTS		TERM 1	TERM 2	TERM 3	TERM 4	TOTAL
Language 1: Home Language		4	4*	4	4*	16
Language 2: Choice of HL or FAL	HL	4	4*	4	4*	16
	FAL	4	4*	4	4*	16
Life Orientation		1	1*	1	2*	5
Mathematics or Maths Literacy		2	2*	2	2*	8
Subject choice 1**		2	2*	2	1*	7
Subject choice 2**		2	2*	2	1*	7
Subject choice 3		2	2*	2	1*	7

Note:

* One of these tasks must be an examination

** If one or two of the subjects chosen for subject choices 1, 2 or 3 include a Language, the number of tasks indicated for Languages 1 and 2 at Home Language (HL) and First Additional Language (FAL) are still applicable. Learners who opt for a Second Additional Language are required to complete 13 tasks in total: 4 tasks in term 1 and 3 tasks in each of terms 2, 3 and 4.

Two of the assessment tasks for each subject must be examinations. In Grades 10 and 11 these examinations should be administered in mid-year and November. These examinations should take account of the requirements set out in Section 3 of this document. They should be carefully designed and weighted to cover all the Learning Outcomes of the subject.

Two of the assessment tasks for all subjects, excluding Life Orientation, should be tests written under controlled conditions at a specified time. The tests should be written in the first and third terms of the year.

The remainder of the assessment tasks should not be tests or examinations. They should be carefully designed tasks, which give learners opportunities to research and explore the subject in exciting and varied ways. Examples of assessment forms are debates, presentations, projects, simulations, written reports, practical tasks, performances, exhibitions and research projects. The most appropriate forms of assessment for each subject are set out in Section 3. Care should be taken to ensure that learners cover a variety of assessment forms in the three grades.

The weighting of the tasks for each subject is set out in Section 3.

2.2.2.2 Number and forms of assessment required for Programme of Assessment in Grade 12

In Grade 12 all subjects include an internal assessment component, which is 25% of the final assessment mark. The requirements of the internal Programme of Assessment for Grade 12 are summarised in Table 2.2. The teacher must provide the Programme of Assessment to the subject head and School Management Team before the start of the school year. This will be used to draw up a school assessment plan for each of the subjects in each grade. The proposed school assessment plan should be provided to learners and parents in the first week of the first term.

Table 2.2: Number of assessment tasks which make up the Programme of Assessment by subject in Grade 12

SUBJECTS		TERM 1	TERM 2	TERM 3	TERM 4	TOTAL
Language 1: Home Language		5	5*	4*		14
Language 2: Choice of HL or FAL	HL	5	5*	4*		14
	FAL	5	5*	4*		14
Life Orientation		1	2*	2*		5
Mathematics or Maths Literacy		3	2*	2*		7
Subject choice 1**		2	2*	(2*) 3*		(6[#]) 7
Subject choice 2**		2	2*	(2*) 3*		(6[#]) 7
Subject choice 3		2	2*	(2*) 3*		(6[#]) 7

Note:

* One of these tasks in Term 2 and/or Term 3 must be an examination

** If one or two of the subjects chosen for subject choices 1, 2 or 3 include a Language, the number of tasks indicated for Languages 1 and 2 at Home Language (HL) and First Additional Language (FAL) are still applicable. Learners who opt for a Second Additional Language are required to complete 12 tasks in total: 5 tasks in term 1, 4 tasks in term 2 and 3 tasks in term 3.

[#] The number of internal tasks per subject differs from 6 to 7 as specified in Section 3 of this document.

Schools can choose to write one or two internal examinations in Grade 12. Should a school choose to write only one internal examination in Grade 12, a scheduled test should be written at the end of the term to replace the other examination. Internal examinations should conform to the requirements set out in Section 3 of this document. They should be carefully designed and weighted to cover all the Learning Outcomes of the subject.

Two of the assessment tasks for all subjects, excluding Life Orientation, should be tests written under controlled conditions at a specified time.

The remainder of the assessment tasks should not be tests or examinations. They should be carefully designed tasks, which give learners opportunities to research and explore the subject in exciting and focused ways. Examples of assessment forms are debates, presentations, projects, simulations, assignments, case studies, essays, practical tasks, performances, exhibitions and research projects. The most appropriate forms of assessment for each subject are set out in Section 3.

2.3 External assessment in Grade 12

External assessment is only applicable to Grade 12 and applies to the final end-of-year examination. This makes up 75% of the final mark for Grade 12. This excludes Life Orientation which is not externally examined.

The external examinations are set externally, administered at schools under conditions specified in the *National policy on the conduct, administration and management of the assessment of the National Senior Certificate: A qualification at Level 4 on the National Qualifications Framework (NQF)* and marked externally.

In some subjects the external assessment includes practical or performance tasks that are externally set, internally assessed and externally moderated. These performance tasks account for one third of the end-of-year external examination mark in Grade 12 (that is 25% of the final mark). Details of these tasks are provided in Section 3.

Guidelines for the external examinations are provided in Section 3.

2.4 Recording and reporting on the Programme of Assessment

The Programme of Assessment should be recorded in the teacher's portfolio of assessment. The following should be included in the teacher's portfolio:

- a contents page;
- the formal Programme of Assessment;
- the requirements of each of the assessment tasks;
- the tools used for assessment for each task; and
- record sheets for each class.

Teachers must report regularly and timeously to learners and parents on the progress of learners. Schools will determine the reporting mechanism but it could include written reports, parent-teacher interviews and parents' days. Schools are required to provide written reports to parents once per term on the Programme of Assessment using a formal reporting tool. This report must indicate the percentage achieved per subject and include the following seven-point scale.

RATING CODE	RATING	MARKS %
7	Outstanding achievement	80 – 100
6	Meritorious achievement	70 –79
5	Substantial achievement	60 – 69
4	Adequate achievement	50 – 59
3	Moderate achievement	40 – 49
2	Elementary achievement	30 – 39
1	Not achieved	0 – 29

2.5 Moderation of the assessment tasks in the Programme of Assessment

Moderation of the assessment tasks should take place at three levels.

LEVEL	MODERATION REQUIREMENTS
School	The Programme of Assessment should be submitted to the subject head and School Management Team before the start of the academic year for moderation purposes. Each task which is to be used as part of the Programme of Assessment should be submitted to the subject head for moderation before learners attempt the task. Teacher portfolios and evidence of learner performance should be moderated twice a year by the head of the subject or her/his delegate.
Cluster/ district/ region	Teacher portfolios and a sample of evidence of learner performance must be moderated twice during the first three terms.
Provincial/ national	Teacher portfolios and a sample of evidence of learner performance must be moderated once a year.

3. ASSESSMENT OF LIFE SCIENCES IN GRADES 10-12

3.1 Introduction

The purpose of assessment in Life Sciences is to determine the competencies of learners in scientific inquiry, problem solving, critical thinking and application of knowledge relevant to Life Sciences. Assessment in the Life Sciences is driven by the three Learning Outcomes through the relevant Assessment Standards. When the Assessment Standards are achieved, then the relevant Learning Outcomes will be considered achieved. The Assessment Standards can be attained through a variety of assessment tasks.

The three Life Sciences Learning Outcomes are differently weighted and each Learning Outcome includes three Assessment Standards. The three Assessment Standards should be addressed at least once in each of the four Life Sciences knowledge areas to cover the Learning Outcomes.

Life Sciences knowledge areas are:

- Tissues, Cells and Molecular Studies
- Structure, Control and Processes in Basic Life Systems of Plants and Humans
- Environmental Studies
- Diversity, Change and Continuity

3.2 Daily assessment in Life Sciences

Daily assessment in Life Sciences provides learners with multiple opportunities to improve and master their scientific inquiry, problem solving, critical thinking and application of knowledge competencies before being assessed in these competencies in the Programme of Assessment. Therefore, daily assessment is developmental in nature and a variety of assessment tasks can be used to develop learners' Life Sciences competencies. For example, tasks such as a concept or mind mapping exercise on nutrition which involves the drawing up of a balanced diet for peers suffering from obesity and/or other forms of malnutrition are not marked for promotion purposes but enhance learners understanding of various concepts in Life Sciences. Practical experiments ground learners in scientific processes. As it is not necessary to record daily assessment for the formal Programme of Assessment or promotion mark, qualitative rubrics and rating scales can be used to monitor learner progress.

3.3 Assessment in Grades 10 and 11

3.3.1 Programme of Assessment in Grades 10 and 11

The Programme of Assessment for Life Sciences in Grades 10 and 11 consists of seven tasks which are internally assessed. Of the seven tasks, the six tasks which are completed during the school year make up 25% of the total mark for Life Sciences, while the end-of-year examination is the seventh task and makes up the remaining 75%.

Two of the tasks should be tests and two examinations in the Grade 10 and 11 Programmes of Assessment. In addition, Life Sciences learners should be assessed in three other tasks such as two **practicals** and one **research project**.

Table 3.1 indicates the suggested tasks for the Programme of Assessment in Grades 10 and 11.

Table 3.1: Suggested tasks for the Programme of Assessment in Grades 10 and 11

FORMS OF ASSESSMENT	**PROGRAMME OF ASSESSMENT**					
	Assessment Tasks					End-of-year assessment
	25 %					75 %
	Practical tasks		Research project	Controlled tests	Midyear exams	November Exam
Number of pieces	**2**		**1**	**2**	**1**	**1**
Marks	**25**	**25**	**20**	**20**	**10**	**300**
Sub-totals	**100**					**300**
Grand Total	**400**					

Practical tasks

Practical tasks can take the form of hands-on activities or hypothesis testing (see Appendix 1 for a hypothesis testing example). In practical activities Life Sciences learners will be assessed on their ability to:

- Follow instructions.
- Make accurate observations.
- Work safely.
- Manipulate and use apparatus effectively.
- Measure accurately.
- Handle materials appropriately.
- Gather data.
- Record data appropriately – drawings, graphs, etc.

Research projects

When designing a research task Life Sciences teachers must ensure that:

- it is an investigative task;
- it addresses Learning Outcome 1, Learning Outcome 2 and Learning Outcome 3;

- a relevant model could support the written and oral presentation; or alternatively if a model is used as part of the project then it should be accompanied by a written or oral presentation;
- it is a long-term task;
- detailed guidelines are provided and where appropriate relevant resources should be made known and/or provided to learners; and
- it focuses on the accessing of knowledge through literature research and primary sources such as people, texts, etc.

See Appendix 2 for an example of a Grade 10 research project.

Tests and the midyear examination

When designing a test and the midyear examination the Life Sciences teacher must ensure that:

- The test in the first term covers all the work dealt with in this term.
- The midyear examination assesses work done in the first and second terms.
- The test set in the third term covers work done in the third term.
- All Learning Outcomes must be assessed using the knowledge areas that were covered in the particular term or terms.
- Tests and examinations must be balanced in terms of the use of cognitive levels (e.g. Bloom's taxonomy) and Learning Outcomes and Assessment Standards.
- Tests and examinations should be analysed diagnostically and appropriate remedial or intervention strategies should be instituted.

The weighting grid provided below should be used to set these tests and examinations:

Table 3.2 Weighting grid: Life Sciences

Learning Outcome 1	Learning Outcome 2	Learning Outcome 3
40 %	**40 %**	**20 %**

3.3.2 End-of-year examinations for Grades 10 and 11

All end-of-year examinations for Grades 10 and 11 should consist of TWO papers, namely Paper 1 and Paper 2:

- **Paper 1** comprises the following two knowledge areas:
  - Tissues, Cells and Molecular Studies
  - Structure and Control of Processes in Basic Life Systems

- **Paper 2** comprises the following two knowledge areas:
  - Environmental Studies
  - Diversity, Change and Continuity

While the knowledge area focussed on in each of the two papers will differ, the format of Papers 1 and 2 are similar:

- Duration – 2½ hours
- Mark allocation – 150 marks

The following grids can be used when setting Grade 10 and 11 examination papers for Life Sciences:

Weighting grid for Paper 1

Question number	Cognitive ability levels				LO1	LO2	LO3	Knowledge areas	
	A	B	C	D				Tissues, Cells, etc.	Structure, Processes
ACTUAL MARKS									
NORM: %	50%		50%		40%	40%	20%	40%	60%
MARKS	75		75		60	60	30	60	90

Weighting grid for Paper 2

Question number	Cognitive ability levels				LO1	LO2	LO3	Knowledge areas	
	A	B	C	D				Environ-mental Studies	Diversity, Change
ACTUAL MARKS									
NORM: %	50%		50%		40%	40%	20%	50%	50%
MARKS	75		75		60	60	30	75	75

The following table provides an indication of the ability levels of assessment for examinations in Life Sciences:

BLOOM'S CATEGORY NAME	CATEGORY REFERENCE	ITEM RECOGNITION DETAILS	WEIGHTING %
KNOWLEDGE	A	Items assess recall of facts	30
COMPREHENSION • Interpretive • Verbal • Numerical	B (BI) (BV) (BN)	Items require more than "A" and assess understanding of routine and familiar material: e.g. from verbal to symbolic and/or from symbolic to verbal e.g. explanations e.g. standard exercises	20
APPLICATION	C	Items require the application of abstractions and generalisations to new, novel or unfamiliar situations	30
HIGHER ABILITIES: • Analysis • Synthesis • Evaluation	D	Items require: • Analysis of data and pattern recognition • Synthesis of data • Evaluation of data against given criteria	20

Suggested outline for each paper:

SECTION	DESCRIPTION	MARKS
A	• Consists of a variety of question types such as multiple-choice questions, terminology, matching items, diagrams, etc.	50
B	• Consists of two questions of 30 marks each or three questions of 20 marks each which assess a variety of skills and competences. • Questions may have sub-questions. • Questions may be based on data in various forms, paragraphs, drawings, etc.	60
C	• The first part to this section consists of one question based on a case study or questions based on data analysis and interpretation. • The second part consists of an essay. • While the essay should focus on Learning Outcome 3, it should also assess the other Learning Outcomes.	40

3.4 Assessment in Grade 12

In Grade 12, assessment consists of two components: a Programme of Assessment which makes up 25% of the total mark for Life Sciences and external assessment which makes up the remaining 75%. The Programme of Assessment tasks are all internally assessed. The external assessment component is the end-of-year examination which makes up the remaining 75%.

Table 3.3: Suggested assessment tasks for Grade 12

FORMS OF ASSESSMENT	PROGRAMME OF ASSESSMENT					EXTERNAL ASSESSMENT
	Assessment Tasks					End-of-year assessment
	25 %					75 %
	Practical tasks		Assignment	Controlled tests	Midyear and trial exams	November Exam
Number of pieces	**2**		**1**	**2**	**2**	**1**
Marks	**20**	**20**	**20**	**20**	**20**	**300**
Sub-totals	**100**					**300**
Grand Total	**400**					

3.4.1 Programme of Assessment in Grade 12

The Programme of Assessment for Life Sciences in Grade 12 consists of 7 tasks. Of the 7 tasks, two are examinations and two are tests. The remaining three tasks must consist of different forms of assessment such as two practicals and an assignment.

In Grade 12 one of the tasks in Term 2 and/or Term 3 must be an internal examination. In instances where only one of the two internal examinations is written in Grade 12, the other examination should be replaced by a test at the end of the term.

Assignments
An assignment is a short task of 1 to 1½ hours and includes activities such as translation activities, analysis and interpretations of data, and drawing and justifying of conclusions.

Practical tasks
These are the same as for Grades 10 and 11. However, in addition Grade 12 learners will be assessed on their ability to:

- Make deductions and evaluations.

Tests and internal exams
When designing a test and the midyear and September examinations, the Life Sciences teacher must ensure that:

- The test in the first term assesses all work covered in this term – up to a third of the marks could include Grade 11 work.
- Midyear examination assesses work done in the first and second terms.
- Third term examinations (trial or preparatory) assess all work done up until that point.
- All Learning Outcomes must be covered using the knowledge area that was covered in the particular term or terms.
- Tests and examinations are balanced in terms of the use of cognitive levels (e.g. Bloom's taxonomy) and Learning Outcomes and Assessment Standards.
- Tests and exams are internally and externally moderated.
- The tests and exams are analysed diagnostically and appropriate remedial or intervention strategies should be instituted.

3.4.2 External assessment in Grade 12

The Grade 12 external examination for Life Sciences consists of two 2½-hour papers counting 150 marks each.

- **Paper 1** comprises the following two knowledge areas:
  - Tissues, Cells and Molecular Studies (60%)
  - Structure and Control of Processes in Basic Life Systems (40%)

- **Paper 2** comprises the following two knowledge areas:
  - Environmental Studies (50%)
  - Diversity, change and continuity (50%)

The format of Papers 1 and 2 are similar to those for Grades 10 and 11 as indicated in section 3.3.2.

3.5 Promotion and certification

Promotion is based on learner performance in tasks completed in the Programme of Assessment in Grades 10 and 11. Therefore, all the results of the various components of the Programme of Assessment must be converted into a numerical score. The final score must then be converted into a code as indicated on the national rating scale in section 2.4. An achievement of a rating code 2

(Elementary achievement: 30%-39%) is the minimum code required for a learner to progress to the next grade in Life Sciences.

3.6 Monitoring and moderation of internal assessment

The assessment tasks and tools designed by a Life Sciences teacher should be moderated by a senior Life Sciences teacher and/or the head of Life Sciences at the school. Alternately, a senior teacher from a neighbouring school can be asked to assist with the moderation of tasks. The head of the department or a senior subject teacher for Life Sciences is responsible for the internal moderation of the Life Sciences formal assessment tasks of learners within a school.

APPENDIX 1: HYPOTHESIS TESTING

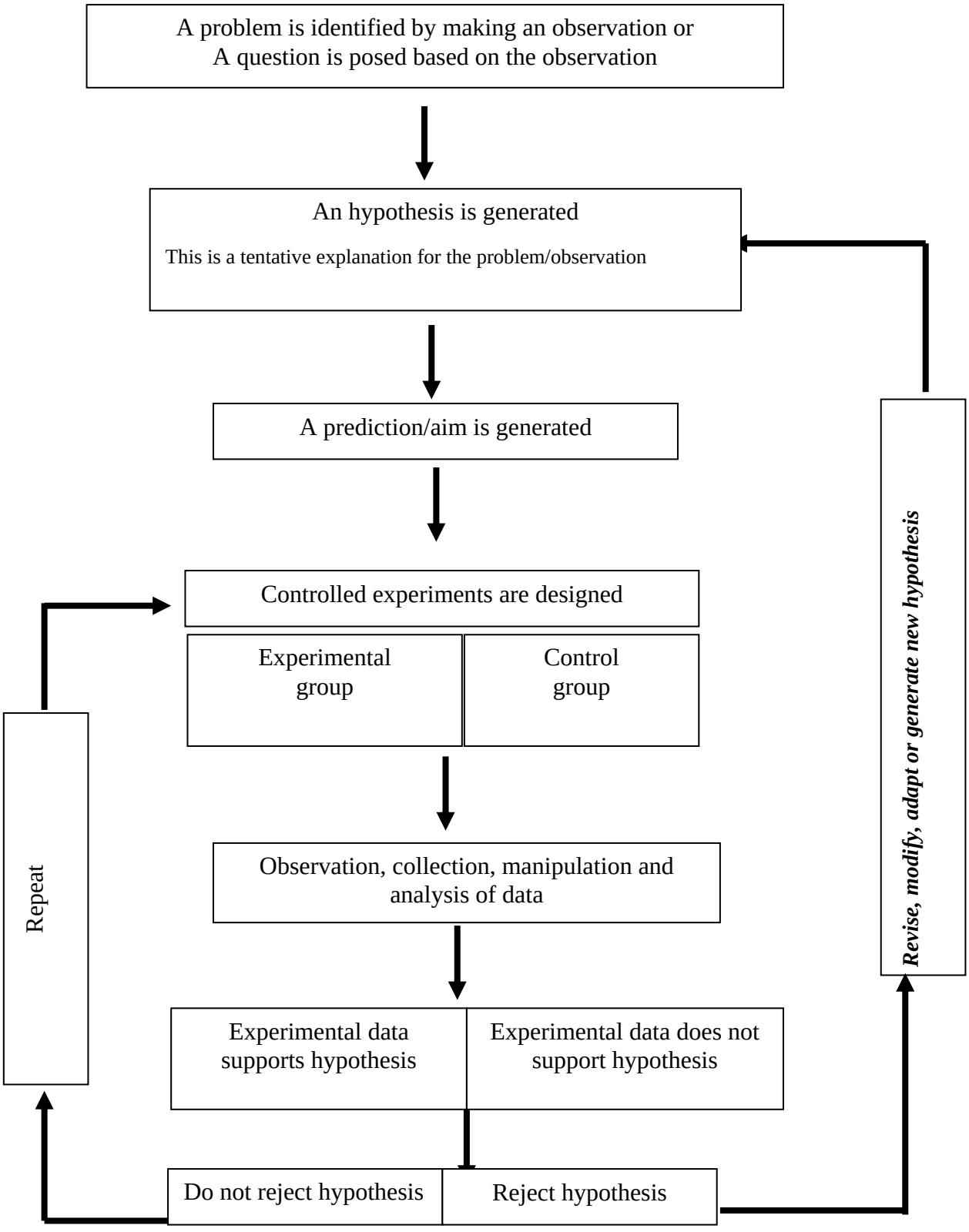
The 'hypothesis testing' approach to assessment has not commonly been used in teaching of Life Sciences. The knowledge, skills and values which feature in the Life Sciences curriculum, however, encourage tasks that call for a higher level of knowledge and skills than those required in a hands-on practical. In Hypothesis testing the Life Sciences learners are assessed on their ability to:

- Use scientific knowledge and understanding to turn ideas into a form that can be investigated, in other words identify a problem.
- Recognise, generate and state alternative hypotheses.
- Generate logical or appropriate predictions.
- Make deductions.
- Consider the factors which need to be taken into account in investigations.
- Plan and conduct controlled experiments to test a hypothesis.
- Draw up procedures for the investigation taking into account the observations or measurements which need to be made and how these are to be used.
- Select appropriate apparatus, instruments and techniques for the investigation.
- Collect, organise and record data appropriately.
- Interpret, analyse, evaluate and synthesise data.
- Draw and apply reasonable conclusions.

The following flow diagram presents a summary of the scientific method.

ASSESSING HYPOTHESIS TESTING INVESTIGATIONS

SUMMARY OF THE SCIENTIFIC METHOD



Notes on Hypothesis Testing

Introduction

Experiments in Life Sciences do not claim to prove that a particular phenomenon occurs. The most an experiment can claim is that the results do not disprove the prediction or proposal. This inability to 'prove' that a particular proposal is 'true' is a feature of many scientific experiments. One way that science progresses is by putting forward a hypothesis, making predictions from the hypothesis and then testing these predictions by experiments. A hypothesis is an attempt to explain some event or observation using whatever information is currently available. The hypothesis is rejected or altered if the result of the experiment does not confirm the predictions.

Skills development

Skills development combines hands-on and minds-on activities and involves investigative work. This type of activity is useful to develop and assess the following three broad skills:

- Planning experimental procedures
- Obtaining evidence
- Interpreting and evaluating

Learners can demonstrate competence in each of the above skills in the following ways:

Planning

- Use scientific knowledge and understanding to turn ideas into a form that can be investigated.
- Make predictions where appropriate.
- Consider the factors which need to be taken into account in investigations.
- Draw up procedures for the investigation taking into account the observations or measurements which need to be made and how these are to be used.
- Select appropriate apparatus, instruments and techniques for the investigation taking into account criteria, for example, the range and accuracy of the measurements and observations required and the need for safe working procedures.

Obtaining evidence

- Use apparatus and materials in a safe and competent manner.
- Use apparatus and instruments to make observations and measurements to an appropriate degree of accuracy.
- Understand the need, where appropriate, to repeat measurements.
- Record observations or measurements systematically using methods appropriate to the information collected and to the purpose of the investigation.

Interpreting and evaluating

- Present results in appropriate ways to the data collected and the purpose of the investigation, including, where appropriate the use of graphs.
- Interpret and evaluate results using, where appropriate, mathematical relationships.

- Identify any trends, patterns and conclusions emerging from consideration of results.
- Draw valid conclusions and decide whether these conclusions agree with the original data.
- Explain the conclusions in light of their scientific knowledge and understanding.
- Consider observations and measurements, including anomalies and sources of error, and suggest, where appropriate, improvement that could be made if the investigations were to be repeated.
- Produce a written report of their investigation, using appropriate scientific terminology and vocabulary.

Criteria for a good hypothesis

A good hypothesis must:

- explain all aspects of an observation;
- be the simplest possible explanation;
- be expressed in such a way that predictions can be made from it; and
- be testable by experiment.

Why controlled experiments?

A control apparatus is set up to make sure that the results of the experiment are due to the conditions being studied and not to other causes which have been overlooked. The term 'controlled experiment' refers to the fact that the investigator sets up a control and controls the conditions in the experiment.

For example, if an investigation was carried out to compare the growth of plants in a house and in a greenhouse, one could not be sure whether it was the extra light or the higher temperature of the greenhouse which caused better growth. Therefore, this would not be a properly controlled experiment. Only one condition (variable) must be altered at a time, either the light or the temperature. Then the results of the experiment and the control can be compared.

Therefore, a properly controlled experiment alters only one variable at a time and includes a control which shows that it is this condition and nothing else which gave the result.

Dependent and independent variables

The independent variable is changed by the investigator. The dependent variable is the result of the experiment. In the investigation to see whether germinating seeds release energy, the independent variable is the presence or absence of the germinating seeds. The dependent variable is the production or non-production of energy as revealed by the thermometer. The outcome of the experiment depends on whether or not germinating seeds are used.

In controlled experiments, it is important to alter only **one independent variable.**

Some important rules in biological investigations

(i) ***Only one variable may be altered at a time in an investigation.***
If more than one variable were altered then it would be impossible to know which one was responsible for the results obtained.

(ii) ***A relatively large amount or number of living material must be used (cells, organisms, etc.).***
If only a relatively small amount of living material were used then it might be unusual and atypical of the species or phenomenon in general.

(iii) ***The results of the experiment must be successfully repeated.***
If the results cannot be repeated then they may have been the outcome of chance which does not constitute valid support for a hypothesis.

A SAMPLE SCORING FORM

Name of learner/group: _____ Date:_____

PART 1: Experimental design	
1. Identifying a problem or describing an observation • *Causal relationship described*	NR 0 1
2. Stating a hypothesis • *Describes an effect that is linked to a variable* • *Effect is described in terms of a particular direction* • *Expected change is indicated* • *Independent variable identified* • *Dependent variable identified* • *Stated in such a way so that predictions can be generated from it* • *Must be testable through experimentation*	NR 0 1 2 3 4 5 6 7
3. Generating predictions / aims • *Logical and clear statement of predictions* • *Stated in a way that is testable through controlled experimentation*	NR 0 1 2
4. Designing an investigative procedure and conducting the investigation • *Provides an appropriate detailed experimental design* • *Furnishes a step-by-step plan* • *Recognises the need for controlled investigations* • *Recognises that only one independent factor should be variable* • *Clearly stated and observed precautionary measures* • *Provides motivation for the appropriate use of equipment* • *Conservative use of materials / chemicals* • *Identifies and criticises limitations of experimental design* • *Presents the experimental design in a diagrammatic form* • *Motivates for the repetition of the procedure*	NR 0 1 2 3 4 5 6 7 8 9 10
5. Planning of the recording of results • *Appropriateness of recording sheet e.g. table, diagram, etc* • *Appropriate instruments used* • *Units of measurement included* • *Results organised sequentially* • *Recognises the existence of errors in measurements*	NR 0 1 2 3 4 5

PART 2: Investigative report	
1. Quality observations and data • *Accurate observations/measurements/calculations made* • *The data collected is consistent* • *Correct units used* • *Data sheet completed* • *Description of observation/data provided where appropriate* • *Multiple sampling* • *Averages of observation/measurements/cal.*	NR 0 1 2 3 4 5 6 7
2. Translating or manipulating data for analysis e.g. in the form of a graph • *Axes correctly identified and labelled* • *Correct axes chosen for the appropriate variable with correct units* • *An appropriate scale used* • *An appropriate title used for the graph* • *Points plotted accurately* • *Points are joined appropriately* • *Curve has a trend that is appropriate to the data presented*	NR 0 1 2 3 4 5 6 7
3. Forming conclusions • *Recognises tendencies and trends in data* • *Conclusion is consistent with the data* • *Relationship among variables described* • *Variable stated in conclusion* • *Recognises sources of errors and / limitations*	NR 0 1 2 3 4 5

EXAMPLE: 1 (Hypothesis Testing)

Stimulus: Teacher brings to class a few slices of stale bread covered with grey to black thread-like structures.

Question: Does the bread produce the grey-black structures?

Hypothesis: If bread is subjected to appropriate environmental conditions such as temperature, light and moisture, without being exposed to the atmosphere then it will produce the grey – black thread-like structures.

Prediction: To determine whether bread produces the thread-like structures when not exposed to the atmosphere.

Experimental design:

- Two sets of apparatus with several slices of bread from the same loaf
- Experimental group must be sealed in plastic bags/containers while the experimental group must be exposed/uncovered
- Both sets must be subjected to the same environmental conditions such as temperature, light/darkness, and moisture.

Results:

Experimental group	Control group
Slice 1:	
2:	
3:	
4:	
5:	
6:	

EXAMPLE 2: (Hypothesis Testing)

Untreated beetroot cells were observed under the microscope. Cell samples from the same beetroot, which had been immersed in one of three different concentrations of sugar solution, were also observed and a comparison made.

Observation: Compared with untreated cells, those in 0,15 molar sugar solution appeared turgid, those in 0,25 molar solution appeared unchanged, while those in 0,35 molar solution appeared to be plasmolysed.

Hypothesis: Beetroot cells are able to lose water, gain water, or remain unchanged when placed in different concentrations of sugar solution.

Predictions: A sample of beetroot tissue immersed in 0,15 molar sugar solution will increase in mass, one in 0,35 molar sugar solution decrease in mass, while one in 0,25 molar sugar solution will neither gain nor decrease in mass.

Experimental design and procedure:

- Remove several cylinders of beetroot tissue from a fresh beetroot
- Slice these into a number of thin discs of equal size
- Dry these discs with filter/blotting paper
- Divide the discs into three equal groups
- Weigh each group
- Subject each group as follows:
  Group A: immerse into a beaker with the 0,15 molar sugar solution
  Group B: immerse into a beaker with 0,25 molar solution
  Group C: immerse into beaker with 0,35 molar solution
- Place all beakers in a water bath at 25^{o}
- After one hour remove each group of discs and dry them and reweigh.

Results:

	Group A (0,15 M)	**Group B (0,25 M)**	**Group C (0,35 M)**
Initial mass of tissue			
Final mass of tissue			
Difference			

APPENDIX 2: EXAMPLE OF A RESEARCH PROJECT

GRADE 10 Project

The effects of smoking on human health

1. Investigate the fitness of a sample of at least 5 smokers and a sample of at least 5 non-smokers by using the pulse rates at rest and after exercise:
   - draw a table for the results
   - make sure the variables are controlled
   - indicate the shortcomings of your investigation (20)

2. Conduct interviews with at least 10 smokers using the survey sheet provided. Analyse the responses received in the survey. (20)

3. Discuss the laws related to smoking in South Africa – with a focus on individual freedom, choice and passive smoking. (10)

4. The table below shows the results of an investigation into the results of smoking during pregnancy.

Number of cigarettes smoked per day by mother during pregnancy	Average birth weight of baby (in kg)
0	3.6
1-4	3.5
5-8	3.2
9-12	2.5
12 or more	1.4

   4.1 Plot bar graphs to show these results (10)

   4.2 Discuss the effects of smoking during pregnancy on the growth of the embryo and child. (6)

5. Write an account on other harmful effects of smoking. Your account should include illustrative material. (9)

6. Marks will be allocated for presentation. (5)

TOTAL: 80

SURVEY SHEET

SURVEY SHEET ON SMOKING (Tick the chosen answer on the sheet)

How many cigarettes do you smoke per day?	Less than 5	
	Between 5 and 10	
	More than 10	
	YES	NO
Have you read the health warning on the cigarette packet?		
Do you cough after you have smoked?		
Do you have trouble breathing after you exercise?		
Do you know that smoking can damage your lungs?		
Do you know that the smoke you exhale is bad for other people around you?		
Have you tried to stop smoking?		
Do you want to live longer?		
Do you know that cigarettes contain the following substances which can harm the body:		
SUBSTANCE	YES	NO
Tar (causes lung cancer)		
Nicotine(increases blood pressure and the risk of heart attack)		
Carbon monoxide (reduces oxygen level in the blood and makes the heart work faster)		
Dust particles (damages the inside of your lungs)		

ASSESSMENT CRITERIA

CRITERIA	MARK ALLOCATION	LEARNER'S MARK
1.Checklist for table of results		
Informative title	1	
Column heading/s	2	
Row heading/s	1	
Layout	3	
Units of measurement	1	
Measurements recorded	1	
Control of variables		
Variables not controlled	0	
At least one variable controlled	1	
At least two variables controlled	2	
At least three variables controlled	3	
Analysis of results		
No analysis undertaken	0	
Analysis does not take all information into account	2	
Analysis is based on all information gathered	4	
Shortcoming of investigation		
Any 2 shortcomings	2x 2 = (4)	
2.Interview		
10 smokers interviewed	2	
Interview response sheets included	2	
Analysis of responses done	10	
Conclusions drawn	6	
3. Laws related to smoking		
State the law/s	3	
State penalty in breaking the law	3	
Comment on individual freedom	2	
Comment on passive smoking	2	
4. Bar graph		
Informative title	1	
Label of X-axis	2	
Label of Y-axis	2	
Axes correctly scaled	2	
Correct drawing of bars	3	
Effect of smoking during pregnancy		
No response provided	0	
Effects partially explained	1-3	
Effects fully explained	4-6	
5. Harmful effects of smoking		
Any 3 effects explained	3x3=(9)	
6. Presentation of Work		
Table of contents provided	1	
Illustrative material included	2	
Neatness of work	1	
Logical sequence of work	1	
TOTAL MARKS	**80**	