REPUBLIC OF TRINIDAD AND TOBAGO
MINISTRY OF EDUCATION

Secondary Education Modernization Programme

SECONDARY SCHOOL CURRICULUM

Forms 4 – 5

Integrated Science

Curriculum Planning and Development Division, Ministry of Education
2009

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Minister's Foreword

The Government of The Republic of Trinidad and Tobago, in its *Vision 2020 Draft National Strategic Plan*, has articulated a vision of "a united, resilient, productive, innovative and prosperous nation with a disciplined, caring, fun-loving society comprising healthy, happy and well-educated people and built on the enduring attributes of self-reliance, respect, tolerance, equity and integrity."

In order to achieve this vision, the nation must ensure that its learners receive a high quality education. This requires that the Ministry of Education make quality education a national priority and that schools make it an institutional imperative.

Curriculum Guides are central to guiding the process to achieving quality. They set the standards for all stakeholders who have an input in the final years of secondary level education. They align the three critical elements of our education system: the teaching/learning process, resources, and the contribution of stakeholders.

We expect that teachers will implement these Guides to ensure that their lessons are relevant to the expressed needs of The Republic of Trinidad and Tobago, while simultaneously meeting the varied needs of the students. It is intended that this outcome will be achieved in a climate where students are taught in ways that are appropriate to their individual learning styles. The Guides support a teaching/learning process that is based on a curriculum that is itself rooted in sound and well established educational theories and practice.

On behalf of the Ministry of Education I thank all those who contributed to the development of these Curriculum Guides
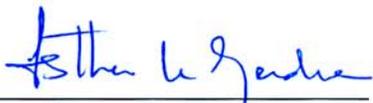
Hon. Esther Le Gendre
Minister of Education
The Republic of Trinidad and Tobago

A Note to Teachers

These Curriculum Guides have been developed by educators, including practising teachers, for teachers. They are intended to assist you to prepare students to meet the rapidly changing demands of life in the 21st century, while ensuring that they acquire the core of general knowledge and experience essential for later education and employment. The new curriculum that they represent is designed to guide the adoption of a more student-centred approach to instruction and the provision of learning opportunities that are relevant to today's students and inclusive of varied learning needs and interests.

Since the beginning of the curriculum development process, we have seen profound changes in the use of technology in education and there is no doubt that similar shifts will take place in the coming years. The challenge for us as educators is to find ways to make our approach to teaching flexible, progressive, and responsive, so that we embrace and motivate change where it benefits learners. This entails becoming lifelong learners ourselves and creating environments that provide necessary community support and foster professional development.

The Guides embody the culmination of seven years of development and revision activity. The National Curriculum will, however, be regularly reviewed to ensure that it continues to meet the needs of all students and matches the goals of society. Your input in this process is vital and we welcome and encourage your ongoing feedback.

Instructional decisions must be based on sound, contemporary educational theory, practice, and research. These documents will serve as important guides for the development of instructional programmes to be implemented at the school and classroom levels. They are organized in several parts. Part 1 is common to all and provides the general philosophy and aims in which every subject is anchored. Part 2 is specific to each subject and includes specific outcomes and sample activities and strategies that may be used to achieve them. The rest of the document is designed to suit the particular needs of each subject area. All the Guides include suggested assessment strategies and recommended resources.

We in the Curriculum Planning and Development Division are confident that the new National Curriculum Guides for Forms 4 and 5 will contribute significantly to enhanced teaching and learning experiences in our secondary schools and, consequently, the achievement of personal learning and national educational goals.

Sharon Douglass-Mangroo
Director of Curriculum Development
August 2008

Acknowledgements

Part 1
The National Curriculum for
Forms 4 and 5

Background

From the Ministry of Education's *Corporate Plan 2008–2012* (p. 4)

The Government of Trinidad and Tobago, in its *Vision 2020 Draft National Strategic Plan*, has articulated a vision of "a united, resilient, productive, innovative, and prosperous nation with a disciplined, caring, fun-loving society comprising healthy, happy and well-educated people and built on the enduring attributes of self reliance, respect, tolerance, equity and integrity…"

Towards the achievement of this Vision, the Government has articulated five developmental pillars:

Developing Innovative People
Nurturing a Caring Society
Governing Effectively
Enabling Competitive Business
Investing in Sound Infrastructure and Environment

The Ministry of Education has been identified as one of the champions for *developing innovative people.* Central to the realization of this pillar is "A highly skilled, well-educated people aspiring to a local culture of excellence that is driven by equal access to learning opportunities."

In conjunction with other key Ministries, the Ministry of Education has been charged with the realization of the following goals:

The people of Trinidad and Tobago will be well known for excellence in innovation.
Trinidad and Tobago will have a seamless, self-renewing, high-quality education system.

A highly skilled, talented and knowledgeable workforce will stimulate innovation driven growth and development.

The richness of our diverse culture will serve as a powerful engine to inspire innovation and creativity.

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Nationally, the reform of the education system is driven by several local, regional and international perspectives. We are committed to a seamless, self-renewing, high-quality education system underpinned by a National Model for Education. This National Model has three (3) foci as follows:

I.   To ensure an alignment of the Education System to Government's Strategic Plan Vision 2020 which mandates that the education system produces caring and innovative citizens

II. To ensure that the Education System produces citizens with a sense of democracy, respect for the rights of others and elders and with the ability to contribute meaningfully to the social and economic development of the country

III. To build a strong sense of nationalism and patriotism in our citizens. (p. 7)

The Secondary Curriculum

In its commitment to comprehensive reform and expansion of the secondary school system, the Government of the Republic of Trinidad and Tobago, in 1996, adopted the report of the National Task Force on Education as educational policy. The specific recommendations for the improvement of secondary education led to discussions with the Inter-American Development Bank (IDB) for loan funding arrangements for a programme, the Secondary Education Modernization Programme (SEMP), to modernize secondary education in Trinidad and Tobago. One of the intended outcomes of this programme was improved educational equity and quality**.**

The Curriculum Guides produced for Forms 4 and 5 in eight subject areas are among the products and contribute to this outcome.

The Curriculum Underpinnings

The new Curriculum has been informed by a wealth of available curriculum theories and processes.

The major forces that influence and shape the organization and content of the Curriculum originate from:

1. Educational philosophy and the nature of knowledge

2. Society and culture

3. The learner and learning process

4. The nature and structure of subject matter to be learned

5. Learning theories

Considerations of these areas represent the foundation on which the National Curriculum is built. The philosophical concerns and educational goals that shaped the Curriculum also formed the basis for the dialogue with stakeholders in which the Curriculum Development Division engaged, with the aim of developing a coherent, culturally focused, and dynamically evolving Curriculum.

An internal analysis of the Education System, together with the research conducted in international forums, has shown that the curriculum is core to the development of innovative people. This Curriculum is aimed at attaining six Essential Learning Outcomes. The six Outcomes identified help to define universally accepted goals that have been developed and underscored by other educational jurisdictions and that have been agreed to be essential. The Essential Learning Outcomes help to define standards of attainment for all secondary school students.

The Essential Learning Outcomes

The learning outcomes deemed essential are in the areas of:

- Aesthetic Expression

- Citizenship

- Communication

- Personal Development

- Problem Solving

- Technological Competence

The achievement of these Essential Learning Outcomes by all students is the goal that every core curriculum subject must facilitate. The core curriculum subjects; their content; and the teaching, learning, and assessment strategies are the means to fulfill this end.

It is expected that by the end of the third year of secondary school, students' achievement in all six areas will result in a solid foundation of knowledge, skills, and attitudes that will constitute a platform for living in the Trinidad and Tobago society and making informed choices for further secondary education.

The Essential Learning Outcomes are described more fully below.

Aesthetic Expression

Students recognize that the arts represent an important facet of their development, and they should respond positively to its various forms. They demonstrate visual acuity and aesthetic sensibilities and sensitivities in expressing themselves through the arts.

Students, for example:

- use various art forms as a means of formulating and expressing ideas, perceptions, and feelings;

- demonstrate understanding of the contribution of the arts to daily life, cultural identity, and diversity;

- demonstrate understanding of the economic role of the arts in the global village society;

- demonstrate understanding of the ideas, perceptions, and feelings of others as expressed in various art forms;

- demonstrate understanding of the significance of cultural resources, such as museums, theatres, galleries, and other expressions of the multicultural reality of society.

Citizenship

Students situate themselves in a multicultural, multi-ethnic environment, and understand clearly the contribution they must make to social, cultural, economic, and environmental development in the local and global context.

Students, for example:

- demonstrate understanding of sustainable development and its implications for the environment locally and globally;

- demonstrate understanding of Trinidad and Tobago's political, social, and economic systems in the global context;

- demonstrate understanding of the social, political, and economic forces that have shaped the past and present, and apply those understandings to the process of planning for the future;

- examine issues of human rights and recognize and react against forms of discrimination, violence and anti-social behaviours;

- determine the principles and actions that characterize a just, peaceful, pluralistic and democratic society, and act accordingly;

- demonstrate understanding of their own cultural heritage and cultural identity, and that of others, as well as the contribution of the many peoples and cultures to society.

Communication

Students use their bodies, the symbols of the culture, language, tools and various other media to demonstrate their deeper understandings of synergies inherent in the exchange of ideas and information, and thus to communicate more effectively.

Students, for example:

- explore, reflect on, and express their own ideas, learning, perceptions, and feelings;

- demonstrate understanding of facts and relationships presented through words, numbers, symbols, graphs, and charts;

- demonstrate sensitivity and empathy where necessary in communicating various kinds of emotions and information;

- present information and instructions clearly, logically, concisely, and accurately for a variety of audiences;

- interpret and evaluate data, and express their conclusions in everyday language;

- critically reflect on and interpret ideas presented through a variety of media.

Personal Development

Students "grow from inside out," continually enlarging their knowledge base, expanding their horizons, and challenging themselves in the pursuit of a healthy and productive life.

Students, for example:

- demonstrate preparedness for the transition to work and further learning;

- make appropriate decisions and take responsibility for those decisions;

- work and study purposefully, both independently and in cooperative groups;

- demonstrate an understanding of the relationship between health and lifestyle;

- discriminate among a wide variety of career opportunities;

- demonstrate coping, management, and interpersonal skills;

- display intellectual curiosity, an entrepreneurial spirit, and initiative;

- reflect critically on ethical and other issues;

- deal effectively with change and become agents for positive, effective change.

Problem Solving

Students know problem solving strategies and apply them to situations they encounter. They demonstrate critical thinking and inquiry skills with which they process information to solve a wide variety of problems.

Students, for example:

- acquire, process, and interpret information critically to make informed decisions;

- use a variety of strategies and perspectives flexibly and creatively to solve problems;

- formulate tentative ideas, and question their own assumptions and those of others;

- solve problems individually and collaboratively;

- identify, describe, formulate, and reformulate problems;

- frame and test hypotheses;

- ask questions, observe relationships, make inferences, and draw conclusions;

- identify, describe, and interpret different points of view;

- distinguish facts from opinions.

Technological Competence

Students are technologically literate, understand and use various technologies, and demonstrate an understanding of the role of technology in their lives, in society, and in the world at large.

Students, for example:

- locate, evaluate, adapt, create, and share information using a variety of sources and technologies;

- demonstrate understanding of and use existing and developing technologies appropriately;

- demonstrate understanding of the impact of technology on society;

- demonstrate understanding of ethical issues related to the use of technology in local and global contexts.

The Curriculum Design and Development Process

In order to achieve the outcomes defined by the underpinning philosophy and goals, the Curriculum Development Division of the Ministry of Education embarked on a design and development programme consonant with accepted approaches to curriculum change and innovation.

Curriculum Design

This Curriculum displays a learner-centered design. Its philosophical assumptions are mainly constructivist. Its major orientation is to curriculum as self-actualization. The Curriculum is student-centred and growth oriented. It seeks to provide personally satisfying experiences for each student. As the student moves from one level to another, activities also expand to allow him/her new insights and approaches to dealing with and integrating new knowledge.

Curriculum Development

The first stage of the curriculum development process consisted of consultations with stakeholders from a cross-section of the national community. Consultations were held with primary and secondary school teachers; principals; members of denominational school boards; members of the business community; the executive of the Trinidad and Tobago Unified Teachers' Association (TTUTA); representatives from The University of the West Indies (UWI), John S. Donaldson Technical Institute, San Fernando Technical Institute, Valsayn Teachers' College and Caribbean Union College; parents; librarians; guidance counsellors; students; curriculum officers; and school supervisors. They were focused on the philosophy, goals, and learning outcomes of education.

The result of these consultations was agreement on:

- the concept of a "core," that is, Essential Learning Outcomes consisting of skills, knowledge, attitudes, and values that students must acquire at the end of five years of secondary schooling;

- the eight subjects to form the core;

- the desirable outcomes of Secondary School Education in Trinidad and Tobago.

In Stage 2 of the process, the officers of the Curriculum Development Division studied the reports of the consultations, the Education Policy Paper, the reports of the Curriculum Task Force and the Task Force for Removal of Common Entrance, as well as newspaper articles and letters to the editor on education during the preceding five years. The School Libraries Division and the Division of School Supervision assisted the Curriculum Development Division in this task. The result of the study was the identification and articulation of a set of desirable outcomes and essential exit competencies to be possessed by all students on leaving school. All learning opportunities, all teaching and learning strategies, and all instructional plans are to contribute to the realization of these outcomes and competencies.

At Stage 3, 10 existing schools were identified to pilot the new Curriculum. Teachers from eight subject areas were drawn from these schools to form Curriculum Writing Teams for each subject. Teachers with specific subject or curriculum development skills from other schools were also included in the teams. The outputs of this phase included learning outcomes specific to each subject that contribute to the fulfillment of the national outcomes; subject content; and teaching, learning, and assessment strategies to support the outcomes.

The draft Curriculum Guides for Forms 1 and 2 were approved by Cabinet for introduction into schools on a phased basis in September 2003. The draft guides for Form 3 were completed and introduced in the following year. Introduction of the new guides was accompanied by professional development and training for principals and teachers. The Ministry also began to supply new and/or upgraded facilities for teaching and learning, and educational technology. At the same time, work began on a new assessment and certification system.

Curriculum Revision

As implementation proceeded, feedback was received in the Curriculum Development Division through school visits, workshops, and reviews by UWI lecturers and other stakeholders. In 2007, a survey was conducted among teachers, followed by focus group meetings, in order to concretize feedback before embarking on the revision process. As in the original curriculum development exercise, revision—the final stage—was carried out by teams of practising teachers led by officers of the Curriculum Development Division.

Teaching of English Language across the Curriculum

Language is a uniquely human capacity. The development of language skills and the ability to understand and use language correctly, competently, and effectively is fundamental to the learning outcomes expressed in the national curriculum. Three simultaneous kinds of learning are envisaged: students learn language, they learn through language, and they learn about language.

The National Curriculum envisages that language development of students takes place across the curriculum and is therefore to be addressed in all subject areas. Students will develop and use patterns of language vital to understanding and expression in the different subjects that make up the Curriculum.

Language plays a major role in learning and occurs when students use the major modes of language—listening, speaking, reading, and writing—to achieve various purposes, among them: to communicate with others; to express personal beliefs, feelings, ideas, and so on; for cognitive development in various subjects of the curriculum; and to explore and gain insight into and understanding of literature. Language is linked to the thinking process, and its use allows students to reflect on and clarify their own thought processes and, thus, their own learning.

The student of Trinidad and Tobago functions in a bidialectal context, that is, the natural language of the student, the Creole, differs from the target language and the language of instruction, Internationally Acceptable English. Both languages are of equal value and worth and are to be respected. Students use their own language as a tool for interpreting the content of the curriculum and for mastering it, and are to be taught to use the target language as effectively and effortlessly as they would their natural language.

The exponential growth in information and the use of information and communication technologies provide the opportunity for students to be critical users of information. Language development and use in this context is also addressed in all subject areas.

Education Policies that Impact on the Curriculum

There are several Ministry of Education policies that impact on the National Secondary Curriculum, though some are still in the process of formalization. These include the National Model for Primary and Secondary Education in Trinidad and Tobago, the ICT policy, Standards for the Operation of Schools, and Quality Standards. Copies of these documents may be obtained from the Ministry offices or the website at *www.moe.gov.tt*. Three policies that have direct impact on the development and implementation of the Curriculum are discussed below.

National Curriculum Policy

A Draft National Curriculum Policy has been approved by Cabinet for consultation with stakeholders. The Policy statements are summarized as follows:

1. The Curriculum must articulate with the goals of national development and be supportive of the aspirations of individuals and their personal development. It must provide opportunities for every student to be equipped with the knowledge, skills, attitudes, values, and dispositions necessary for functioning in an interactive, interdependent society.

2. The Curriculum must be so managed as to ensure the provision of a quality curriculum experience for all students at all levels of the system.

3. At every level of the system, there must be equitable provision of requisite facilities, resources, services, and organizational structures that are conducive to and supportive of effective learning and teaching and healthy development.

4. Continuous quality management must support all curriculum and related activities at every level of the system.

5. Ongoing research and professional development activities must equip education practitioners for continued effective practice.

Though not yet formally accepted, these statements are worthy of consideration at all stages of the curriculum cycle.

Inclusive Education Policy

The Ministry of Education is committed to "support the delivery of inclusive education in all schools by providing support and services to all learners, and by taking appropriate steps to make education available, accessible, acceptable and adaptable to all learners." An inclusive curriculum is acknowledged to be the most important factor in achieving inclusive education. In planning and teaching the school curriculum, teachers are therefore required to give due regard to the following principles:

- The National Curriculum Guides set out what most students should be taught at lower secondary school but teachers should teach the required knowledge and skills in ways that suit students' interests and abilities. This means exercising flexibility and drawing from curricula for earlier or later class levels to provide learning opportunities that allow students to make progress and experience success. The degrees of differentiation exercised will depend on the levels of student attainment.

- Varied approaches to teaching, learning, and assessment should be planned to allow all students to participate fully and effectively. Account should be taken of diverse cultures, beliefs, strengths, and interests that exist in any classroom and that influence the way students learn.

- Students with special needs shall receive additional instructional support in the context of the regular curriculum, not a different one. The guiding principle of equity is to supply students who need it with additional help to achieve set standards rather than to lower the standards.

- Continuous formative evaluation must be used to identify learning needs and to shape instruction, thus maximizing students' opportunities for achieving success. Assessment strategies must be appropriate to the way the curriculum is designed and delivered, as well as to each student's individual learning profile and stage of development.

- Suitable technology shall be used in instruction to facilitate learning and enhance success.

ICT in the Curriculum

The following statements are taken from the Ministry of Education's ICT in Education Policy (pp. 28–29).

Curriculum Content and Learning Resources

- Curriculum and content must increasingly maximize the use of ICT.

- ICT must be integrated into the development and delivery of the curriculum.

- ICT integration and ICT competency measures across the curriculum shall be driven through the development and delivery of an ICT-infused curriculum.

The Core Curriculum Subjects

These are subjects for which every student is required to demonstrate achievement of the stated outcomes in Forms 4 and 5. Additional subjects that contribute to students' holistic development and further their interests and aspirations may also be offered thereafter.

A minimum time allocation is recommended for each core subject. The Principal, as instructional leader of the school, will make the final decision according to the needs of the students and the resources available at any given time.

The subjects and the time allocations are as follows:

Subject	No. of Periods	Subject	No. of Periods
English/Language Arts	6	Mathematics	5
Science	4	Health and Physical Education	2
Spanish	4	Visual and Performing Arts	4
Social Studies	4		

At the end of Form 5, students will be assessed for the National Certificate of Secondary Education (NCSE), Level 2.

Curriculum Implementation

Implementation of the Curriculum is a dynamic process, requiring collaboration of the developers (curriculum teams) and users (teachers). In implementation, teachers are expected to use the formal curriculum, as described in the Curriculum Guides, to plan work and teach in a manner that accomplishes the objectives described. Teachers translate those objectives into units of study, determining the appropriate sequence and time allocation according to the learning needs of their students. The new Curriculum Guides provide sample teaching and assessment strategies but it is the role of the professional teacher to select and use sound teaching practices, continually assessing student learning, and systematically providing feedback to the curriculum team for use in revising and improving the guides.

The Curriculum Development System advocated by the Ministry of Education involves stakeholders, specialist Curriculum officers, Principals, Heads of Departments, and Teachers, each with specific roles and responsibilities. Some of these are outlined in the table below.

SYSTEM COMPONENT	MEMBERS	ROLE
National Curriculum Council	**Stakeholders**	• **Advise on curriculum policy, goals, and standards**
Curriculum Planning and Development Division (Head Office and District based)	Curriculum Officers	• Curriculum planning • Provide leadership in identifying curriculum goals and determining the process for development of curriculum materials • Lead writing teams (includes teachers) • Monitor implementation • Provide teacher support • Advise on processes and materials for effective implementation and student assessment • Evaluate curriculum
School Curriculum Council	Principal/Vice Principal and Heads of Departments	• Make major decisions concerning the school curriculum such as assigning resources • Provide guidelines for Instructional Planning Teams

SYSTEM COMPONENT	MEMBERS	ROLE
Instructional Planning Teams/School Instructional Committees	Teachers	• Cooperate on tasks necessary for effective implementation, such as: yearly work plans, units of study, development of materials to individualize the curriculum, identification and development of learning materials, student assessment and evaluation.

Curriculum Implementation at School Level

The "School Curriculum" refers to all the learning and other experiences that the school plans for its students. It includes the formal or written curriculum as well as all other learning activities, such as those offered by student clubs, societies, and committees, as well as sporting organizations (e.g., cricket team, debating society, Guides, Cadets).

The School Curriculum Council develops the School Curriculum in alignment with the National Curriculum. It consists of the Principal and/or Vice Principal and Heads of Department. The duties of the Council include the development of school culture, goals, vision, and curriculum in alignment with the National Curriculum and culture. It also provides support for curriculum work and performs evaluation functions.

In providing support for curriculum work, the Council:

• encourages teachers to identify challenges and try new ideas;

• timetables to allow for development of curriculum materials, for example, year plans, units, instructional materials;

• ensures availability of learning materials;

• provides instructional leadership;

• ensures appropriate strategies for student success.

In performing evaluation functions, the Council:

- monitors the curriculum (observation, test scores, student books, talks);

- assesses the hidden curriculum (discipline policies, fund allocation, physical environment);

- evaluates the school programme of studies.

The roles of the instructional teams and the individual teacher are described in the following tables:

Role of School Instructional Committees
Develop/Revise/Evaluate work programmes
Determine resource needs
Identify/Develop instructional materials
Conduct classroom action research
Integrate and align curriculum
Identify and develop appropriate assessment practices
Develop reporting instruments and procedures (student and teacher performance)
Keep records

Role of the Individual Teacher
Develop/Revise instructional programme
Individualize curriculum to suit students needs and interests
Develop/Evaluate/Revise unit plans
Develop/Select appropriate learning materials
Select appropriate teaching strategies to facilitate student success
Integrate as far as possible and where appropriate
Select appropriate assessment strategies
Monitor/Assess student learning; Keep records
Evaluate student performance
Evaluate classroom programmes
Conduct action research
Collaborate with colleagues

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Part 2
The Integrated Science Curriculum
Forms 4 and 5

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- Mrs. Dipwatee Maharaj, Director of Curriculum Development, led the completion of the Curriculum.

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- The Curriculum Officers and members of the Curriculum Writing Teams brought their knowledge, skills and practical experiences of teaching and learning to the Curriculum development workshops and skillfully synthesized all to produce the document.

- Dr. June George and a team from School of Education provided an evaluation of the document with suggestions.

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Vision Statement

The Science Curriculum will:

- stimulate students' curiosity and creativity
- develop competence in the use of the knowledge and methods of Science
- develop students' critical awareness of the role of Science in everyday living.

Rationale for Teaching and Learning Science

Science is the study of the biological and physical environment. It is a method of problem-solving which requires that all the necessary resources and skills be used to gather objective evidence, analyse and synthesize that evidence, then make inferences and draw conclusions. These activities require specific skills and habits of mind, such as accuracy, discipline, and integrity in the application of scientific principles, which are fundamental to scientific activity. The Science Curriculum is designed to develop these skills and habits of mind.

A properly conceptualized and implemented Science programme is designed to enable students to:

1. develop personal strengths, which include the ability to read, write, and complete mathematical operations; communication skills; interpersonal and intra-personal skills; problem-solving skills; and positive attitudes to work. Students involved in Science activities may have many of their social and psychological needs met, such as the need for recognition, affection, security, and belongingness;

2. demonstrate an awareness of social realities and natural phenomena. Students' natural curiosity can be tapped and made the prime motivating device in inspiring them to learn about Science;

3. appreciate Science as an enjoyable activity, which includes artistic experiences. Creating projects, carrying out investigations that they planned, taking part in Science games and contests, and recognizing that recreational activities and sports such as basketball and swimming can be explained by using scientific concepts and principles, all make Science more relevant for students;

4. recognize Science as a means of advising them on how to live healthy and safe lives. Science teaches us about the causes and prevention of disease. It can also introduce students to the real, scientific reasons why they should avoid dangerous drugs and alcohol;

5. recognize vocational potentials. The future revolves around Science and technological competence. There is no vocation of the future that will not be influenced by Science and Technology. A Science education helps us to induct our students into the technological society.

It is clear, therefore, that Science helps us to understand ourselves as well as our environment. That understanding can naturally transfer to the development of the healthy, safe, and successful interdependence of all people.

At the upper secondary level, students' experiences in Science will lead them to have a conceptual understanding of the natural world, of man's place in it, and of his responsibility to maintain and preserve it. At the same time, Science education will equip students with scientific knowledge and skills for employment or for further education in Technology, in Science-related fields and in different trades.

Thus, greater emphasis is placed in this Curriculum on the outcomes of relating Science and Technology to each other, and to the world outside the school, as well as on the need for sustainable development. The development of students' understanding of the concept of sustainability is stressed in a variety of contexts (e.g., in the study of ecology). Communication skills and the use of appropriate terminology are given greater emphasis, for example, students are expected to describe what they are doing by using the terminology associated with specific scientific and technological concepts.

This Science Curriculum also builds on and reinforces certain aspects of the Language and Mathematics curricula. For example, it emphasizes the importance of clear, concise communication, and requires the use of various charts, tables, and graphs for communicating observations and measurements. It also includes other forms of communication, for example, the use of SI metric units, and experimental reports. Care must be taken to ensure that expectations involving SI metric units and other communication-related knowledge and skills are consistent with the expectations in Language and Mathematics for the relevant year levels.

Characteristics of a Good Scientist

In this Curriculum**,** the study and practice of Science should support an individual's development in three important areas: attitudes, processes (methods), and products. To be a successful scientist, one must first possess the right attitudes. Science helps us to develop a positive attitude to nature and how it affects us, and to the environment. Other attitudes that will be useful to us as we engage in Science activities are curiosity, open-mindedness, healthy scepticism, perseverance, a positive approach to failure, cooperation, impartiality, humility, and tolerance.

A good scientist must also be able to apply certain processes in the study and practice of Science. Scientific ways of solving problems involve the application of special methodologies that demand different types of thinking and reasoning skills. These can be divided into two areas: basic and integrated process skills. Basic process skills relate to enquiry skills such as observation, classification, communication, measurement, estimation, prediction, and inference. Integrated process skills relate to conceptual understanding. For Science to make sense, it must be placed in a familiar context and be relevant.

Observation is an important process in Science as it requires the use of the senses and requires that some form of measurement be made. Measurement is central to Science because the types of results gained may be seriously affected by the accuracy of the measurements. It is therefore crucial that students be properly grounded in the skills of length, mass, time, temperature, and current measurement.

General Intended Learning Outcomes

The following general Intended Learning Outcomes identify competencies expected of students upon completion of the study of Integrated Science in the upper secondary school:

1. Understanding of the nature of Science

2. Empowerment, attained through their knowledge of the role of Science in addressing the complex social issues related to the environment

3. Mastery of the skills and knowledge required for scientific enquiry

4. Willingness to acquire and apply scientific and technological knowledge to the mutual benefit of self, society and the environment.

These outcomes can best be arrived at through investigative approaches where students assume an active role in meaning-making. All instructional activities proposed within the Curriculum Units prepare students for relevant assessment tasks by supporting the development of the concepts and skills required for solving problems in society and their application to everyday life.

Structure of the Curriculum Document

The Integrated Science Curriculum is designed to incorporate topic areas from the separate sciences that must be integrated during the teaching/learning process. A spiral curriculum design has been utilized to ensure that students progress smoothly as they develop knowledge and skills in Science. The deliberate sequencing of the units in the Curriculum will allow them to develop the knowledge and skills required to complete the final end-of-year assessment tasks.

The Curriculum is intended to support the development of conceptual understanding. "Conceptual understanding" refers to the knowledge that students gain from their experiences in and out of the class setting while carrying out instructional activities identified in the document, such as investigations, discussions or the presentation of findings and interpretations. Conceptual understanding will be derived from the overarching concepts in the topics in Science that are identified for each unit. Although the concepts remain the same, the expected outcomes should change, depending on the age and developmental level of the student. Much of this conceptual understanding can best be assessed using the alternative forms of assessment proposed in this Curriculum.

The following chart shows a suggested sequencing among the Units in the Curriculum, which may be adapted as deemed necessary by teachers.

NCSE LEVEL II

FORM FOUR MODULES

Health and Wellness	Diseases	Science in Sports	Chemistry at work	Industries in Trinidad and Tobago	Electricity at work

FORM FIVE MODULES

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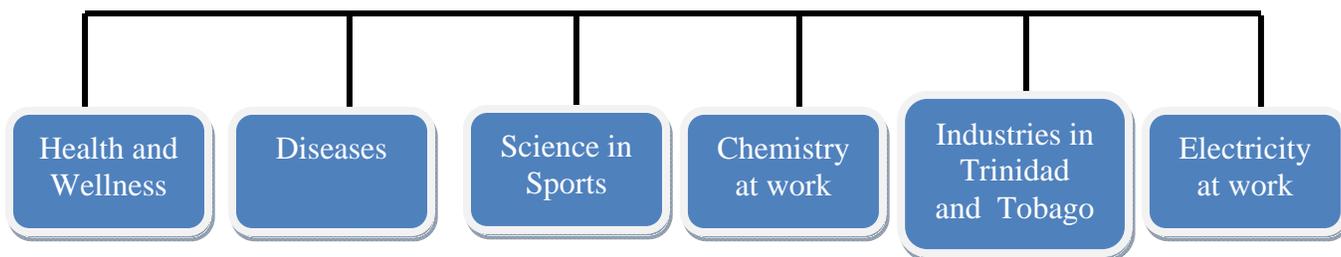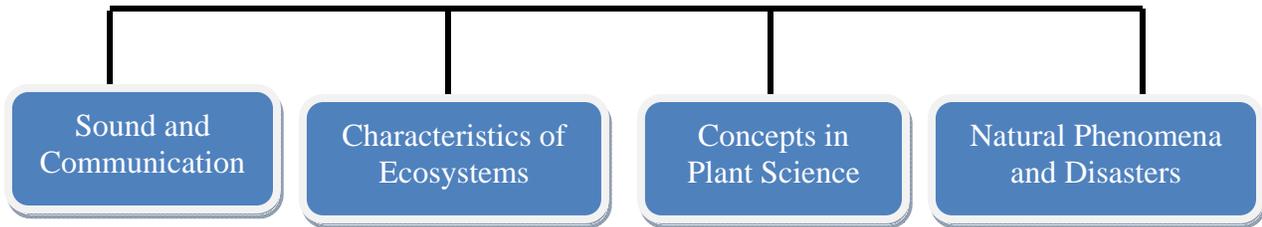
Programme for Form Four

PROGRAMME FOR FORM 4

Module	Topics	Sub-Topics
1. Health and Wellness	Factors that Contribute Towards a Healthy Lifestyle	1. What is health? 2. Making healthy food choices – Balanced diet 3. Making healthy food choices – Malnutrition 4. Exercise and physical fitness 5. Wellness and Recreational activities
2. Diseases	Diseases and You	1. Classes of diseases 2. Causes, effects and treatment of diseases 3. Use of technology in diagnosing and treating of diseases
	Immunity	1. Immunization
	Drugs	1. Classes of drugs 2. Effects of drugs on the body
3. Science in Sports	Materials in Sports	1. Choosing appropriate materials for sporting equipment
	Scientific Principles Involved in the Movement of Objects through Fluids	1. Movement and forces 2. Movement through air 3. Movement through water
	Safety in Sports	1. Sports-related injuries 2. Simple First Aid treatment

PROGRAMME FOR FORM 4

Module	Topics	Sub-Topics
4. Chemistry at Work	Common Chemical Reactions at Home	1. Neutralization reactions 2. Decomposition reactions 3. Redox reactions 4. Use of metals and non-metals in everyday life 5. Chemistry in food preservation
	Safety	1. Safe handling, storage, and disposal of chemicals
5. Industries in Trinidad and Tobago	Chemical Process in Industries	1. Distillation 2. Electrolysis
	Machines in Industry	1. Types of machines and how they work 2. Choosing machines for a particular job 3. Industrial Safety
	Industrial Safety	1. Working in a safe environment 2. Safe disposal of industrial materials

PROGRAMME FOR FORM 4

Module	Topics	Sub-Topics
6. Electricity at Work	The Production and Transmission of Electricity	1. The production of electricity 2. The transmission of electricity
	Domestic Consumption of Electricity	1. Using electricity safely 2. Power consumption of domestic appliances and devices 3. How much does electricity cost?

Programme for Form Five

PROGRAMME FOR FORM 5

Module	Topics	Sub-Topics
7. Sound and Communication	Sound	1. Characteristics of sound 2. Classification of musical instruments 3. Transmission and reception of sound 4. Noise pollution and its consequences
	Communication Devices	1. Electromagnetic waves 2. Communication devices
8. Characteristics of Ecosystems	Characteristics of an Ecosystem	1. The features of an ecosystem
	Imbalance in Ecosystems: Pollution	1. Waste Disposal 2. Air Pollution 3. Water Pollution 4. Misuse of an ecosystem
9. Concepts in Plant Science	Plant Nutrients	1. The role of nutrients in plant growth
	Soil	1. Components of soil 2. Improvements and maintenance of soil quality
	Methods of Plant Cultivation	1. Growing plants under controlled conditions 2. Pest control
	Production of New Plants	1. Sexual and asexual reproduction in plants
	Biotechnology in Agriculture	1. What is biotechnology
	Safety	1. Safe use and storage of agricultural equipment and chemicals

PROGRAMME FOR FORM 5

Module	Topics	Sub-Topics
10. Natural Phenomena and Disasters	Plate Tectonics	1. Structure of the earth's crust
	Features Associated with Plate Tectonics	1. Volcanoes 2. Earthquakes
	Climate	1. Storms, hurricanes and floods 2. Lightning

MODULE 1: HEALTH AND WELLNESS

Overview

In this Module, students will be exposed to the various factors which contribute to Health and Wellness. Today's hectic lifestyles often result in the neglect of the importance of eating healthy foods and participating in activities which contribute to the general well-being of individuals.

This Module attempts to take students through the various aspects of Wellness, providing tangible experiences which should encourage substantial efforts towards having a healthy lifestyle.

General Outcomes:

At the end of this module students will:

1. demonstrate knowledge of healthy lifestyle practices
2. conduct investigations related to diet and fitness
3. communicate information related to health, both orally and in writing
4. make decisions related to maintaining health.

Standard: The maintenance of good health is a personal responsibility.

Topic 1 - Factors that Contribute Towards a Healthy Lifestyle

Sub-topic 1: What is health?			
Concepts	**Specific Outcomes**	**Suggested Teaching Strategies**	**Suggested Assessment Activities**
Health is a state of physical, social and mental well-being.	*Students will:* • identify the relationship between physical, social and mental well-being.	Brainstorming of students' ideas about what constitutes health	• Students could create a poster/journal, write a paragraph etc., identifying practices that affect their health positively and negatively.
Sub-topic 2: Making healthy food choices – balanced diet			
A balanced diet provides adequate nutrients and energy for the maintenance of good health.	*Students will:* • discuss the components of a balanced diet • relate dietary requirements to individual needs • explain the terms Dietary Reference Value (DRV) and reference Daily Intake (RDI). • evaluate "fad" diets.	Explore the various approaches to defining a balanced diet e.g. the multi-mix principle, consider vegetarianism, food pyramid. Small group discussions and presentations on factors which influence the energy requirements of an individual e.g. gender, age, height, weight, level of physical activity, basal metabolic rate Research using ICT the terms DRV and RDI as well as applicable standards Research and discuss some 'fad' diets using ICT.	• Evaluate menus at the school cafeteria. Make recommendations to ensure that balanced meals are available to students. • Plan balanced diets to match individual needs e.g. footballer, an elderly person, a pregnant woman. • Evaluate nutritional and energy content information on food labels. • Undertake a survey of popular diets and rate them as balanced or unbalanced

Sub-topic 3: Making healthy food choices – malnutrition			
Concepts	**Specific Outcomes**	**Suggested Teaching Strategies**	**Suggested Assessment Activities**
Malnutrition can result from over-nutrition or under-nutrition.	*Students will:* • relate malnutrition to unbalanced diet	Discussions on incidence of over-nutrition and under-nutrition.	• Prepare a plan to educate the school community about the health risks associated with malnutrition.
	• identify diseases that result from malnutrition and their causes	Using photos and working in groups, allow students to match deficiency diseases e.g. anemia, goitre, rickets, kwashiorkor and marasmus and their causes	• Students prepare a brochure outlining diseases, causes and corrective measures. • Prepare a presentation based on research conducted.
	• explain how these deficiency diseases can be corrected	Using textbooks, suggest how they can be corrected.	• Students design meals which could reduce the incidence of obesity especially in young people.
Many diseases can develop as a result of unbalanced diets.	• evaluate eating patterns as they relate to lifestyle diseases e.g. obesity, Type 2 diabetes, hypertension, coronary heart disease among others	Conduct research on lifestyle disease as a widespread problem in Trinidad and Tobago. Calculate Body Mass index (BMI) and relate values to obesity.	
Eating disorders may result in malnutrition.	• understand the health risks associated with eating disorders e.g. anorexia nervosa and bulimia.	Research on anorexia nervosa and bulimia and the physiological effects on the body e.g., risk of heart failure.	• develop a plan for counseling students with eating disorders.

Sub-topic 4: Exercise and physical fitness			
Concepts	**Specific Outcomes**	**Suggested Teaching Strategies**	**Suggested Assessment Activities**
Exercise promotes physical well-being.	*Students will:* • distinguish between aerobic and anaerobic respiration • define the term aerobic exercise • discuss the benefits associated with aerobic exercise • discuss muscle fatigue • discuss physical fitness • describe how fitness might differ in different individuals • measure changes in pulse and breathing rates before and after a simple exercise • embark on a programme to improve their own physical fitness.	Questioning/class discussion. Using their own experiences, students can discuss the benefits of aerobic exercise e.g. cardiovascular and respiratory fitness, loss in weight, improved coordination etc. Photos showing athletes with cramps. The teacher can explain anaerobic respiration. Photos of different individuals are displayed and students discuss their fitness. Carry out exercises to measure changes in pulse and breathing rates before and after exercise of varying intensity e.g. walking and jumping. • Students brainstorm and discuss with the physical education teacher a programme to improve their own physical fitness.	• Conduct quiz. • Group discussion of the importance of physical activities e.g. brisk walking, jogging, football, basketball etc. • Questions on the difference between aerobic and anaerobic respiration • Represent and interpret data on pulse and breathing rates in tables and graphs. • With the use of a table, compare resting pulse rate of athletic and non-athletic students. • Students will write a report on their individual fitness programme.
Resting pulse rate is an indication of fitness.			

Sub-topic 5: Wellness and recreational activities			
Concepts	**Specific Outcomes**	**Suggested Teaching Strategies**	**Suggested Assessment Activities**
Wellness is an attitude to life where one is determined to strive for better health.	*Students will:* • discuss wellness • identify various recreational and leisure activities which can contribute to wellness • develop a lifestyle which demonstrates an appreciation of wellness.	Class discussion linking issues of diet, and exercise and physical fitness to wellness Students list their favourite leisure activities and suggest how these activities contribute to their wellness	• Students design activities to promote wellness in the school environment. • Presentation of a programme which will contribute to their own wellness

Resources

- Food labels
- Nestlé's Nutrition and You leaflet
- Caribbean Food and Nutrition Institute
- Cajanus magazine (Published by Caribbean Food and Nutrition Institute)
- Food and Nutrition texts
- www.nestlecaribbean.com
- www.who.com

MODULE 2: DISEASES

Overview

The presence of diseases can have a great impact on the quality of life. At the individual level, it can prevent a person from working and providing for himself/herself and family. Widespread diseases can affect the economy of the country.

This Module looks at the various categories of diseases, their causes, effects and methods of treatment. Emphasis is put on empowering students to prevent the spread of diseases. The use of technology and drugs in the treatment of diseases is also considered.

General Outcomes:

At the end of this module students will:

1. demonstrate a knowledge of causes, effects and treatment of common diseases
2. assess the role of immunization in reducing the spread of diseases
3. describe the effects of common drugs on the body.

Standard: Types, causes, effects and treatment of diseases

Topic 1 – Diseases and You

Sub-topic 1: Classes of diseases			
Concepts	**Specific Outcomes**	**Suggested Teaching Strategies**	**Suggested Assessment Activities**
There are different types of diseases.	*Students will:* • classify common diseases in Trinidad and Tobago into the categories; physical, infectious, deficiency, inherited, degenerative, mental and lifestyle.	Using the Internet, students research various diseases and classify them accordingly.	• Create a pamphlet/poster/rap to inform peers about a specific disease.

Sub-topic 2: Causes, effects and treatment of diseases			
Concepts	**Specific Outcomes**	**Suggested Teaching Strategies**	**Suggested Assessment Activities**
Diseases are caused by a number of factors. Different methods are used to treat diseases.	*Students will:* • briefly describe the cause, effects and treatment of common diseases.	Students research information on diseases using pamphlets and brochures from health centers. Diseases should include: HIV/AIDS, HPV, herpes, gonorrhoea, syphilis, dengue fever, gastroenteritis, tuberculosis, cardiovascular diseases, diabetes, arthritis, hypertension, asthma, Alzheimer's disease and schizophrenia.	• Draw a table to show diseases and their causes, effects and treatment

Sub-topic 3: Use of technology in the diagnosis and treatment of diseases			
Concepts	**Specific Outcomes**	**Suggested Teaching Strategies**	**Suggested Assessment Activities**
Technology is used in diagnosing and treating diseases.	*Students will:* • describe the role of medical technology in diagnosis and treatment of diseases.	Using ICT, students can research technologies, e.g. CAT scan, MRI, X-Ray, ultrasound, laser, ECG, digital glucose testing, blood pressure testing, mammography, dialysis and orthopedic braces.	• Write an essay on the increasing role of medical technology in diagnosing and treating diseases.

Topic 2 – Immunity

Sub-topic 1: Immunization

Concepts	Specific Outcomes	Suggested Teaching Strategies	Suggested Assessment Activities
Immunization protects the body against some diseases.	*Students will:* • describe the process of immunization • name common diseases for which immunization is available. • evaluate the role of immunization in maintaining health	A guest speaker from the Health Center can provide information on: - immunization - common diseases for which immunization is available - role of immunization in maintaining health Class discussion on why it is mandatory to be immunized before entering primary school.	• Prepare a leaflet/poster/ rap/song on Immunization. • Role-play a Public Health Nurse advising parents on immunization of their children.

Topic 3 – Drugs

Sub-topic 1: Classes of drugs

Concepts	Specific Outcomes	Suggested Teaching Strategies	Suggested Assessment Activities
A drug is a substance which, when taken into the body, may modify one or more of its physical or mental functions. Drugs may be classified according to their effects on the body.	*Students will:* • define the term "drug" • classify drugs into the following categories: stimulants, depressants, narcotics, hallucinogens, analgesics • explain the meaning of the term "drug dependency" • explore treatment available for "drug dependency".	Class discussion to arrive at a definition of the term "drug", and drug dependency Students investigate the availability of drug treatment centers and collect information on methods of treatment.	• Formulate an anti-drug programme in school. • Prepare posters informing of types of drugs and treatment available.

Sub-topic 2: Effects of drugs on the body

Concepts	Specific Outcomes	Suggested Teaching Strategies	Suggested Assessment Activities
Some drugs affect the body in negative ways.	*Students will:* • discuss the short and long term effects on the body of the following drugs: marijuana, cocaine, caffeine, solvents • describe the implications of the improper use of antibiotics.	Class discussion and use of information from various sources obtained from the Internet Students research the use of antibiotics for the treatment of bacterial infections using ICT and the improper use of antibiotics.	• Draw a cartoon to depict the short and long term effects of named drug. • Design a pamphlet to show the consequences of the improper use of antibiotics.

Resources

- Biology textbooks
- Community Health Workers
- Guest Speaker from HIV/AIDS Foundation
- Pumpkinvine: Magazine of Alcoholics Anonymous
- Specialist from the Ministry of Health
- Video clips with relevant information
- NADAPP

MODULE 3: SCIENCE IN SPORTS

Overview

Sport is increasingly viewed as essential to the holistic development of human beings. Participation in sports is important for social and health reasons. It helps to develop team spirit and contributes to the general health and well-being of an individual. It is important for students to understand the basic scientific principles involved in various aspects of sports e.g., selection of appropriate equipment and playing surfaces, developing correct techniques and having knowledge of safety procedures. This Module aims to empower students to use the scientific principles involved for improved and safe performance when participating in sporting activity.

General Outcomes:

At the end of this module students will:
1. critically evaluate sporting equipment and play surfaces
2. understand how certain concepts can enhance the execution of sporting skills particularly in aquatics and ball games
3. understand that safety concerns must be addressed in the planning and execution of sporting activities
4. select First Aid techniques appropriate to identified sports-related injuries.

Standard: The application of scientific principles to the enhancement of sporting activities

Topic 1- Materials in Sports

Sub-topic 1: Choosing appropriate materials for sporting equipment			
Concepts	**Specific Outcomes**	**Suggested Teaching Strategies**	**Suggested Assessment Activities**
Materials used in sporting equipment have specific physical properties.	*Students will:* • identify and discuss common mechanical properties of matter • list types of materials commonly used in the construction of equipment and indicate the relevant mechanical properties of each • state and explain the reasons for selecting a particular play surface in terms of its properties.	Lectures by the Physical Education teacher to assess the mechanical properties of sporting equipment. Refer to elasticity, strength, durability, buoyancy, density in equipment such as a wooden cricket bat, a leather football, net of tennis racquet, a pole for pole vault. Students develop and test hypotheses based on how well different types of balls bounce on different surfaces.	• Display information collected in a table form. • Role play a salesman selling hockey equipment. • Write up laboratory reports.

Topic 2- Scientific Principles involved in movement of object through fluids

Sub-topic 1: Movement and forces			
Concepts	**Specific Outcomes**	**Suggested Teaching Strategies**	**Suggested Assessment Activities**
The application of force can cause an object to travel in a linear, circular or parabolic pathway.	*Students will:* • apply Newton's Laws of Motion to an object moving through water • understand the concept of centripetal force in relation to the hammer throw and discus • explain the motion of projectiles.	Students watch video of a swimmer and identify the stages at which Newton's Laws are applied. Students critically look at video of sporting activities of the hammer throw, discus and javelin and discuss the science involved. Investigate how the angle at which a ball/arrow/dart/discus is projected affects its range using a paper projectile and a rubber band.	• Using diagrams students can illustrate and explain the movement of the swimmer • Write up a laboratory report.

Sub-topic 2: Movement through air			
Concepts	**Specific Outcomes**	**Suggested Teaching Strategies**	**Suggested Assessment Activities**
Various factors affect movement of an object through air.	*Students will:* • explain how the motion of an object through air is affected by resistance • evaluate the ways in which track and field athletes attempt to reduce the effects of air resistance • explain how smoothness of the surface of a ball can cause variation of its motion.	Practical activity to determine the distance traveled by an object when thrown through the air e.g. ball, javelin, discus Class discussion on the types of clothing athletes wear Invite professional ball player to demonstrate and explain the spin of a ball. Class athletes share experiences in football, cricket, basketball.	• Write up laboratory report. • Students design athletic wear for a particular sport. • Group presentations to explain the spin of different types of balls
Sub-topic 3: Movement through water			
Various factors affect movement of an object through water.	*Students will:* • describe factors that affect movement of objects through water.	By critically looking at video clips, students can identify drag, upthrust, streamlining, buoyancy and action/reaction forces. Students can also explore methods to make movement through water more efficient.	• Design a model to demonstrate features associated with the improvement of movement through water.

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Topic 3 – Safety in Sports

Sub-topic 1: Sports – related injuries			
Concepts	**Specific Outcomes**	**Suggested Teaching Strategies**	**Suggested Assessment Activities**
Injuries can occur during sporting activities.	*Students will:* - explain how some common types of sports injuries arise, using scientific principles - compare strategies used to prepare for and recover from selected sporting activities.	Students research the following using ICT: sprains, strains, fractures torn ligaments, cramps, heat exhaustion, dehydration, shin splints, rotator cup damage and concussion. Students suggest ways of alleviating them. The Physical education teacher can discuss the benefits of warming up at the start and cooling down at the end of exercise for some activities such as jogging, track and field events, football and swimming.	- Group presentations on specific injuries and their treatments - Students demonstrate strategies to the athletes in the class.
Sub-topic 2: Simple First Aid treatment of sports-related injuries			
Simple treatments can be used in the treatment of sports-related injuries.	*Students will:* - explain the scientific principles underlying simple First Aid treatment of sports-related injuries - execute basic techniques in First Aid.	Lecture and training in First Aid conducted by St. John's Ambulance Brigade or Red Cross personnel. Lecture will include: - use of ice to constrict blood vessels and slow down blood flow - application of heat to prevent blood clots - supports used for fractures, strains, sprains. Lecture and training in First Aid conducted by St. John's Ambulance Brigade or Red Cross personnel	Students demonstrate treatment of common injuries.

Resources

- Videos of sporting events
- St. John's Ambulance Brigade
- Physical Education teachers
- Physics textbooks
- Relevant Internet sites

MODULE 4: CHEMISTRY AT WORK

Overview

Many common activities in the home and workplace involve the use of chemicals and chemical reactions. In this Module, students will identify simple chemical reactions used in everyday life.
They will also explore the relationship between the use of metals and non-metals and their physical and chemical properties.
Safety aspects associated with the use and disposal of chemicals will also be investigated.

General Outcomes:

At the end of this module students will:

1. demonstrate an understanding of chemical reactions encountered in everyday life and their practical applications at home and in the workplace
2. recognize the importance of common chemical substances used at home and in the workplace
3. relate the use of metals and non-metals to their physical and chemical properties
4. demonstrate an understanding of general safety procedures as they apply to materials in the home.

Standard: Understand the importance of chemical reactions in everyday activities

Topic 1 – Common Chemical Reactions in the Home

Sub-topic 1: Neutralization reactions			
Concepts	**Specific Outcomes**	**Suggested Teaching Strategies**	**Suggested Assessment Activities**
Neutralization is the reaction between an acid and a base to form a salt and water.	*Students will:* • explain the process of neutralization • relate neutralization to common household activities • explain neutralization in terms of pH.	Investigate neutralization between dilute hydrochloric acid and sodium hydroxide (use word equation). Demonstration to show neutralization reactions, for example, fruit and tea stain removal, use of toothpaste, removal of rust stains with salt and lime juice. Discussion of treatment of insect bites and indigestion Practical activity to monitor the changes of pH in a neutralization activity	• Laboratory report on practical exercises • Create a table relating common household activities and neutralization reactions. • Write up laboratory report.

Sub-topic 2: Decomposition reactions

Concepts	Specific Outcomes	Suggested Teaching Strategies	Suggested Assessment Activities
Decomposition is the breakdown of a substance to form two or more substances.	*Students will:* • explain the process of chemical decomposition • state the products of decomposition of baking soda • describe a chemical test used to identify carbon dioxide • relate decomposition to common household activities.	Investigate decomposition using an acid and baking soda. Investigate the decomposition of baking soda and perform a test to identify carbon dioxide in the products The Home Economics teacher will discuss the use of baking powder/ soda as a raising agent and browning of sugar to stew meats.	• Write a word equation for decomposition. • Write up laboratory report. • Oral questions and answers

Sub-topic 3: Redox reactions			
Concepts	**Specific Outcomes**	**Suggested Teaching Strategies**	**Suggested Assessment Activities**
A redox reaction is one type of chemical reaction.	*Students will:* • explain the term "redox reactions". • describe some common household reactions as redox reactions • explain the process of bleaching fabrics.	Using models, the teacher can discuss the term 'redox reactions'. Project on dyeing of hair, whitening of teeth, rusting, browning of local foods when exposed to air e.g., green figs, yams Students investigate methods of preventing browning e.g., use of lime juice; covering with water. Students design an experiment to determine the optimum pH which would prevent the browning of green figs or yams. Using demonstrations, including stain and dye removal from fabrics, discuss bleaching.	• Write word equations for redox reactions. • Observations made in project report. • Write up a project report on observations made on browning of foods and its prevention • Lab report on the design of the experiment • Prepare an instruction pamphlet for housewives on the use of bleach.

Sub-topic 4: Use of metals and non-metals in everyday life			
Concepts	**Specific Outcomes**	**Suggested Teaching Strategies**	**Suggested Assessment Activities**
Physical and chemical properties of metals and non-metals determine their use in everyday life.	*Students will:* • list the physical properties of metals and non-metals	Through observation and simple activities, students can determine the following physical properties of metals and non-metals: appearance, density, melting and boiling points, hardness, conductivity, malleability.	• Draw a table comparing the physical properties of metals and non-metals.
	• list chemical properties of metals	Carry out simple experiments to compare reactivity of metals with water, steam, acids, oxygen.	• Write up laboratory reports.
	• relate physical and chemical properties of substances to their use.	Students conduct a survey of the use of metals and non-metals in the environment, for example, the use of copper in electrical wires, helium in balloons, silver/gold jewellery, aluminum/iron in pots, plastics in food containers, steel drums in the production of steel pans.	• Students list materials being used in their surroundings and identify the property of the material being utilized in each case.
An alloy is a mixture of a metal and one or more other elements.	• define the term "alloy".	Class project on the nature of alloys referring to brass, steel (including stainless) solder.	• Questions on the comparison between metals and alloys
	• discuss how alloying improves the properties of metals.	Using textbooks or ICT, research and compare the properties of alloys with their corresponding pure metals.	

Sub-topic 5: Chemistry in food preservation			
Concepts	**Specific Outcomes**	**Suggested Teaching Strategies**	**Suggested Assessment Activities**
Chemicals and chemical reactions are involved in the process of food preservation.	*Students will:* • discuss the role of micro-organisms in food spoilage • discuss common methods of food preservation • explain the principle behind each preservation method • determine the best method for preserving a particular food	Students research the topic and make presentations to the class. Research, using ICT, on salting, sugaring, drying, freezing, pickling and use of preservatives e.g. sodium benzoate. The home economics teacher will discuss the following: - Salting and sugaring to remove water from micro-organisms - Drying removes water from the food so micro-organisms cannot thrive - Pickling provides pH which is inappropriate for the survival of micro- organisms. Working in groups, students carry out laboratory activities using different preservation methods to preserve the same food.	• Assessment of oral presentations • Students create a poster describing the various methods. • Students will determine the preservation method as seen in pictures of preserved food and explain in a written report. • Students design and execute an experiment to determine the best method for drying herbs. • Justification of the best preservation method for each type of food from each group of students.

Topic 2 - Safety

Sub-topic 1: Safe handling, storage and disposal of chemical

Concepts	Specific Outcomes	Suggested Teaching Strategies	Suggested Assessment Activities
Household chemicals may be hazardous and should be handled and stored safely.	*Students will:* • identify some common safety symbols • describe methods for the safe disposal of household materials • evaluate practices used in the handling, storage and disposal of household materials and chemicals.	Students conduct a survey of labels on household chemicals and identify safety symbols and safety information. Students research disposal methods used locally e.g., dumping, burning, burying and their consequent effects e.g., water pollution, air pollution etc. Talk by specialist from the Solid Waste Management Company on the proper methods of disposal of waste. Students describe appropriate safety procedures for handling and storing of everyday chemicals e.g., pharmaceuticals, insecticides, bleach and oven cleaners	• Display safety symbols for poisonous, corrosive, explosive and flammable chemicals. • Review disposal techniques of solids, liquids and gases such as plastics, car batteries, aerosol cans etc. • Students comment on the extent to which proper disposal practices are observed in their neighborhoods. • Students make a list of rules to be followed in a household with young children with respect to handling and storage of household chemicals.

Resources

- Help tips on stain removal from the Internet
- Safety signs and symbols from chemical labels and packaging
- Video clip on safety in the home
- Chemistry textbooks

MODULE 5: INDUSTRIES IN TRINIDADAND TOBAGO

Overview

These are many large scale industries which contribute to the economy of Trinidad and Tobago. Many industrial processes are based on scientific processes. In this Module, students will consider some of these processes, the machinery used to do the work and the effects of industrial activity on the environment. The need for safe practices will also be explored.

General Outcomes:

At the end of this module students will:
1. demonstrate an understanding of the scientific principles involved in certain industrial processes
2. demonstrate an understanding of the use and maintenance of simple machines
3. conduct investigations on processes and machines in industries
4. recognize the role of Science and Technology in the manufacture of products
5. demonstrate an understanding of the need for safe practices in industries

Standard: Understand the different types of chemical processes in industries

Topic 1 – Chemical Processes in Industries

Sub-topic 1: Distillation			
Concepts	**Specific Outcomes**	**Suggested Teaching Strategies**	**Suggested Assessment Activities**
Distillation is based on the difference in boiling points of components in a mixture.	*Students will:* • explain the process of distillation	Investigate through practical work the use of evaporation and condensation to separate a pure liquid from a mixture.	• Drawing and labelling of the apparatus for distillation
	• carry out a simple distillation process	Practical activity to separate pure water from seawater	
			• Students write up laboratory report.
	• list some uses of distillation	Research using the Internet to discuss the use of simple distillation in the alcohol and dry cleaning industries and in desalination	
	• explain fractional distillation.	Using drawings of fractional distillation column in the petroleum industry, the teacher discusses the fractions produced	• Students prepare a chart showing the different fractions and their boiling points obtained from petroleum.

Sub-topic 2: Electrolysis

Concepts	Specific Outcomes	Suggested Teaching Strategies	Suggested Assessment Activities
Electrolysis involves passing an electric current through a substance causing it to decompose.	*Students will:* • describe the process of electrolysis • investigate the large-scale use of electrolysis in industry • describe the process of electroplating • evaluate the benefits of electroplating.	Demonstration of electrolysis with students identifying anode, cathode, electrolyte, products using copper sulphate solution Discussion using newspaper articles, on the establishment of an aluminum smelter in Trinidad and Tobago Observation of electrolysis where a metal is deposited on a cathode Research the advantages of electroplating, e.g., "chroming" of steel pans, gold plating of jewellery, galvanizing.	• Drawing and labeling of the electrolytic cell • Debate the "pros" and "cons" associated with establishment of an aluminum smelter in Trinidad. • Plan and design an experiment for galvanizing

Topic 2 – Machines in Industry

Sub-topic 1: Types of machines and how they work			
Concepts	**Specific Outcomes**	**Suggested Teaching Strategies**	**Suggested Assessment Activities**
Identify a machine as any device by means of which a force applied at one point can be used to overcome a force at some other point.	*Students will:* • explain the definition of a machine and classify simple machines	Students carry out practical activities to investigate the working of pulleys, wheels, gears, inclined planes and levers.	• Classify simple machines as 1st class, 2nd class, 3rd class.
Several machines/ operations in industry are controlled by computers.	• examine the role of the computer in the operation of machinery in industrial plants.	Students research use of computer-controlled processes in local industries e.g., petroleum refining, electricity generation etc. Visit to an industrial site where possible.	• List computer-controlled processes in the industries. • Students write up a report.

Sub-topic 2: Choosing machines for a particular job			
Concepts	**Specific Outcomes**	**Suggested Teaching Strategies**	**Suggested Assessment Activities**
Machines do specific jobs.	*Students will:* • evaluate machines according to their efficiency • assess the suitability of a particular machine for performing a given task.	Calculate the efficiency of the different types of machines listed. Use a guest speaker from industry. Discussion should include suitability, cost- benefits, environmental effects, pollution and availability of human resources.	• Describe experiments to measure the efficiency of the different types of machines listed. • Students make a survey of construction or industrial sites and evaluate the extent to which these machines are put to use.
Machines may lose their efficiency.	• discuss how machines become inefficient • identify ways of reducing inefficiencies in machines	Review of relevant literature to: - consider the effects of friction, rusting, wear and tear, lack of lubrication as contributing factors. - explore different methods of reducing friction in machines.	• Students undertake a project to reduce inefficiency in machines at home. Students produce a written report.

Topic 3 – Industrial Safety

Sub-topic 1 : Working in a safe environment			
Concepts	**Specific Outcomes**	**Suggested Teaching Strategies**	**Suggested Assessment Activities**
Safety is important in the working environment.	*Students will:* • identify common industrial safety signs	With reference to the OSHA document, students will obtain information on safety signs for the following: Explosion/Release of Pressure, Danger, Hard Hat area, Falling Objects, High Voltage, Hazardous Materials, Chemical Splash area, Emergency Stop.	• Draw and display these safety signs on a chart.
	• evaluate the importance of safety gear in industries	Students discuss hazards which could be alleviated by the use of protective gear such as helmets, boots, harness, goggles, coats, gloves and gas masks.	• Students evaluate the school compound for unsafe practices. They compile guidelines for proved safety on the school compound. • List flammable substances.
	• identify conditions necessary to start a fire	Based on experiences, students discuss components needed to start and maintain a fire i.e. fuel, heat and oxygen.	
	• describe methods of extinguishing fires including chemical and electrical fires	Students research different types of fire extinguishers and their suitability for different types of fires e.g., electrical and oil fires.	• Students prepare a document making recommendations to the Principal for the provision of fire extinguishers in the workshop areas of the school. They must identify the type of extinguisher, with reasons for their selection.
	• select the best type of fire extinguisher for given circumstances.		

Sub-topic 2 : Safe disposal of industrial materials			
Concepts	**Specific Outcomes**	**Suggested Teaching Strategies**	**Suggested Assessment Activities**
Industrial waste must be disposed of safely.	*Students will:* • describe the safe disposal of various classes of material	Students do research using ICT, on the proper disposal of the following: - liquids – chemicals, oils, hot water - medical waste - waste from food processing plants - nuclear waste - gases and consider burning, burying and storing in drums as some methods of waste disposal.	• Portfolio on industrial waste disposal
	• discuss pollution and health hazards associated with improper waste disposal.	Using video clips, students discuss: - pollution of rivers and the effect on aquatic organisms - health hazards posed by exposure to infected waste - dangers associated with exposure to radioactive material. Students evaluate facilities available locally for disposal of high-risk waste.	• Students research a large-scale local industry and assess whether their disposal of waste products poses any danger to people in the environment. • Write a field report.

Resources

- Chemistry texts
- Industrial manuals
- Laboratory manuals
- Physics texts
- Safety manuals from industries
- Specialist person from the Ministry of Labour
- OSHA document

MODULE 6: ELECTRICITY AT WORK

Overview

Electricity has transformed the world into a rapidly advancing technological society and is mainly responsible for the mechanization of work. It is used to power appliances in the home as well as in major industries. It is therefore important that students understand the principles behind its use in the home, as well as the safety and economic implications of its use.

In this Module, students will look at issues related to the harnessing of electrical energy for domestic purposes and the student is empowered to make informed decisions on safety and sustainability in the use of electricity .

General Outcomes

At the end of the module students will:
1. examine issues of sustainability, efficiency and wastage in relation to the production, transmission and consumption of electricity in the Caribbean
2. assess consumer information related to the domestic use of electricity
3. critique common practices related to the use of electricity for domestic purposes
4. develop best practices for conservation and safety when using electricity.

Standard: Understand the production, transmission of electricity and its responsible use for domestic purposes

Topic 1 – The Production and Transmission of Electricity

Sub-topic 1 : The production of electricity

Concepts	Specific Outcomes	Suggested Teaching Strategies	Suggested Assessment Activities
Sustainability is a critical factor guiding current and future trends in the production of electricity.	*Students will:* • critically assess traditional and alternative methods of producing electricity that are currently practiced in the Caribbean. • evaluate the potential for the use of renewable sources in the future production of electricity in the Caribbean.	Undertake research on each method as found in a specific Caribbean island and evaluate each in terms of efficiency, economical and environmental impact.	• Conduct a debate on the topic: "Alternative energy sources for the production of electricity are not sustainable".

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Sub-topic 2 : The transmission of electricity			
Concepts	**Specific Outcomes**	**Suggested Teaching Strategies**	**Suggested Assessment Activities**
Heat losses are the main source of wastage of electrical energy as it is transmitted from the power station.	*Students will:* • relate energy losses in the transmission of electricity to the current flow and the resistance of the wire • understand that the transmission of electricity at high voltages reduces energy losses.	Practical activity to identify the parameters which affect energy loss from a passive resistor (metallic conductors of different materials and thicknesses). Demonstrate the use of transformers for stepping up and down voltages and measure the current changes in each case. Explain that the higher the voltage, the smaller the current and the lower the power loss in connecting wires.	• Report on practical • Explain the principles involved in the transmission of electricity by reference to a model showing how electricity is transmitted from a power station to homes.

Topic 2- Domestic Consumption of Electricity

Sub-topic 1 : Using electricity safely			
Concepts	**Specific Outcomes**	**Suggested Teaching Strategies**	**Suggested Assessment Activities**
Electricity can be dangerous if used inappropriately and carelessly. There are devices which enable safe use of electricity.	*Students will:* • identify risks involved in using electricity in relation to high voltages and current and their effects on the human body e.g., shocks and electrocution • explain international conventions for wiring using a 3-pin plug • explain the safety functions of fuses, circuit breakers, surge protectors • explain the need for differently rated fuses and flexes • discuss best practices for using electricity safely.	Examination and discussion of the safety guidelines printed in user manuals and packaging materials of various appliances Lecture and demonstration by EHS personnel on the effects of an external current on the body and how to assist someone who is in shock or has been electrocuted Demonstration and lecture on the wiring of a 3 pin plug with emphasis on the importance of the earth wire Discussion of household lighting and protective devices by an electrician Examination and observation of each device Practical activities to make observations on the effect of varying the load current in a circuit Use newspaper articles to stimulate an exploration of the dangers associated with using common household appliances e.g., hair dryers and electric razors in the bathtub.	• Creation of safety rules for use of electrical devices in different environments (homes, labs. Classrooms) • Description of modification of a 3 pin plug for use in a 2 pin outlet • Annotation of diagrams of each safety device mentioned • Creation of a table of features of devices and their corresponding safety functions • Students select the appropriate fuse for specific appliances and justify their choice. • Students mount a campaign to encourage the safe use of electricity at home suggesting reasons for TTEC's advisory on kite flying, tree cutting, fruit picking and fallen wires.

Sub-topic 2 : Power consumption of domestic appliances and devices			
Concepts	**Specific Outcomes**	**Suggested Teaching Strategies**	**Suggested Assessment Activities**
Power rating of an appliance determines how much electrical energy it uses.	*Students will:* • explain the term 'power rating" and calculate power from basic electrical quantities	Discussion with worked examples on calculating power as a measure of energy consumed in unit time	• Design a lab to demonstrate the heating effect of bulbs of different power rating.
	• determine and compare the electrical energy consumption of various appliances	Students record the power rating found on various appliances as referred to in manufacturers' pamphlets and publications of T&TEC.	• Complete tables of appliances and suggested power rating. Use the information to deduce the most energy efficient appliances.
	• evaluate household appliances and devices according to their energy efficiency.	Conduct a field trip to a nearby department store to survey energy efficient household appliances and devices.	• Explain the significance of the "energy star" label on some appliances.

Sub-topic 3: How much does electricity cost?			
Concepts	**Specific Outcomes**	**Suggested Teaching Strategies**	**Suggested Assessment Activities**
The cost of electricity is determined by the amount of power consumed.	*Students will:* • explain the term "kilowatt-hour". • discuss issues related to electricity consumption.	Use problems to deduce unit from previous definitions. Students monitor meter readings during the week and at weekends for one month, and evaluate the data collected in relation to the following differentials, including rural, urban, level of incomes, ages of children, presence of commercial activity etc.	• Problem sheet • Present a report on data collected and findings.
	• interpret information on an electricity bill • determine the cost of electricity based on information found in an electricity bill • critically examine the issue of conservation of electricity.	Students read electricity bills to ascertain: - the amount of energy used - the cost of energy - other related charges e.g. fuel tax, VAT. They calculate the total bill. Students brainstorm methods of reducing the amount of electricity used in the household. They discuss the use of parallel circuits, fluorescent bulbs etc., as means to reduce energy losses.	• Completion of an electricity bill by estimating typical energy used of a particular category of household and calculation of the total bill. • Students produce a list of rules/practices to be followed in order to conserve electricity at home.

Resources

- Newspaper articles on electrical mishaps
- Picture/video clip showing unsafe use of electricity
- Pictures of and energy information on various domestic appliances
- Schematics from a variety of appliances
- TTEC leaflets and website
- http://www.nytimes.com/learning

MODULE 7: Sound and Communication

Overview

This Module looks at the characteristics of sound and the part that sound plays in our everyday lives. Firstly, the Module looks at the nature of sound, how it is generated and transmitted, how it is detected and its effects on humans.

Sound plays an important role in communication such as speech, music generation and radio transmission. Students would be exposed to some devices used in the communication of sound.

General Outcomes

At the end of the module students will:

1. understand how sound is generated, transmitted and received
2. conduct investigations on scientific concepts which relate to certain aspects of communications
3. discuss the scientific principles of communication devices commonly found in the home and workplace
4. examine the role of technology in enhancing communication.

Standard: Understand the processes involved in the production, transmission and reception of sound

Topic 1- Sound

Sub-topic 1 : Characteristics of sound			
Concepts	**Specific Outcomes**	**Suggested Teaching Strategies**	**Suggested Assessment Activities**
Vibrations produce sound. Sound has specific characteristics.	*Students will:* • discuss the nature of sound as a mechanical wave • explain how sound is produced • identify various parameters used to describe sound • describe factors that affect the quality of sound.	Explore different ways in which sound is produced e.g., plucking of a string, blowing through air, air over vocal cords. Explain the terms amplitude, period, frequency, wavelength, and speed, using a tuning fork and oscilloscope. Derive relationship by referring to graphical representation of sound wave. Use of music to discuss harmonics and overtones in relation to sound quality	• Completion of table of instruments showing method of sound propagation/ characteristic of sound produced. • Annotation of graphical representations of waves • Problem sheet • Oral quiz

Sub-topic 2 : Classification of musical instruments			
Musical instruments are classified according to the way in which the sound is generated.	*Students will:* • classify musical instruments into wind, string and percussion, according to the method of generating sound • discuss how the materials used in making instruments and tension affect the characteristics of sound produced.	Use a variety of musical instruments, e.g., steelpan, dholak, flute and violin, to classify into the three groups. Use the guitar to discuss how frequency varies with type, thickness and tension of strings.	• Categorize the instruments seen in a picture of an orchestra. • Design and construct a musical instrument (a "box bass" for a parang band, a mini tenor pan from a fruit juice can etc.) and present a report on the activity.

Sub-topic 3 : Transmission and reception of sound			
Concepts	**Specific Outcomes**	**Suggested Teaching Strategies**	**Suggested Assessment Activities**
A medium is necessary for the transmission of sound.	*Students will:* • describe how sound travels through different media • use the Particle Theory to explain why sound needs a medium • identify parts of the human ear • describe how we hear.	Students perform simple activities (bell jar experiment) to demonstrate the transmission of sound through different media. Use simulations-slinky to explain that sound is transmitted when particles vibrate against each other. Class discussion and use of model of the human ear to identify relevant parts involved in the process of hearing. Include prevention of damage to the ear.	• Report on activities. • Fill in the blanks in a paragraph on sound transmission. • Students complete a Crossword puzzle describing the structure and functions of the ear.

Sub-topic 4 : Noise pollution and its consequences			
Concepts	**Specific Outcomes**	**Suggested Teaching Strategies**	**Suggested Assessment Activities**
Loud noises can be harmful to health.	*Students will:* • define the term "intensity" and its unit the "decibel"	Use model of wave or slinky to illustrate the concept of intensity as energy distributed per unit area.	• Problem sheet to calculate sound intensity in terms of decibel
	• relate high amplitude and frequency to characteristics of sound such as loudness, pitch and noise	Class discussion using claves and tambourine to illustrate. Consider noise as sound that has changing frequency (no definite pitch) and irregular vibrations	• Classification (matching/table) of various instruments and devices according to their loudness and pitch.
	• identify the audible range of humans and explain why loud sounds can have adverse effects on health.	With reference to the appropriate sections of the Noise Pollution Control rules, identify the audible range.	• Students complete an application (mainly sections B-D) to the Environmental Management Authority for permission to host a Carnival fete.
		Students research the effects of high and low frequency sound on the body. Consider rupture of eardrum, deafness, rise in blood pressure etc. Discuss continued exposure to loud noises by musicians, airport and industrial workers.	• Develop a plan to convince classmates of the danger of staying near to the big speaker boxes during a party.

Topic 2 – Communication Devices

Sub-topic 1 : Electromagnetic waves			
Concepts	**Specific Outcomes**	**Suggested Teaching Strategies**	**Suggested Assessment Activities**
Radio waves enable sound to be transmitted over long distances.	*Students will:* • describe the electromagnetic spectrum listing the sources, properties and uses of the main components	Research on the electromagnetic spectrum emphasizing that it is a classification of waves of varying wavelengths and frequencies	• Complete a table of source/properties/uses of the main components of the electromagnetic spectrum.
	• explain the use of radio waves in sound transmission	Conduct demonstration of reflection, refraction, diffraction and resonance of radio waves and discuss their roles in transmission and reception of radio signals.	• Prepare an annotated poster to explain how radio waves travel over hills etc.
	• discuss the use of different types of antennae.	Use pictures to stimulate discussion of long and dish antennae.	• Complete a table of comparison of types of antennae.

Sub-topic 2 : Communication devices			
Concepts	**Specific Outcomes**	**Suggested Teaching Strategies**	**Suggested Assessment Activities**
There are many devices used for the communication of sound.	*Students will:* • explain the role of transducers in communication • explain in simple terms how some communication devices work • explain in simple terms how the Internet operates.	Provide examples of common transducers and elicit the energy conversions for each. Research the working of the telephone, cell phone, microphone, bar code reader. Students discuss research on the history and development of the Internet.	• Completion of crossword/fill the blanks of relevant statements • Quiz in the format of a battle between two teams • Students e-mail an essay entitled "Imagine a world without the Internet", to the teacher.

Resources

- Musical instruments from each category: percussion, wind, string
- Charts and model of the human ear
- Websites e.g. http://science.howstuffworks.com about.physics.com.

MODULE 8: CHARACTERISTICS OF ECOSYSTEMS

OVERVIEW

Environmental awareness has become an important feature of modern life. The need to conserve the biotic and abiotic components of the ecosystem needs to be appreciated by everyone. In this Module, students will explore the relationships in an ecosystem in an effort to understand how various events – both natural and man-made can cause imbalance to occur. It is expected that students will develop concern for maintaining a healthy environment.

GENERAL OBJECTIVES

At the end of this module students will:
1. Understand the components of an ecosystem
2. demonstrate an understanding that ecosystems are in a state of dynamic equilibrium
3. recognize that relationships within an ecosystem maintain equilibrium.

Standard: Biomes are composed of many kinds of ecosystems.

Topic 1 – Characteristics of an Ecosystem

Subtopic 1 : The features of an ecosystem			
Concepts	**Specific Outcomes**	**Suggested Teaching Strategies**	**Suggested Assessment Strategies**
A stable ecosystem exists in a state of dynamic equilibrium.	*Students will:* • identify characteristics of ecosystems	Classroom discussion and student research to identify biotic and abiotic factors in ecosystems	• A table is drawn listing biotic and abiotic factors.
There is a flow of energy within an ecosystem.	• describe biogeochemical cycles necessary to maintain equilibrium within an ecosystem	Use of Internet to demonstrate cycles to students Brainstorming and classroom discussion on the importance of the flow of energy and nutrients through an ecosystem	• Complete graphic organizer of cycle(s). • Using diagrams, students can show the flow of energy and nutrients within the selected ecosystem.
Activities can affect the balance in an ecosystem.	• identify food chains and food webs that exist within ecosystems • investigate conditions/ relationships in a local ecosystem which can lead to imbalance • evaluate the role of individuals and communities in maintaining a stable ecosystem.	Use of ICT to demonstrate diagram to students along with classroom discussions Classroom discussion and brainstorming on the benefit of the wise use of resources to sustainable development Use of newspaper articles to discuss how local activities/events can affect balance in an ecosystem.	• Students investigate local activities/events which may affect balance in an ecosystem and report on findings. • Students design a campaign to sensitize the community about actions individuals can take to help maintain an ecosystem.

Topic 2 – Imbalance in Ecosystems: Pollution

Concepts	Specific Outcomes	Suggested Teaching Strategies	Suggested Assessment Strategies
Sub-topic 1: Waste disposal			
Proper disposal of waste is vital in maintaining a stable ecosystem.	*Students will:* • define the term "pollutant" • outline the categories of pollutants • evaluate the efficiency of the methods of disposal of waste in the community • identify ways to correct any imbalance in the ecosystem caused by inefficient disposal of waste.	Classroom discussion and student research using ICT Carry out a survey of methods of disposal of waste in a selected community Brainstorming to analyze the extent to which these waste materials affect balance in the ecosystem Consult with Solid Waste Management Company on individual and community participation in waste disposal activities.	• Quiz on matching pollutants to types of pollution • Prepare a table to show suitable methods of disposal of these materials. • Present a written/oral report to the class explaining the efficiency of these methods. • Design an improvement plan for the disposal of waste in the school or community.

Sub-topic 2 : Air pollution			
Concepts	**Specific Outcomes**	**Suggested Teaching Strategies**	**Suggested Assessment Strategies**
A variety of substances pollute the air.	*Students will:* • identify common air pollutants and their sources	Use ICT, students' research and classroom discussion on greenhouse gases, acid rain, chlorofluorocarbons (C.F.C's) and local examples such as smoke from burning landfills, Sahara dust, dust from cement factory and car exhaust fumes.	• Table of air pollutants and their sources
Air pollutants affect the environment in different ways.	• describe the effects of these pollutants on an ecosystem	Student research and classroom discussion on the effects of these pollutants on the living and non-living e.g., greenhouse effect, global warming, depletion of the ozone layer and breathing disorders	• Perform an experiment to illustrate the greenhouse effect.
	• suggest how air pollution can be reduced	Student research and brainstorm on reducing air pollution.	
	• list some international agreements that address the need to reduce air pollution globally	Students research the Kyoto Treaty and Montreal Protocol on gas emissions	• Students debate on how effective these international agreements can be in reducing air pollution worldwide.

Sub-topic 3 : Water pollution			
Concepts	**Specific Outcomes**	**Suggested Teaching Strategies**	**Suggested Assessment Strategies**
A variety of substances pollute water.	*Students will:* • identify common water pollutants and their sources	Students research and use photos to discuss pollutants: - biological (sewage from food processing plants, farm waste) - chemical (pesticides, heavy metals, fertilizers, oil) and - solids (plastics, household appliances, lead batteries).	• Prepare a table identifying examples of water pollutants and their sources
	• discuss the effects of oil spills on a marine ecosystem	Classroom discussion on case studies involving marine oil spills	• Students list emergency measures taken locally to deal with oil spills.
Water pollution can affect living organisms in different ways.	• define the term "eutrophication"	Class discussion and student research on the nutrient effect of some pollutants in an aquatic system	• Group presentations on local and global examples of eutrophication
	• discuss how water pollution can be reduced	Students research and discuss how discharge of effluent from factories etc. can be monitored.	• Write a letter to EMA suggesting how discharge from factories can be monitored

Sub-topic 4 : Misuse of an ecosystem			
Concepts	**Specific Outcomes**	**Suggested Teaching Strategies**	**Suggested Assessment Strategies**
Overexploitation of resources in an ecosystem is a cause of imbalance.	*Students will:* • identify human activities which lead to over exploitation of resources within an ecosystem	Using newspaper articles, students can discuss overexploitation of resources e.g. over fishing, over hunting, deforestation, mining and quarrying.	• Students investigate local examples of overexploitation of resources and present their findings.
Conservation can be related to the preservation of species as well as to the management of the ecosystem.	• discuss the consequences of overexploitation of an ecosystem	Through further discussions, students will identify some consequences e.g., extinction of species, baring of land resulting in erosion and landslips	• Students produce a pamphlet aimed at informing the community about the dangers of over exploitation of resources in an ecosystem.
	• define the term "conservation"	Brainstorm and discuss to arrive at a definition of conservation. Field visit to swamp/wetland ecosystem. Students will observe and discuss conservation methods.	• Report on visit to include conservation efforts.
	• describe measures that attempt to conserve fish, wildlife, forest and land and mineral resources	Using information obtained from the Ministry of Agriculture, students will discuss conservation.	• Students investigate and make presentations on existing regulations which focus on conservation e.g., hunting season, control of timber cutting, protection of Scarlet Ibis and quarrying.
Poor land use can have negative effects on the ecosystem.	• evaluate the effects of poor land use.	Using pictures, students can discuss poor agricultural practices, flooding, silting of waterways, loss of soil, loss of habitats etc.	• Students suggest ways of reducing the problems and present findings to class.

Resources

- Environmental Management Authority—Pamphlets
- GLOBE Manual and CD-ROM
- Institute of Marine Affairs – leaflets and other documents
- Junior Environmentalists of Trinidad and Tobago (JETT) newsletter
- National Geographic – Magazine; Cable channel; website
- Solid Waste Management Company—Specialist personnel
- Video clips e.g. Earth Report
- Wild Fowl Trust Manual

MODULE 9: CONCEPTS IN PLANT SCIENCE

OVERVIEW

Advances in Science and Technology have allowed the manipulation of ecosystems for different reasons. In the area of agriculture, this is especially evident. Here, the modification of the structure and nutrient content of soil, and certain characteristics of plants, are noteworthy examples.

In this Module, students will explore ways in which plants can enhance human life.
Safety procedures associated with chemicals will also be considered.

GENERAL OBJECTIVES

At the end of this module students will:
1. demonstrate an understanding of the conditions necessary for plant growth and propagation
2. investigate the effects of various conditions on the growth of plants
3. recognize that plant characteristics can be modified through biotechnology
4. comment on the impact of biotechnology on society.

Standard: Plants can enhance human life.

Topic 1 – Plant Nutrients

Concepts	Specific Outcomes	Suggested Teaching Strategies	Suggested Assessment Strategies
Sub-topic 1: Role of nutrients in plant growth			
Inorganic nutrients are needed for the proper growth of plants.	*Students will:* • identify the essential nutrients necessary for plant growth	Research and compile list to identify macro and micronutrients and their function in the plants.	• Complete table.
	• recognize the signs of nutrient deficiency in plants.	Conduct experiments to determine the effects of deficiency of nutrients on plants, using culture solutions.	• Students write up a report.

Topic 2 – Soil

Sub-topic 1: Components of soil

Concepts	Specific Outcomes	Suggested Teaching Strategies	Suggested Assessment Strategies
Soil is a mixture of mineral matter, water, air, humus and living organisms.	*Students will:* • describe the components of soil	Practical activity e.g., sedimentation, determination of percentage of air, water, humus using different types of soil	• Students write up reports.
Soil type is determined mainly by the proportions of its components.	• identify the three soil types with reference to drainage, pH, organic matter, salinity etc.	Use data obtained in both sets of practical activities to classify the sample as sandy, clay or loam.	• Create a table of sample/observation/inference.

Sub-topic 2: Improvement and maintenance of soil quality			
Concepts	**Specific Outcomes**	**Suggested Teaching Strategies**	**Suggested Assessment Strategies**
Soil quality may be improved or maintained in different ways.	*Students will:* • discuss how different types of soil can be modified for optimal growth of plants • explain how crop rotation enhances soil quality.	Specialist person to lead discussion on addition of lime, sand and humus Field visit to research planting of different crops at different times to vary the nutrient demand on the soil.	• Plan and design an experiment, that compares growth rate of a plant before and after modifying a base soil • Students prepare a report

Topic 3 – Methods of Plant Cultivation

Sub-topic 1: Growing plants under controlled conditions			
Concepts	**Specific Outcomes**	**Suggested Teaching Strategies**	**Suggested Assessment Strategies**
Plants can be grown under controlled conditions.	*Students will:* • describe different methods of plant cultivation • describe the advantages and disadvantages of each method of plant cultivation.	Students look at a variety of methods e.g. organic farming, hydroponics, grow box method, greenhouse, tissue culture etc. Field trip to hydroponics farm/greenhouse	• Students list the various methods and describe how each method controls conditions of growth. • Create a table of comparison that considers cost, efficiency and benefits of the various methods.
Sub-topic 2: Pest control			
Concepts	**Specific Outcomes**	**Suggested Teaching Strategies**	**Suggested Assessment Strategies**
Crop pests may be controlled by biological or chemical means.	*Students will:* • identify common crop pests in Trinidad and Tobago • describe how common crop pests can be controlled biologically and chemically.	Students research common crop pests. Research and discuss locally used methods of biological and chemical control e.g. ladybird beetle consumes the mealy bug; insecticides and fungicides.	• List common crop pests. • Students prepare arguments for and against the use of biological and chemical methods, including cost, rate of action, environmental considerations.

Topic 4 – Production of New Plants

Concepts	Specific Outcomes	Suggested Teaching Strategies	Suggested Assessment Strategies
Sub-topic 1: Sexual and asexual reproduction in plants			
New plants can be produced sexually and asexually.	*Students will:* • compare asexual and sexual reproduction	Using diagrams, the teacher will discuss: the number of parents involved in each type; the characteristics of the offspring.	• Tabulate differences between each type of reproduction.
There are different methods of vegetative reproduction.	• describe methods of vegetative reproduction	Field trip to agricultural station to observe grafting; tissue culture etc.	• Report of field visit
	• compare different forms of vegetative reproduction.	Students research and discuss advantages/disadvantages of each method, in terms of rate of reproduction and economic benefits.	• Write an essay on the benefits of tissue culture in the production of orchids and/or pineapples.

Topic 5 – Biotechnology in Agriculture

Sub-topic 1: What is biotechnology?			
Concepts	**Specific Outcomes**	**Suggested Teaching Strategies**	**Suggested Assessment Strategies**
The use of Biotechnology can change characteristics of a plant.	*Students will:* • explain the term "Biotechnology"	Use documentaries to stimulate discussion.	• Quiz
	• discuss applications of biotechnology in each of the following areas: - Medicine - Agriculture - Bioremediation and - Biodegradation	Research and group discussion Refer to drug production, improved crop quality and removal of environmental pollutants.	• Class debate on the "pros" and "cons" of biotechnology
	• evaluate the benefits/risks of biotechnology to society	Research projects that consider: costs; contribution to the economy; potential of genetically modified foods to harm human beings and upset the ecosystem.	

Topic 6 – Safety

Concepts	Specific Outcomes	Suggested Teaching Strategies	Suggested Assessment Strategies
Sub-topic 1: Safe use and storage of agricultural equipment and chemicals			
Safety is important in the use of agricultural chemicals.	*Students will:* • explain the need for The safe use and disposal of agricultural chemicals	Using labels/packaging materials, discuss the poisonous nature of some of these chemicals.	• Prepare a list of precautions to be taken by a farmer who uses agricultural chemicals on his crops.

Resources

- Agricultural Science teachers
- Farmers Training Centre at Centeno
- Labels on bottles of agricultural chemicals
- Specialist personnel from the Ministry of Agriculture
- Tissue culture laboratory at UWI

MODULE 10: NATURAL PHENOMENA AND DISASTERS

OVERVIEW

Natural disasters result in damage or loss of human life, property, crops as well as livestock. The damages to ecosystems are significant and may require considerable investment of resources if they are to be remediated. Most natural disasters result from either sudden changes in the movements which take place in the earth's crust resulting in earthquakes and volcanoes or heightened climatic and weather conditions as evident in flooding, lightning, storms and hurricanes.

This Module explores how these natural phenomena occur, their effects on the population and safety precautions which should be taken to minimize possible devastating results.

GENERAL OBJECTIVES

At the end of this module students will:
1. understand that under certain conditions, the normal continuous movement of the earth's surface can suddenly become vigorous and result in earthquakes or volcanoes
2. state and explain practices for monitoring earthquakes and volcanic activity and the effective management of these disasters if they occur
3. evaluate the effects of temperature, pressure and rainfall on climate and relate these to natural phenomena which take place in the Caribbean.

Standard: Understands the effects of basic earth processes

Topic 1- Plate Tectonics

Sub-topic 1: Structure of the earth's crust			
Concepts	**Specific Outcomes**	**Suggested Teaching Strategies**	**Suggested Assessment Strategies**
Plate tectonics contribute to movements in the Earth's surface.	*Students will:* • discuss the plates which make up the earth's crust	Using photos and pictures the teacher can: - refer to major and minor plates floating on the partially molten mantle - refer to the relative significance of friction and gravitation.	• Students will draw and explain plate motion using the pictures given.
	• identify the driving forces of plate motion.	Students construct models to illustrate constructive, destructive and transform fault plate margins	• Students demonstrate and explain to the class how the model works.

Topic 2 – Features Associated with Plate Tectonics

Sub-topic 1: Volcanoes			
Concepts	**Specific Outcomes**	**Suggested Teaching Strategies**	**Suggested Assessment Strategies**
Volcanoes should be monitored due to their effects on the environment.	*Students will:* • discuss how visible and invisible changes in volcanoes are monitored.	Through presentation, the Geography teacher can: • describe the use of observational checklist and other methods for the collection of data on visible changes in steaming, relief features, foliage etc. Using research and ICT, the students and teacher can: • discuss measurement of ground movements, earthquakes, variations in gas compositions, and deviations in local electrical and magnetic fields.	• Using video clips of a volcanic eruption, create a monitoring diary of visible and invisible changes that can be expected before and during the eruption.
	• explain the short and long term effects of volcanic activity on the environment.	View a documentary on volcano activity in Montserrat with subsequent dislocation of the population. Consider the positive and negative effects.	• Students will design a pamphlet showing precautions which should be taken to prevent loss of life when a volcano erupts and suggest appropriate recovery activities.

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Sub-topic 2: Earthquakes			
Concepts	**Specific Outcomes**	**Suggested Teaching Strategies**	**Suggested Assessment Strategies**
Earthquakes should be monitored regularly due to their negative impacts on the environment.	*Students will:* • discuss an earthquake in terms of tectonic activity	Using diagrams/ flip charts/videos, the teacher can: • discuss sudden movements in the earth's crust that occur when moving plates collide.	• Drawing of tectonic plates to describe an earthquake
	• define the terms epicenter, focus and aftershock	Students research definitions.	• Prepare a poster with definitions.
	• describe how earthquakes are measured	Field trip to seismic research laboratory. Refer to the use of seismographs using the Richter scale.	• Design a bulletin which informs on the dangers associated with earthquakes and measures for preparedness.
	• describe the effects of earthquakes	Use of documentaries or movies to demonstrate the extent of damage which occurs, e.g., loss of life, destruction of property, tsunamis etc. Students discuss their personal experiences of earthquakes.	• Students list precautions which could be taken to reduce damage to buildings and loss of life.

Topic 3- Climate

Sub-topic 1: Storms, Hurricanes and Floods			
Concepts	**Specific Outcomes**	**Suggested Teaching Strategies**	**Suggested Assessment Strategies**
Changes in temperature, pressure and rainfall contribute to climatic activity.	*Students will:* • monitor environmental temperature over a period of time	Students monitor maximum/ minimum temperature of their immediate environment for one month.	• Display daily temperatures for one month and make inferences.
	• relate air movement/wind, to pressure differences	Using pictures from the Internet, the teacher can: • discuss the distribution of pressure and winds across a hurricane.	• Students draw and explain wind movements.
	• describe how rainfall is measured	Appropriate use of rain gauge to monitor rainfall in school compound	
	• describe the features and formation of a storm and a hurricane	Students can look at a video clip/movie of a storm and discuss that a hurricane is a high energy system with winds over 120 kph.	• Display data collected over a one month period and draw appropriate conclusions.
A hurricane is an extreme form of cyclonic storm.	• explain how hurricanes are predicted and tracked	Research on satellite tracking and hurricane aeroplanes which determine the path of the hurricane.	• Prepare a poster to show the structure of a hurricane.
	• discuss the impact of a hurricane to human activities	Discussion to include students' experiences of hurricanes; precautions to be taken before, during and after a hurricane.	• Plan a weather bulletin on the progression of the climatic conditions and indicate when storm and hurricane warnings are appropriate.

Sub-topic 1: Storms and hurricanes			
Concepts	**Specific Outcomes**	**Suggested Teaching Strategies**	**Suggested Assessment Strategies**
Certain weather conditions such as heavy rain, thunderstorms or hurricanes can cause flooding.	• explain the causes of flooding • outline the impacts of flooding.	Students can brainstorm and use their experiences to explain the causes of flooding which can include: increase in wind currents, high rainfall, deforestation, poor farming, overgrazing, over-cultivation, poor water management, population pressure. Research on past destructive floods and discuss the impact of flooding. Refer to: economic loss; resources used in reconstruction; destruction of environment; disease; loss of life; making soil more fertile and providing nutrients in which it is deficient.	• Students prepare a plan of action to be followed before during and after a hurricane. • Students prepare poster/ project on measures taken to reduce flooding. • Analysis of a case study of a village sited near a river.

Sub-topic 2: Lightning

Concepts	Specific Outcomes	Suggested Teaching Strategies	Suggested Assessment Strategies
Lightning is a natural example of the electrostatic phenomenon.	*Students will:* • explain charging by friction and induction • discuss the dangers associated with lightning.	Use of video clips to discuss the formation of lightning and the use of the lightning rod as a means to safely dissipate charges. Discussion to include students' experience of lightning; precautions to be taken when there is lightning.	• Explain why we hear the thunder associated with lightning before it is actually seen. • Prepare poster on the dangers associated with lightning.

Resources

- Geography texts
- Geography teachers
- Movies on disasters
- National Geographic – channel, magazine, website
- NEMA—leaflets, brochures
- Newspaper articles on relevant information
- Photographs
- Seismic Research Unit, U.W.I.—Specialist person

Part 3
Teaching and Assessment Strategies

Proposed Teaching and Learning Strategies

Teaching and Learning Science

> *"If school is not inviting, if the tasks are not clear, interesting and at an appropriate level, how can we expect pupils to be on task? Adverse student reactions should be expected when classes are dull, teaching is uninspired, and failure is built in."*

<div align="right">William Morse (1987)</div>

No good educator would deny that the quality of teaching and learning plays a vital role in promoting students' understanding and learning of scientific concepts.

Science classrooms must be places where creativity and innovation are encouraged, appreciated and recognized. Teachers need to take care not to dispense content in a boring and unappealing manner. Instead, they need to operate in a manner that would capture and sustain the interest of various types of learners. Thus, the Science classroom needs to be one in which students are actively engaged in doing Science.

Young people learn more readily about things that are tangible and directly accessible to their senses—visual, auditory, tactile, and kinesthetic. Students need to be engaged and given the opportunity to emulate and practise things that we want them to know and do. They cannot learn to think critically, analyse information, communicate scientific ideas, make logical arguments, work as a team and acquire desired skills unless they are permitted and encouraged to do so. There needs to be repetition of activities, together with constructive feedback that would enhance growth and development. In order to accomplish these things, teachers' selection of strategies for instructional delivery that employ different modes is strongly advocated. Approaches selected must meet the varying needs of learners and should also appeal to their varying multiple intelligences as outlined by Howard Gardner.

Thus, many different and varying teaching strategies must be used, including both direct and indirect instructional strategies. Any strategy selected, however, must:

- match the different ways that students learn;
- provide opportunities for students to perform authentic scientific inquiry;
- allow students to operate in a collaborative and cohesive manner;
- draw upon students' previous experiences and build on them;
- be student friendly.

Teachers also need to exploit the rich resources that are present in the larger community. They need to use these to their advantage in bringing about teaching and learning of Science. Some of the multiple instructional resources available include:

- the electronic media – computers, CDs, DVDs, videos, and the Internet
- the print media – textbooks, posters and maps, journals, magazines
- manipulatives – models, puzzles, specimens, games, and measuring tools
- the community – expert people, institutions, the external environment, museums, factories, and natural resorts.

A list of suggested strategies and resources is presented below.

The use of such strategies and resources may demand significant changes in the delivery of Science programmes. These may include change in their perception of learners, change in their perception of scientific learning, change in their perception of teaching and change in their modes of scientific instruction.

Suggested Instructional Strategies and Resources

Lectures
Demonstrations
Discussions
Questioning
Reading
Oral reports/Presentations
Debates
Investigations
Field trips
Problem- solving
Projects
Simulations
Role play
Computer-based learning
Guest speakers
Videos/CD-ROMs
Chalk board/Marker board
Educational software/computers

Assessment in the Science Curriculum

It is strongly advocated, that as teachers deliver this Science programme they use a variety of different classroom assessment strategies as they deem fit. This will cater to the individual differences of learners as we try to determine the level of learning that has occurred. Assessment strategies may be selected from the list outlined at the end of this section or teachers may use any other method that is appropriate.

> *"Assessment is the systematic collection of data about what students know, understand and are able to do. Assessment is not an arbitrary or private judgement springing from professional mystique, but a matter of meeting clear criteria open to public scrutiny."*
>
> Pratt (1980)

Classroom assessment is used by various stakeholders to serve their particular needs. It is used by students to indicate to them what they know, where they are having difficulties, where they need extra assistance and where they should place more emphasis. It also helps them to recognize what they can do and how well they can do it. Teachers use classroom assessment to guide their choice of instructional strategies and to inform decision - making in other aspects of the curriculum implementation process. It also helps them to plan and to deliver reports about student progress to parents. Finally, parents use it to recognize how their children are progressing in school and if and where they need to provide extra help and guidance for them.

Brookhart (1997) contended that a variety of assessment tools should be used to measure achievement targets, and that the tools selected should depend upon the students and the subject matter being assessed. Students' perception of a task and their ability to handle the task influence both the effort they devote to such tasks and the extent to which they achieve success.

Assessment and instruction should be linked. The type of assessment selected should be carefully chosen to relate to the intended Learning Outcomes and should demonstrate validity and clarity of purpose. Students have individual learning styles and react differently to forms of assessment. It is therefore important to ensure that a variety of assessment strategies be used, so that the level of disadvantage implied by an over-reliance on a narrow range of assessment is minimized.

Tests and examinations have always been recognized as a classical way of measuring students' progress and are integral to accountability in schools and in the education system. These highly visible forms of monitoring progress are known as summative assessment and are used not only by policy makers and administrators but also by parents and employers. Summative assessment usually takes place at the end of a programme of learning, in order to find out what has been learnt and what standard the learners have reached.

To be truly effective, assessment should also be formative. In formative assessment, teachers make frequent interactive assessment of students' understanding. This enables them to adjust their teaching to meet individual student needs. Formative assessment is ongoing assessment and helps to shape the learning process by providing feedback to learners and teachers. A more detailed or diagnostic assessment may also be necessary where students are facing particular difficulties.

A variety of summative and formative assessments strategies should be used in order to guide teaching and learning. This should not only incorporate traditional pen/pencil and paper tests, but must also use alternatives to such tests. Interest in alternative assessment has grown rapidly in the last decade or two, as a result of educators' dissatisfaction with the traditional mode of assessment, which was not meeting their changing needs. Alternative assessment methods range from writing essays to hands-on performance tasks that should be authentic.

<div align="center">

Suggested Assessment Strategies

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Pen/pencil and paper test
Final exams
Essays and assignments
Field reports
Group work
Exhibitions
Portfolios
Presentations
Performance
Projects
Laboratory work
Oral presentations
Quizzes
Simulation
Role play
Debates
Journals and learning logs
Formal and informal observation
In-class questions and learning probes
Peer assessment
Student self-assessment

Any assessment approach used must be reliable and valid. It must include an appropriate scoring rubric that is unambiguous and transparent.

Part 4
Glossary and References

Glossary

Annotate
   Add a brief note to a label

Classify
   Place into groups according to similarities and differences

Compare
   Identify similarities and differences for each feature.

Define
   State concisely the meaning of a word or term

Demonstrate
   Show clearly by giving evidence

Describe
   Give detailed information on the appearance and/or arrangement of a structure or process. Descriptions may employ words, drawings, and/or diagrams

Design
   (a) Plan and present an activity/item with all relevant practical detail
   (b) Plan and present an experiment applying the scientific method

Draw
   Construct a two-dimensional illustration to show accurate likeness and proportion of a specimen, using drawing guidelines

Investigate
   Use the scientific method to arrive at logical conclusions

Measurement
   Involves identifying the quantity, unit, and measuring instruments, and using instruments correctly

Observe
   Study and examine, using appropriate senses and/or extensions of them (e.g., thermometer, microscope, etc.)

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