Science

syllabus - Grade 9

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Contents

Introduction

Basis for School Science Curriculum Reform

Previous curriculum reform, aimed at teaching Science at secondary level through the subjects, Environmental Studies for grade 6 and Science & Technology for grades 7-11, faced following drawbacks.

- Lack of adequate opportunities for the students to acquire internationally accepted Science process skills.
- Omission of some essential basic scientific concepts in the course which hindered systematic development of scientific concepts.
- Fewer opportunities provided for students to engage in a learning- teaching process which enables proper comprehension of scientific concepts.

Furthermore, the following factors that prevailed in the school Science curriculum have also contributed to the decline in the quality of Science.

- Environment related activities subject at primary level has not contributed to comprehension of basic scientific concepts as expected.
- Deviation of the learning-teaching process from practical situations towards transmission of knowledge through text books.
- Examination oriented learning-teaching process resulting in students being diverted from exploration based learning towards mechanical learning.

Basically, the prime objective of the new curriculum reform is to alleviate these shortcomings and to minimize the curriculum gap between G.C.E. (O/L) and G.C.E. (A/L) as well. In order to achieve this objective, measures should be taken to avoid the separation of theoretical aspects from practical activities in Science.

Present curriculum reform is expected to introduce a new approach to provide opportunity to amalgamate theoretical aspects and practical activities. New methodology is unique as the science curriculum has been developed according to the following distinctive features:

- Competency based
- Activity oriented
- Student centered

Science subject is introduced as a **common Science curriculum** for grades 6-9, and as a **subject curriculum** for grades 10-13. However, in the science curriculum for grades 10-11 the three main subjects of Physics, Chemistry and Biology are presented as three modules with equal weight for the G.C.E. (O/L) examination.

Science syllabi for grades 6-9 has been developed as a spiral curriculum based on the broad themes given below.

- Observing the environment
- Organisms and life processes
- Matter, their properties and interactions
- Earth and space
- Energy, force and work

The new curriculum reform consists of a set of competencies and competency levels , a continuum of activities together with a set of activities which provide opportunities to extend the learning-teaching process beyond the classroom environment.

Course Objectives for Grade 6 - 11 Science

On completion of this course, the student will be able to;

- develop scientific concepts and principles systematically through a joyful learning environment.
- develop competencies related to problem solving by using processes in science and scientific method appropriately.
- develop competencies pertaining to managing environmental resources intelligently by understanding the potential of such resources.
- develop competencies related to the usage of scientific knowledge to lead a physically and mentally healthy life.
- develop competencies pertaining to becoming a successful individual who will contribute to the development of the nation in collaboration, engage in furthe studies and undertake challenging job prospects in the future.
- develop competencies related to understanding the scientific basis of the natural phenomena and the universe.
- use appropriate technology to maintain efficiency and effectiveness at an optimum level in utilizing energy and force.
- develop competencies related to evaluation of day to day life experiences and information acquired through media by employing scientific criteria with a back ground of limitations and dynamic nature of science.

Learning -Teaching Methodology

In deciding upon the learning teaching methodology relevant to the course, attention has been paid to the planning of learning-teaching activities so as to facilitate building up of student competencies based on exploration. In preparing for competency-based education, in this manner, an obvious change in the role of the teacher is expected.

The transmission role practiced in our classroom from way back and the more recently introduced transaction role is evident in the classroom even in the present day. When taking the deterioration of the thinking skills, personal skills and social skills of school leavers into consideration, it needs no effort to understand that there is a need for the development of the learning-teaching methodology and how it should be effected.

In the transmission role while the teacher is considered an individual who knows everything, his task has become that of considering the student as one who does not know anything and of transmitting knowledge to him. This learning-teaching process that takes the guise of lectures is restricted only to the flow of knowledge from the teacher to the student, does not make an adequate contribution either to the stimulation of student thinking or to the development of his personal and social skills.

The dialogue initiated by the teachers within the class is the initial stage of the transaction role apart from the ideas that flow from the teacher to the class and from the class to the teacher. These dialogues get gradually transformed into discussions as a result of the student-student interaction that takes place subsequently. The teacher is continuously involved in the task of questioning in order to take the student from the known to the unknown, from the simple to the complex and from the concrete to the abstract.

While, in competency-based education, student tasks occupy a powerful position, the teacher occupies the position of a resource person who mediates in order to provide every student in the class with at least the competency proximate to each relevant competency. For this purpose the basic functions the teacher is expected to perform include planning of a learning environment consisting of the materials and other facilities necessary for learning, close observation of how students learn, identification of student abilities and inabilities and the promotion of student learning through feed back and provision

of feed forward as well as the preparation of instruments of assessment for the extension of learning beyond the classroom. The teacher's role based eventually upon the tasks above is called the transformation role.

The series of activities that can be used in the implementation of the descriptive curriculum introduced in the first part of this course guide, has been included in its second part. Each of these activities has been developed so as to contain a minimum of three steps. It is expected to get the student involved in the learning process through the first step of the activities. As such, this step is called the "Engagement" step. As an introduction to this step, the teacher assumes the Transaction role and engages in a dialogue with the students. Later, along with the transformation of this dialogue to a discussion the students engage in exploration and are provided the opportunity to recall the pre-knowledge related to the basic competency they should develop and to acquire a hint regarding the future of the activity. The teacher possesses a host of strategies that can be used in these exchanges of ideas. Some of the devices at the disposal of the teacher for the exchange of these ideas are questioning/stimulants like pictures, newspaper advertisements and flash cards/use of puzzles or case studies/dialogues, role play, poems, songs and demonstrations, video tapes or audio tapes. In summary, the first step of the activities is implemented with the objective of actualizing the three objectives below.

- Winning over of the attention of the class.
- Providing the students with the opportunity for students' recall of the necessary pre-knowledge.
- Introducing the elements of the explanation the students are expected to be directed to under the second step of the activity.

It is with the objective of providing the students with the opportunity of Exploration that the second step of the activity has been planned. Students base their exploration on a special leaflet prepared for the purpose. The teacher has to plan this explanation to enable the students to engage in cooperative learning through the exploration of various aspects of the problem, in groups. Some of the most important qualities of this step are involvement in the conscious group discussions and the use of the resource materials provided. As a result of involvement in group activities through a long period of time, student will acquire the ability to develop a number of skills like self-discipline, listening to others, working cooperatively with others, helping them, management of time, obtain creations of high quality, honesty etc. In directing students to exploration, while the teacher should avoid taking decisions regarding leadership, he should build up the background necessary to surface. Accordingly, the students will have the privilege of taking on leadership when opportune, based on hidden abilities.

During the 3rd step of the activity, every group will get the opportunity of presenting the results of its exploration for the enlightenment of the others. What the teacher has to do here is to encourage students to group presentations. It would be effective if students are directed so as to ensure that every member is given responsibility in the planning of the presentation. An important quality of this step, related to the explanation of student findings, is the creation of the opportunity for the voice of students to be heard in the classroom where, commonly the voice of the teacher had dominated.

After the explanation of the findings in the third step of the activities, students should be directed to elaboration. Each group is given the opportunity to provide constructive suggestions on its findings first, and subsequently, members of other groups are given this opportunity. Anyway the final review is the responsibility of the teacher. The teacher is expected to touch on all the important points relevant to the students' exploration.

The main responsibility of the teacher in this learning teaching process is to monitor continuously, whether the classroom learning-teaching process is implemented successfully, as expected. While assessment and evaluation should be made use of for this purpose, the teacher is provided the opportunity, through planned activities, in the learning teaching process itself. The teacher is given the opportunity for assessment while the students are involved in exploration during the second stage of the activity and for evaluation when the students are involved in explanation and expansion during the third stage. A detailed inquiry into assessment and evaluation will be provided later on in this document.

The teacher is provided direction on the transformation role by the learning –teaching methodology described so far. While priority is given to group exploration here, the teacher is also afforded the opportunity for transaction, discussion and short lectures. While there is room for transaction and discussion, the teacher may also give a short lecture, under review, in the final stage. In the development of the learning-teaching methodology related to this curriculum, the first to be introduced under the curriculum reforms for the new millennium, the attention paid to the important features relevant to the transmission as well as the transaction roles of the teacher, apart from the transformation role, is a special feature of this methodology.

Assessment and Evaluation

Assessment and Evaluation can be identified as two interconnected programs that can be conveniently implemented in the classroom in order to identify the levels of competence achieved by students so as to establish that the students have actualized the expected learning outcomes through the learning-teaching process. If the assessment is implemented properly, it is not difficult for all the students studying in the class to acquire a competency at least proximate to the relevant skill. On the other hand, what evaluation expects is to identify what the levels of competency the students have achieved are.

Teachers involved in assessment can provide their students with guidance of two types. This guidance is commonly called “feedback” and “feed forward”. When the weaknesses and inabilities of students are discovered, it is the task of the teacher to provide feedback in order to overcome their learning difficulties and to provide feed forward to improve their skills when their abilities and strengths are discovered.

It is necessary that students find out as to which competencies in the course they have been able to actualize and the relevant levels for the success of the learning-teaching process. Accordingly, determination of the levels of competency students have achieved through the program of evaluation and the communication of student progress to parents as well as other relevant sections, is expected of the teacher.

This curriculum comprises a student centered, competency-based, activity oriented approach. The transformation role of the teacher and learning through action becomes the core for the purpose of making life meaningful.

An attempt has been made to integrate assessment and evaluation with the learning and teaching of the curriculum implemented through a series of activities developed in the past. When students are involved in exploration under the second step of each activity, the teacher will be able to subject them to assessment and to evaluation when students present their findings and subject same to elaboration.

The teacher is expected to move among the students engaged in exploration, observe the tasks they are involved in, help them to solve in the classroom itself any problems they happen to encounter and provide them facilities and guidance.
Five common criteria are suggested to facilitate the task of assessment and evaluation. Out of these criteria, the first three criteria are based on knowledge, skills and attitudes that combine to develop each competency. The two final criteria support students in the inculcation of two attitudes important in their life. The teacher should make an effort to identify these criteria and the five behavioral changes within the classroom itself while the students are active and strengthen them under assessment and quantify these behaviors under evaluation.

The learning-teaching process can be broadened through the improvement of the evaluation program. For this purpose the teacher has the opportunity of creating several evaluation situations through an activity continuum. The program of assessment can be made meaningful by dividing the activity continuum to several activity clusters to facilitate identification of evaluation points. It is necessary that the evaluation instrument being used with respect to each activity is introduced to the students at the beginning of every activity cluster. It is also necessary in the selection of learning varieties, those activities where student motivation to learn are helped to blossom forth, is selected. Below is a list of the relevant activities.

- Concept maps
- Wall newspapers
- Quizzes
- Question and answer books
- Portfolios
- Exhibitions
- Debates
- Panel discussions
- Seminars
- mpromptu speeches
- Role-play
- Presentation of literature reviews
- Field books/ nature diaries
- Practical tests

The third part of the course guide has been planned in order to introduce the suggested evaluation points and instruments of evaluation selected for this purpose. In this manner, students will be able to involve themselves in learning with interest and motivation while the learning teaching process is further broadened as a result of the evaluation process being implemented between as well as in the course of activities.

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No.	Competencies	Competency levels	Content	Time in minutes
		FIRST TERM		
1.0	Observes the environment as a scientist.	1.1 Uses scientific method to investigate phenomena in the environment.	● Steps of the scientific method ● Observations ● Identification of the problem ● Formulation of hypotheses ● Testing of hypotheses ● Making conclusions ● Scientific inventions ● Disprove the theory of Spontaneous Generation ● Discovery of Penicillin	120
		1.2 Uses microscope to observe minute objects.	● Usage of light microscope ● Parts of light microscope ● Proper usage of light microscope	120
		1.3 Investigates the importance of micro-organisms.	● Applications of microbial activities ● Production of compost ● Coir industry ● Production of diary products ● Production of vinegar ● Production of immunization vaccines and antibiotic ● Harmful effects of micro organisms ● Diseases ● Food spoilage	120
		1.4 Uses laboratory equipments appropriately.	● Volumetric instruments ● Measuring cylinder ● Beaker	120

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No.	Competencies	Competency levels	Content	Time in minutes
			• Pipette and Burette • Flask • Instruments to measure mass/weight • Triple beam balance • Chemical balance • Spring balance • Instruments to measure electricity • Ammeter • Voltmeter • Multimeter • Other laboratory equipments • Boiling tube/Test tube/Ignition tube • Test tube holder • Funnel • Thistle funnel • Watch glass • Petridish • Slide and coverslip • Trough • Density bottle • Bunsen burner • Spirit lamp • Tri-pod • Motar and pestle • Wash bottle • Cork borer	

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No.	Competencies	Competency levels	Content	Time in minutes
			• Filter paper • Forceps, Tongs, Pliers	

2.0	Investigates to identify the nature of earth and space.	2.1 Investigates the development of various views on solar system.	• Ancient views
			  • Geo-centric model
			• Modern views
			  • Helio-centric model
				120

		2.2 Investigates on constellations.	• Identification of constellations
			  • Zodiac
			  • Other constellations
			  • Ursa major and Ursa minor(Great bear and Little bear)
			  • Crux (Southern cross)
			  • Orion
			  • Pleiades (Seven sisters)
			• Uses of constellations.
				120

		2.3 Inquires about the information on the nature of space.	• Existence of stars and galaxies • Birth and death of stars • Origin and expansion of universe	120

3.0	Uses concepts, principles and theories, related to energy, work and force effectively.	3.1 Elaborates on simple linear motion by using vector and scalar quantities.	• Scalar quantities
			  • Distance, time and speed
			• Vector quantities
			  • Displacement, velocity, acceleration and decelaration
			• Simple calculations on uniform speed/velocity
				120

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No.	Competencies	Competency levels	Content	Time in minutes
			• Speed = $\frac{\text{distance}}{\text{time}}$ Velocity = $\frac{\text{displacemnt}}{\text{time}}$	

		3.2 Investigates appropriate mechanical strategies used in various work sites.	• Strategies that facilitate mechanical work in work sites.
			  • Construction of buildings
			  • Repairing of vehicles
			  • Agriculture
				120

		3.3 Investigates on qualitative and quantitative aspects of global energy resources.	• Primary energy resources
			  • Crude oil
			  • Coal
			  • Natural gas
			  • Nuclear energy
			  • Bio mass
			  • Wind
			  • Potential energy of water
			  • Solar energy
			• Unequal distribution of primary energy resources
			• Secondary energy resources
			  • Electricity
			  • Super-heated steam
			  • Thermal
			• Conversion of primary energy resources into secondary energy resources
			  • Electricity from potential energy of water
			  • Electricity from crude oil
				120

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No.	Competencies	Competency levels	Content	Time in minutes
			● Super-heated steam from coal ● Heat from fire wood ● Need for the conversion ● Wastage of energy from conversion	
		3.4 Investigates the use of alternative energy resources as a solution for energy crisis.	● Alternative energy resources ● Bio-diesel ● Alcohol (Ethanol/Methanol) ● Biomass ● Bio-gas ● Solar cells ● OTEC (Ocean Thermal Energy Conversion) ● Ocean waves/tidal ● Solar energy ● Fuel cells ● Hydrogen ● Methane ● Scientific basis of the above energy resources ● Ways of using them as substitutes for existing energy resources ● Advantages and disadvantages of the use of the above energy resources	1 2 0
SECOND TERM				
4.0	Inquires on the properties, uses and interactions of matter.	4.1 Explores evidences for the occurrence of a chemical reaction.	● Differences between physical and chemical changes ● Evidences for the occurrence of a chemical reaction ● Changes of temperature (Heat exchange)	120

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No.	Competencies	Competency levels	Content	Time in minutes
			• Change of colour • Formation of precipitate • Production of sound/light • Formation of gases	

		4.2 Investigates on the behaviour of atoms.	• Law of conservation of mass
			• Experiments to confirm the law of conservation of mass
			• Dalton's atomic theory
			• Modern discoveries about the atom
			  • Sub atomic particles (electrons, protons, neutrons)
			  • Nuclear model of the atom
				120

		4.3 Uses chemical symbols to denote elements.	• Use of symbols in chemistry
			  • Symbols of elements
			  • Development
			  • International standards/conventions
			  • Applications
				120

		4.4 Investigates on the interactions of metals and non-metals with air, water, acids & bases.	• Combustion • Reactions with water • Reactions with acids • Reactions with bases (only examples of Mg, Fe, C, S)	120

		4.5 Investigates about alloys and their applications.	• Commonly used alloys
			  • Properties
			  • Applications
				120

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No.	Competencies	Competency levels	Content	Time in minutes

		4.6 Conducts simple experiments to identify nutrient components in food.	• Major types of nutrients
			  • Carbohydrates
			  • Proteins
			  • Lipids
			• Tests to identify major nutrient components
			  • Iodine test
			  • Benedict test
			  • Bi-uret test
			  • Sudan III test
			  • Translucent oil patch test
				120

		4.7 Analyses criteria on the standards and quality in selecting suitable consumer goods.	• Standards, SLS/ISO • Date of manufacture and date of expiry • Ingredients • Packaging • Total weight / net weight • Consumer/eco – friendly nature	120

		4.8 Investigates on the properties and uses of composite materials.	• Natural and artificial composite materials
			• Composite materials according to their structural arrangement.
			  • Reinforced with particles
			  • Reinforced with fibers
			  • Layered
			• Uses of composite materials
				120

		4.9 Investigates on the properties and usages of polymers.	• Monomers and polymers • Natural and artificial polymers • Uses of polymers • Problems associated with the usage of artificial polymers and solutions	120

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No.	Competencies	Competency levels	Content	Time in minutes

		4.10 Prepares solutions to suit the requirements.	• Mixtures
			• Solutions
			  • Solutes, solvents and solutions
			  • Saturated and unsaturated solutions.
			  • Selection of solvents
				120

		4.11 Conducts experiments to find out methods of generating of electricity.	• Structure and function of cells
			  • Simple cell
			  • Dry cell
			  • Lead-acid accumulator
			• Electricity generators
			• Bicycle dynamo
			• Solar cell
				120

		4.12 Investigates on the uses of nano technology.	• Concept of nano technology
			  • Natural nano systems
			  • Artificial nano systems
			• Uses of nano technology
			  • In the medical field
			  • In generation of energy
			  • Production of consumer goods.
			• Possible harmful effects of nano technology
				120

	THIRD TERM			
	5.0 Investigates the diversity of plants. .	5.1 Explores the morphological diversity of flowers.	• Parts of a flower • Pedicel, receptacle, sepals, petals, androecium and gynoecium • Arrangements of those parts in various flowers	120

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No.	Competencies	Competency levels	Content	Time in minutes

			• Symmetry of flowers
			  • Radial symmetry
			  • Bilateral symmetry
			  • Asymmetry
				120

		5.2 Analyses the structure of flowers according to scientific conventions.	• Features used to describe a flower
			  • Whole flower and half flower
			  • Floral diagram
			  • Floral formula
				120

		5.3 Explores the patterns of inflorescence.	• Arrangement of racemose inflorescence
			  • Simple raceme, spike, spadix, corymb, capitulum and umbel
			• Arrangement of cymose inflorescence
			  • Simple cyme, dichasial cyme, helicoid cyme and scorpiod cyme
				120

		5.4 Analyses the structure of fruits using scientific definitions.	• Types of fruits
			  • Simple fruits
			  • Dry fruits
			  • Fleshy fruits
			  • Aggregate fruits
			  • Composite fruits
				120

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No.	Competencies	Competency levels	Content	Time in minutes

		5.5 Investigates on the adaptations of fruits and seeds for wide dispersal of plants.	• Major methods of dispersal of fruits and seeds
			  • By wind
			  • By water
			  • By animals
			  • Explosive mechanisms
			• Special adaptation for each method of dispersal of seeds and fruits
				120

		5.6 Uses the diversity of life-time of plants to fulfil the day-today pursuits.	• Annual plants • Biennial plant • Perennial plants • Uses of the above plants	120

6.0	Uses generation and transmission of waves and their properties to fulfill day-to-day pursuits.	6.1 Uses the behaviour of light to fulfill day-to-day pursuits.	• Reflection of light
			  • Laws of reflection
			  • Reflection of a light beam through a plane mirror
			  • Marvels of reflection of light
			• Refraction of light
			  • Refraction of a light beam through a glass block
			  • Dense and rare media
			  • Uses of refraction
			  • Simple microscope
			  • Lens of the eye
			  • Spectacles
			  • Farsight - Convex lens
			  • Shortsight - Concavelens
			  • Marvels of refraction of light
				120

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No.	Competencies	Competency levels	Content	Time in minutes
		6.2 Uses the behaviour of sound to fulfill day-to-day pursuits.	• Phenomena related to the behaviour of sound • Reflection • Echo • Reverberation • Resonance • Absorption • Musical melody and noise	120
7.0	Discovers the values of marvels in the environment.	7.1 Discovers the marvels in the world of animals.	• Animals that exhibit mysterious characters • *Planaria* • Mekong catfish • *Bufo kotagamii* • Arrowhead toad • Vampire bat • Sea horse • Giant panda • Weaver bird	120
8.0	Exhibits the preparedness in management of natural disasters and associated risks.	8.1 Contributes to minimize the risks associated with drought.	• Scientific factors based on the occurrence of draught • Short term • Long term • Scientific approach for the management of disaster associated with drought conditions.	120

Grade 9 Syllabus - Science

No.	Competencies	Competency levels	Content	Time in minutes

			• Before the disaster
			  • Weather forecasts, previous experiences and observations
			• During the disaster
			  • Predicting the circumstances that can occur on available data and information
			  • Scientific measures that can be taken to minimize the damages to life and property
			• After the disaster
			  • Sanitary measures
			  • Effective management of newly emerged environmental conditions
				120

		8.2 Contributes to minimize disaster conditions associated with tsunami.	• Scientific factors based on the occurrence of tsunami
			• Scientic approach for tsunami disaster management
			  • Before the disaster
			  • Announcements of tsunami warning centers
			  • Previous experiences and observations
			  • During the disaster
			  • Predicting the circumstances that can occur on available data and information
				120

Grade 9 Syllabus - Science

No.	Competencies	Competency levels	Content	Time in minutes

			• Scientific measures that can be taken to minimize damages to life and property
			• After the disaster
			  • Sanitary measurer
			  • Effective management of newly emerged environmental conditions	