The Spiral Progression Approach in Science

Marlene B. Ferido, Ph.D.
UP NISMED
Tracks in the K to 12 Curriculum

Track 1. Technical-Vocational-Livelihood

Track 2. Sports and Arts

Track 3. Academic
   Strand 1. Science, Technology, Engineering, & Mathematics (STEM)
   Strand 2. Humanities, Education, and Social Sciences (HES)
   Strand 3. Business, Accountancy, and Management (BAM)
The aim of K to 12 is to help graduates:

• acquire mastery of basic competencies
• be more emotionally mature
• be socially aware, pro-active, involved in public and civic affairs
• be adequately prepared for the world of work or entrepreneurship or higher education
• be legally employable with potential for better earnings
• be globally competitive
Enhanced Basic Education Curriculum

Aims to give every learner an opportunity to receive quality education based on an enhanced & decongested curriculum that is internationally recognized and comparable.
The science curriculum has a big role to play in achieving this aim

Science education aims to develop

... scientific literacy among students that will prepare them to be informed and participative citizens

who are able to make judgments that may have social, health, or environmental impact.
Scientific literacy refers to an individual’s…

- scientific knowledge and use of that knowledge to identify questions, acquire new knowledge, explain scientific phenomena and draw evidence-based conclusions about science-related issues

- understanding of the characteristic features of science as a form of human knowledge and inquiry

Programme for International Student Assessment (PISA), 2009
Whether or not students pursue careers that involve science and technology, the science curriculum will provide students with a repertoire of competencies important in the world of work and in a knowledge-based society.
“Compartmentalization of topics within broad curriculum areas such as biology, chemistry, and physics within the science curriculum is likely to inhibit transfer of learning across topics. … students who exit school early do not have the basic functioning skills across requisite areas of science.”
The science curriculum is designed around three domains of learning science.
The science curriculum is constructed around the development of scientifically, technologically and environmentally literate Filipinos who are

• critical problem solvers
• responsible stewards of nature
• innovative and creative citizens
• informed decision makers
• effective communicators.
Monitoring the implementation of the curriculum and its effects is necessary because in time, its design will become obsolete.

Monitoring should answer the following:

1. Does the actual curriculum match the design?
2. Are the students acquiring the knowledge, skills, and attitudes through the designed curriculum?
3. Are the learners able to demonstrate the acquired knowledge, skills, and attitudes?
Component 1: Inquiry Skills
Basic Science Processes

Integrated Skills

Scientific Inquiry Skills

Higher Order Thinking Skills
Component 2: Content & Connections
Sequence may vary from grade to grade.
Component 3: Scientific Attitudes and Values

- Intellectual honesty
- Objectivity
- Perseverance
- Active listening
- Assuming responsibility
- Taking initiative
- Independent learning
- Analyzing and evaluating information, procedures, and claims.
- Making decisions based on sound judgment and logical reasoning.
A learner-centered curriculum provides for opportunities that create learning environments which optimize learning and allow learners to think well and apply principles to new situations.
• The focus of scientific inquiry is proposing explanations for observations about the world around us.

_Inquiry into authentic questions generated from student experiences is the central strategy for teaching science._

National Science Education Standards, p. 31
Inquiry-based science teaching enables students to ...

- ask questions and use evidence to answer them;
- conduct an investigation and collect evidence from a variety of sources;
- develop an explanation from the data; and
- communicate and defend their conclusions.

Source: NRC, 1997
The scope and sequence of the content are developed such that concepts and skills are revisited at each grade level with increasing depth.

As more facts and principles on each topic are encountered, the understanding grows in breadth and depth, creating a metaphorical spiral.
Spiral progression approach

Progression is not only vertical (e.g., increasing complexity), but also horizontal (e.g., broader range of applications).

Learning is extended, reinforced and broadened each time a concept is revisited.
In a spiral progression approach to teaching and learning ...

- New concepts are built on pupils’ prior knowledge and skills to allow gradual mastery from one grade level to the next.

- There is “vertical articulation” or a progression of competencies from elementary to high school.
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<thead>
<tr>
<th>Grade 7</th>
<th>Grade 8</th>
<th>Grade 9</th>
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<tbody>
<tr>
<td><strong>FORCE AND MOTION</strong></td>
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<tr>
<td>From a simple understanding of motion, students learn more scientific ways of describing (in terms of distance, speed, and acceleration) and representing (using motion diagrams, charts, and graphs) the motion of objects in one dimension.</td>
<td>This time, students learn about the concept of force and its relationship to motion. They use Newton’s Laws of Motion to explain why objects move (or do not move) the way they do (as described in Grade 7). They also realize that if force is applied on a body, work can be done and may cause a change in the energy of the body.</td>
<td>To deepen their understanding of motion, students use the Law of Conservation of Momentum to further explain the motion of objects.</td>
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<td>Grade 7</td>
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<tr>
<td>ENERGY</td>
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<tr>
<td>This time students recognize that different forms of energy travel in</td>
<td>Students learn that transferred energy may cause changes in the</td>
<td>Students explain how conservation of mechanical energy is applied in</td>
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<td>different ways—light and sound travel through waves, heat travels</td>
<td>properties of the object. They relate the observable changes in</td>
<td>some structures such as roller coasters and in natural environments</td>
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<tr>
<td>through moving or vibrating particles, and electrical energy travels</td>
<td>temperature, amount of current, and speed of sound to the changes in</td>
<td>such as waterfalls. They further describe the transformation of</td>
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<td>through moving charges.</td>
<td>energy of the particles</td>
<td>energy that takes place in hydroelectric power plants.</td>
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</table>
In Grade 5, they learned about the different modes of heat transfer. This time, they explain these modes in terms of the movement of particles.

Students learn that transferred energy may cause changes in the properties of the object. They relate the observable changes in temperature, amount of current, and speed of sound to the changes in energy of the particles.

Students also learn about the relationship between heat and work and apply this concept to explain how geothermal power plants operate. After they have learned how electricity is generated in power plants, students further develop their understanding of transmission of electricity from power stations to homes.
**Grade 7**

Students will learn how to locate places using a coordinate system. They will discover that our country’s location near the equator and along the Ring of Fire influences what makes up the Philippine environment (e.g. natural resources, climate).

**Grade 8**

As a result of being located along the Ring of Fire, the Philippines is prone to earthquakes. Using models, students will explain how quakes are generated by faults. They will try to identify faults in the community and differentiate active faults from inactive ones.

**Grade 9**

Being located along the Ring of Fire, the Philippines is home to many volcanoes. Using models, students will explain what happens when volcanoes erupt. They will describe the different types of volcanoes and differentiate active volcanoes from inactive ones. They will also explain how energy from volcanoes may be tapped for human use.
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<td><strong>Astronomy</strong></td>
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<tr>
<td>Students will explain the occurrence of the seasons and eclipses as a result of the motions of the Earth and the Moon. Using models, students will explain that because the Earth revolves around the Sun, the seasons change, and because the Moon revolves around the Earth, eclipses sometimes occur.</td>
<td>Students will complete their survey of the Solar System by describing the characteristics of asteroids, comets, and other members of the Solar System.</td>
<td>Students will now leave the Solar System and learn about the stars beyond. They will infer the characteristics of stars based on the characteristics of the Sun. Using models, students will show that constellations move in the course of a night because of Earth’s rotation while different constellations are observed in the course of a year because of the Earth’s revolution.</td>
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# Earth and Space
## Spiralling of Concepts

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<tr>
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<tr>
<td><strong>Meteorology</strong></td>
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**Grade 7**

Students will explain the occurrence of atmospheric phenomena (breezes, monsoons, ITCZ) that are commonly experienced in the country as a result of the Philippines’ location with respect to the equator, and surrounding bodies of water and landmasses.

**Grade 8**

Being located beside the Pacific Ocean, the Philippines is prone to typhoons. In Grade 5, the effects of typhoons were tackled. Here, students will explain how typhoons develop, how typhoons are affected by landforms and bodies of water, and why typhoons follow certain paths as they move within the Philippine Area of Responsibility.

**Grade 9**

In this grade level, students will distinguish weather from climate. They will explain how different factors affect the climate of an area. They will also be introduced to climatic phenomena that occur over a wide area (El Niño and global warming).
<table>
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| • Doing Scientific Investigations  
  Ways of acquiring knowledge  
• Diversity of Materials in the Environment  
  - Solutions  
  - Substances & Mixtures  
  - Elements & Compounds  
  - Acids & Bases  
  - Metals & Nonmetals | • Particle model of matter  
  the behavior of matter in terms of the particles it is made of  
• Atomic structure  
• Periodic table of elements |
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<tr>
<td><strong>Properties and Structure</strong></td>
<td><strong>Using models, students learn that matter is made up of particles, the smallest of which is the atom. These particles are too small to be seen through a microscope.</strong></td>
<td><strong>Using their understanding of atomic structure learned in Grade 8, students describe how atoms can form units called molecules. They also learn about ions. Further, they explain how atoms form bonds (ionic and covalent) with other atoms by the transfer or sharing of electrons. They also learn that the forces that hold metals together are caused by the attraction between flowing electrons and the positively charged metal ions.</strong></td>
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<td>In Grade 6, students learned how to distinguish homogenous from heterogeneous mixtures. In Grade 7, students investigate properties of solutions which are homogeneous mixtures. They learn how to express concentrations of solutions qualitatively and quantitatively. They distinguish mixtures from substances based on a set of properties.</td>
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<tr>
<td><strong>Properties and Structure</strong></td>
<td><strong>They distinguish mixtures from substances based on a set of properties.</strong></td>
<td><strong>They also learn that the forces that hold metals together are caused by the attraction between flowing electrons and the positively charged metal ions.</strong></td>
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<tr>
<td>Students begin to do guided and semi-guided investigations, making sure that the experiment they are conducting is a fair test.</td>
<td>The properties of materials that they have observed in earlier grades can now be explained by the type of particles involved and the attraction between these particles.</td>
<td>Students explain how covalent bonding in carbon forms a wide variety of carbon compounds. Recognizing that matter consists of an extremely large number of very small particles, counting these particles is not practical. So, students are introduced to the unit, mole.</td>
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# Matter
## Spiralling of Concepts

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<td>Students recognize that materials combine in various ways and through different processes, contributing to the wide variety of materials. Given this diversity of materials, they recognize the importance of a classification system. They become familiar with elements and compounds, metals and non-metals, acids and bases.</td>
<td>Students learn that particles are always in motion. They can now explain that the changes from solid to liquid, solid to gas, liquid to solid, and liquid to gas, involve changes in the motion of and relative distances between the particles, as well as the attraction between them.</td>
<td>Students explain how new compounds are formed in terms of the rearrangement of particles. They also recognize that a wide variety of useful compounds may arise from such rearrangements</td>
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## Changes that Matter Undergo

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<td>Further, students demonstrate that homogeneous mixtures can be separated using various techniques.</td>
<td>They also recognize that the same particles are involved when these changes occur. In effect, no new substances are formed.</td>
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## LIVING THINGS & THEIR ENVIRONMENT

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<th>Grade 7</th>
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| • Microscopy  
  • Levels of Organization  
  • Asexual and sexual reproduction in plants  
  • Cells in humans, animals & plants | • Biodiversity, the collective variety of species living in an ecosystem  
• Interactions: explaining the food chain in an ecosystem  
• Parts & function: digestive system and how enzymes affect digestion  
• Cellular reproduction & genetics |
# Living Things & their Environment

## Spiraling of Concepts

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<tr>
<td>In Grade 7, students are introduced to the levels of organization in the human body and other organisms. They learn that organisms consist of cells, most of which are grouped into organ systems that perform specialized functions.</td>
<td>In Grade 8, students learn how the body breaks down food into forms that can be absorbed through the digestive system and transported to cells. Students learn that gases are exchanged through the respiratory system. This provides the oxygen needed by cells to release the energy stored in food.</td>
<td>Students learn the coordinated functions of the digestive, respiratory, and circulatory systems.</td>
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<td>Parts and Function</td>
<td>They also learn that dissolved wastes are removed through the urinary system; solid wastes are eliminated through the excretory system.</td>
<td>They also learn that nutrients enter the bloodstream and combine with oxygen that was taken in through the respiratory system. Together, they are transported to the cells where oxygen is used to release the stored energy.</td>
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<td>After learning how flowering and non-flowering plants reproduce, Grade 7 students learn that asexual reproduction results in genetically identical offspring whereas sexual reproduction gives rise to variation.</td>
<td>Students learn the process of cell division by mitosis and meiosis. They understand that meiosis is an early step in sexual reproduction that leads to variation.</td>
<td>Students learn the structure of genes and chromosomes, and the functions they perform in the transmission of traits from parents to offspring. Students learn the structure of genes and chromosomes, and the functions they perform in the transmission of traits from parents to offspring.</td>
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<td><strong>Heredity: Inheritance and Variation</strong></td>
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### Biodiversity and Evolution

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<tr>
<td>Students learn that the cells in similar tissues and organs in other animals are similar to those in human beings but differ somewhat from cells found in plants.</td>
<td>Students learn that <em>species</em> refers to a group of organisms that can mate with one another to produce fertile offspring. They learn that biodiversity is the collective variety of species living in an ecosystem. This serves as an introduction to the topic on hierarchical taxonomic system.</td>
<td>Students learn that most species that have once existed are now extinct. Species become extinct when the environment changes and they fail to adapt.</td>
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<tr>
<td><strong>Ecosystems</strong></td>
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<tr>
<td>Students learn that interactions occur among the different levels of organization in ecosystems. Organisms of the same kind interact with each other to form populations; populations interact with other populations to form communities.</td>
<td>Students learn how energy is transformed and how materials are cycled in ecosystems.</td>
<td>Students learn how plants capture energy from the Sun and store energy in sugar molecules (photosynthesis). This stored energy is used by cells during cellular respiration. These two processes are related to each other.</td>
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math worksheets in cebuano & waray

videos

interactive worksheets

For more T/L materials, please visit:
curriculum.nismed.upd.edu.ph

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UP NISMED initiated an online community with the country’s science and mathematics educators called *KaSaMa Teachers* (*Ka Science, Ka Mathematics*).

Members contribute, participate, and interact to share practices, ideas, challenges, and solutions.

Membership is free.

As of 04 July 2013, *KaSaMa Teachers* has 751 members.
K to 12 Science Resources in KaSaMa Teachers

Members now have access to the complete DepEd K to 12 science resources: Get the link.

1. K to 12 Science Curriculum Guide (25 April 2013 version)
2. Grade 7 Science Learner's Material (complete volume)
3. Grade 7 Science Teacher's Guide (complete volume)
4. Grade 8 Science Learner's Module (complete volume)
5. Grade 8 Science Teacher's Guide (complete volume)

Add to these the following UP NISMED webinar resources for teachers:

1. Grade 7 Science recording and presentations (7 webinars) Access them
2. Grade 8 Science recording and presentations (1 webinar, more coming up) Access them
http://engageteachers.adobeconnect.com/kasamateachers

• Series of free webinars for science educators in the country. Intel Education grants free use of the Adobe Connect Pro webinar platform.

• The webinars aim to share critical information, resources, and updates to support science teachers in their implementation of the K to 12 science curriculum.

• Begun in July 2012, the webinars take place every 4th Friday of the month, from 4:00 to 5:30 p.m. Completed seven (7) webinars for Grade 7; one webinar in Grade 8 (more coming)

• PowerPoint presentations, webinar recordings, and ongoing discussions on the webinars and on K to 12 science are available in KaSaMa Teachers.
2013 National Conference in Science and Mathematics Education

http://ncsme2013.nismed.upd.edu.ph

Theme: Empowering Teachers for the K to 12 Curriculum through Lesson Study

Date: 22-24 October 2013  
Venue: UP NISMED, Diliman, Quezon City

Registration fee (meals, conference kit, book on lesson study)

- Early bird (until 15 August 2013): Php 5,500.00
- Regular rate: Php 6,000.00

NOW on the conference website:
- Registration Form, DepEd Advisory, CHED Memo, Tentative Programme

For more info, contact
- email: 2013ncsme@gmail.com
- Tel. No.: (02) 9274276/9281563 ext. 212/111
Thank you!