MODULE 6.4

CURRICULUM AND INSTRUCTION: THE TEACHING OF SCIENCE

Teacher Induction Program

Teacher Education Council, Department of Education

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TEACHER INDUCTION PROGRAM

MODULE 6.4

Curriculum and Instruction: The Teaching of Science

Dear Inductee,

Welcome to the DepEd family!

The significance of science to our lives cannot be overemphasized. In a world that is growing increasingly dependent on the development of science and technology, scientific literacy has become an important goal for all students. As a science teacher, you play a very significant role in preparing our children to become lifelong learners, a quality that will enable them to meet the challenges in this fast changing world.

Unfortunately, quite a number of teachers, especially the new ones, find science a difficult subject to teach. Some even have the notion that science is confined in the laboratory and cannot be taught effectively without using sophisticated science equipment. This module is intended to help you become more confident in presenting science lessons to your students in more meaningful ways.

Lesson 1 focuses on the nature and foundations of science teaching. It gives emphasis to the "what's", "why's" and "how's" of science teaching.

Lessons 2 and 3 present a repertoire of strategies and techniques that you can use in teaching science effectively. These lessons are anchored on the fact that students learn science concepts most effectively through a balance of hands-on activities and solid content knowledge.

Lesson 4 focuses on how you can assist students in conducting science investigative projects. This lesson is based on the belief that a working knowledge of how to solve problems scientifically will enable our students to become better critical thinkers and wise decision- makers in the future.

Lessons 5 and 6 deal with assessment. These lessons present several assessment tools you can use to guide you in your teaching and in determining the quality of learning that has taken place.

Each lesson in this module usually has the following parts: Introduction, Objectives, Text, Learning Task or Activity, and Self-Check Questions. Answers to the self-check questions are found at the end of this module.

You will learn best from this module if you do the following:

1. take the pretest before going through the module;
2. do all the exercises and activities;
3. try out the suggested strategies in your actual teaching;
4. keep the products of the activities you do as part of your portfolio; and
5. take the posttest after you have finished all the lessons.

Please do not write answers to the SCQ's and activities in the module. Record/ write answers in a notebook/journal. This is a part of your formative evaluation. The Teacher Education Council (TEC) shall provide the booklet for summative evaluation

It is hoped that through this module, your experiences as a beginning teacher will be as pleasant and fulfilling as possible.

We wish you the best of luck and many happy long years in your teaching career!

The Authors

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PREASSESSMENT

Directions: Write the letter of the choice that best answers the question.

1. Why do we have to choose a strategy that will match our students' expectations, perceptions and learning styles?
   a. Students always want to play games.
   b. It will be easy for us to finish the syllabus.
   c. We have insufficient facilities and equipments to carry the task.
   d. It motivates students to actively participate in activities.
2. There are a lot of low-achievers in Mrs. Teodora's science class. What strategy should she avoid using?
   a. Independent research
   b. Direct instruction
   c. Drill practice
   d. Discussion
3. Which strategy can be used to develop among students the ability to learn and to share work together for the attainment of a common goal?
   a. Question and answer
   b. Demonstration
   c. Cooperative learning
   d. Group discussion
4. In which of the following situations will demonstration be most appropriate to use?
   a. There is danger in the use of some materials.
   b. The lesson calls for the use of many materials.
   c. The teacher wants to develop students' interest in science.
   d. The students are noisy and inattentive to the lesson.

5. In which phase of the lesson do the children learn through their active involvement?

   a. Exploration
   b. Evaluation
   c. Concept extension
   d. Concept explanation

6. Mr. Caparas teaches biology in a fishing community. The place is a coastal area. Which life cycle can be best taught in said area?

   a. The life cycle of mosquitoes.
   b. The life cycle of lapu- lapu.
   c. The life cycle of butterflies.
   d. The life cycle of the garden snail.

7. Which of the following can be considered as a limitation of the use of the inquiry method as a strategy in teaching science?

   a. It involves the use of sophisticated science equipment
   b. It involves abstract mathematical concepts
   c. It is difficult to anticipate the results.
   d. It leads to confusion.

8. Which of the following statements is true?

   a. Inquiry allows students to learn many skills and concepts at a time.
   b. Students develop a sense of failure when using the inquiry method.
   c. Inquiry is too demanding on the part of the teacher
   d. Inquiry is self-directed and spontaneous.

9. Which activity can be used to clarify ideas and assist the development of logical thinking?

   a. Puzzle solving
   b. Games
   c. Experiment
   d. Drill

10. Field trip is one of the strategies teachers employ in teaching science. What is the first step that a teacher should do in conducting a field trip?

    a. Visit the place

    b. Discuss the dangers

    c. Discuss the intended result

    d. Name the things to bring for the trip

11. You want to develop the process skills of your students. What will you do?

    a. Enumerate the steps of the scientific method.

    b. Provide students a hands-on activity.

    c. List the different process skills.

    d. Define process skills.

12. Students need experience with real phenomena in a real world. What activity can the class undertake for this purpose?

    a. Experimentation

    b. Inquiry session

    c. Project Making

    d. Field trip

13. At the end of the chapter on radical numbers, the teacher gives an examination. What type of evaluation does the teacher employ?

    a. Aptitude test

    b. Diagnostic test

    c. Formative test

    d. Summative test

14. Mrs. Cruz is to teach biology in her school. She wants to know the entry knowledge of the students in the subject. What should she do in order to get the information?

    a. Initiate a whole class discussion

b. Administer a summative test

c. Give a diagnostic test

d. Give a formative test

15. Why is a rubric considered as the most appropriate way of scoring performance assessment?

a. It is the fad today.

b. It is easy to prepare and maybe re-used.

c. It shows the good and bad points of the students.

d. It communicates to students how to evaluate their own work.

II. Below are concepts/ ideas taken from the different lessons in this module. Using concept map, show how these concepts/ ideas are related. (**10 points**)

Science teaching/ learning

Content

Process skills

Scientific attitudes

Constructivist approaches

Inquiry approach

Cooperative Learning

Discovery approach

Reflective teaching

Learners learn and develop as a whole person

Learners learn at different rates

Learners have different learning styles

Assessment

Traditional assessment

Performance- based assessment

Portfolio assessment

Journal writing

Multiple Choice

Matching type

Rubrics

24 – 25 **Excellent (E)**

21 – 23 **Very Satisfactory (VS)**

19 – 20 **Satisfactory Plus (SP)**

17 – 18 **Satisfactory (S)**

15 – 16 **Moderately Satisfactory (MS)**

0 – 14 **Needs Reinforcement (NR)**

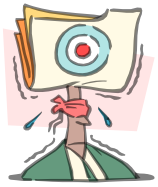
LESSON 1

FOUNDATIONS OF SCIENCE TEACHING AND LEARNING

INTRODUCTION

Science teaching is a complex endeavor. It may bring frustrations and disappointments. However, it can also bring satisfaction and successes that may outweigh the difficulties. Being new in the teaching profession, you may not feel confident handling your classes. Fear not! This is normal for new teachers like you.

To give you confidence, you must be prepared. Being prepared means not only having adequate knowledge of the scientific discipline but also sufficient knowledge of the nature of your pupils/students and what it takes to teach science. It is important to bear in mind that what you choose to teach in science and how you teach it will be influenced by your views of both science and the children. This lesson will give you a better understanding of science teaching and how students learn science best.



OBJECTIVES

At the end of the lesson, you should be able to:

- discuss the nature of science teaching;
- discuss the relevance of knowing the students' characteristics to effective science teaching;
- identify the learning styles of your students; and
- manage science classes effectively.

READ

1.1 What to Teach

One of the dilemmas new science teachers commonly have is deciding what to teach. Are you experiencing this problem too? To gain a better understanding of what you should teach in science, let us first define what science is.

As defined by Dr. Rosalyn Yalon, a Nobel Laureate in Medicine, science is….

"…. not simply a collection of facts. It is a discipline of thinking about rational solutions to problems after establishing the basic facts derived from observations. It is hypothesizing from what is known to what might be and then attempting to test the hypothesis….logical thinking must come first; the facts can come later.

In the light of this definition, we can say that science teaching has three interacting facets, namely: **knowledge, process skills** and **attitudes.**

Knowledge is sometimes labeled as the products of science. It generally refers to facts, concepts, principles, laws, and theories.

Process skills are the empirical and analytic procedures used by scientists in solving problems. Competence in using these skills provide children with the ability to apply knowledge not only to science and other subject areas in the classroom but also to their daily lives outside the classroom. Once your students learn to use the science process skills to solve problems, you can be sure that they will become lifelong learners. For this reason, the science process skills have been called **life-long learning skills.** Appendix A lists some of the science process skills that you should try to develop among your students.

Scientific attitudes refer to the general predispositions that characterize the work of scientists. Some of the important attitudes students will have to learn and demonstrate in science include curiosity, honesty, objectivity, openness, perseverance, skepticism, and withholding judgment.

Clearly, as a science teacher, you should not only be concerned with what science is all about. You should also see to it that your students develop the different basic process skills and scientific attitudes.

SCQ 1.1

1. Aside from the factual knowledge, what else should science teaching include?

2. Why are the science process skills considered life-long learning skills?

3. As a science teacher, which do you think should be given more emphasis—the acquisition of factual knowledge or the development of science process skills? Why do you think so?

1.2 The Learners: A Second Look

To make science meaningful to your students, you need to know their characteristics. Knowing them will give you ideas on how best they can learn.

In your pre-service education, you have studied these characteristics. The succeeding discussion will focus on the characteristics of learners which are relevant to science teaching.

1. **Learners learn and develop as a whole person**. The learners' cognitive, affective, physical, social and emotional areas are intricately intertwined. Learners cannot grow in one area without affecting the other areas. As a teacher, bear in mind that you are responsible for the development of the whole individual, not just one or two particular areas of his/her development.

2. **Learners grow through the same predictable stages but at different rates.** This means that children of the same age group may not exhibit uniform characteristics. Some may be more intellectually or socially advanced than the others in the same age group. You, as the teacher, should make allowances or provisions for the differences that may be found among your students.

3. **Learners learn best through active involvement with concrete experiences.** Research studies show that the use of hands-on activities can result in significant improvements in academic performance and attitude of students towards science. Hands-on approaches to teaching science is consistent with the philosophy of learning and instruction called **constructivism.**

According to the constructivist's point of view, learners are not passive recipients of knowledge; rather, they are active constructors and re-constructors of their own understanding. Constructivists view learning as creating new knowledge and deriving meanings by combining incoming information with what they already know.

4. **Learners are curious and eager to learn.** When the teacher fits the learning environment to learners' interests, needs and their levels of maturity, they become highly motivated. Their curiosity and desire to learn are enhanced. Learners learn best what is meaningful to them. They learn best in an environment that is

natural, relaxed and free of competitive elements rather than in settings that are highly structured and tightly organized.

5. **Learners have different learning styles.** Learning styles are preferred ways that different individuals have for processing and responding to environmental stimulus (Kuchuck and Eggen, 1997). Learning styles are also referred to as cognitive styles. Each student has his/her own learning style.

Some of your students may learn best through visual mode, others are primarily aural, tactile or kinesthetic learners. Some like to work alone rather than with others; some like to be given tasks that are structured for them rather than to be asked to develop their own structures.

To have an idea of the learning styles of your students. You may use the Perceptual Strength Inventory devised by Dunn and Dunn (1987). You may try it on yourself first.

ACTIVITY 1.1

What is My Style?

Instructions:

Use the following the following codes to answer this activity .

N- Never (1) **O**-Occasionally (3) **A**-Always (5)
R-Rarely (2) **F**-Frequently (4)

Read each of the sentences carefully. Under column **A**, write **N** for **never** if the statement does not reflect your style, **A** for **always** if the statements reflects your style , and so on. Under Column B, give the numeric value for each choice. Write your answers on a separate sheet of paper

A	B	
___	___	1. I like to listen to verbal instructions.
___	___	2. I learn best by seeing, reading and watching.
___	___	3. Using my hands - feeling or touching - is my style.
___	___	1. I form the sounds of words to recall them.
___	___	2. I need to construct and use strong visual image associations to learn.
___	___	3. I like to play with objects while learning.
___	___	1. I remember information by hearing myself say the words
___	___	2. I need to create a picture on paper or in my mind to remember It.
___	___	3. I learn by taking notes while listening.
___	___	1. I read aloud instead of silently talking to myself.
___	___	2. I like to create pictures to match with the words.
___	___	3. I underline ideas while listening.
___	___	1. I memorize information or associate my memories with songs.
___	___	2. I need to see the words rather than the images.
___	___	3. I need to highlight pertinent information.
___	___	1. I take active part in discussions.
___	___	2. I daydream to imagine what things look like.
___	___	3. I doodle, fold a paper, play with a pencil a ball pen or paper clip while learning.

B. Once you have completed your preferences in Column A, and have written the values for each of your responses in Column B, get the sum of all the values assigned for each answer and write the score on the summary.

Score	Your learning style
Sum of 1's ___	Auditory = ___
Sum of 2's ___	Visual = ___
Sum of 3's ___	Tactile/Kinesthetic = ___

The biggest sum indicates your preferred learning styles

Based on the Perceptual Strength Inventory that you have accomplished, what is your learning style? Administering the inventory to your students will give you an idea of their preferred learning modalities. While some students may have two or more preferred learning modalities, each has a distinct perceptual strength. Table 1.1 gives the characteristics of learners according to each type of learning modalities espoused by Dunn and Dunn.

Table 1.1 Characteristics of Learners According to Dunn and Dunn's Learning Style Inventory

Type of Learner	Characteristics
Visual	Looks at all study materials Uses charts, maps, filmstrips, notes and flashcards Practices visualizing or picturing words/concepts in their head Writes everything for frequent and quick review
Auditory	Uses tapes Finds it easy to learn by listening Fills gaps in notes with taped lectures Listens and takes notes Reviews notes frequently Sits in lecture hall or classroom where he/she could hear well Summarizes and recites aloud after reading something
Kinesthetic/Tactile	Traces words as he/she reads text Writes facts to be learned several times Keeps a supply of scratch paper for writing facts Likes being active and involved Learn while in motion Plays with objects while learning Highlights pertinent information Often takes down notes either during a lecture or when reading new or difficult text Doodles or folds a paper, plays with a pencil or ball pen while learning

1.3 Implications to Teaching

With the characteristics of learners in mind, your teaching will be more effective if you do the following:

- *Present science as a way of finding out rather than as a body of facts to be memorized.*

  Allowing learners to discover and to organize the information equip them with problem-solving and decision-making skills. It also results in knowledge that is more easily remembered and recalled than rote learning.

- *Emphasize learning by doing*

  A number of researches show that learners learn better when they are personally involved in physical or hands-on activities. The science process skills, for example, can only be taught through experiencing science. These skills are not developed by reading, listening to lectures, watching demonstrations, videos or movies or working with the computer. The thrill of science can only be fully realized through direct involvement of the learner.

- *Encourage interactions among learners*

  Give opportunities for students to work together in groups. Students who work together learn more from each other. They also develop their social and communication skills in the process.

- *Adapt science experiences to the learners' developmental levels*

  Learners differ on how they operate mentally. Therefore, you must arrange experiences that fit what they can do. Providing experiences that are appropriate to your students' developmental level will result in better learning and achievement. It will also give students a feeling of success.

- *Use a variety of approaches in teaching science*

  As discussed earlier, students have different learning styles. To be more effective, you must be aware of their learning styles and you

must consider them in choosing which teaching methods to use. According to Dr. Rita Dunn, Director, International Learning Styles Network, *"Students can learn any subject matter when they are taught with methods and approaches responsive to their learning* styles**."** This implies that for your teaching to be more effective, you should be sensitive to your students learning styles. How you deliver your lesson relates proportionally to how your students store, process and retrieve information. Better performance will result when you match your teaching styles to the learning styles of your students.

SCQ 1.2

Directions: Encircle the letter of the option that best answers each of the following questions.

1. Carlos is a grade 6 pupil. He loves to draw and learns better if the printed material he reads is accompanied with pictures or illustrations. He frequently writes what has been read. What is Carlos' learning style?

    a. Auditory

    b. Visual

    c. Tactile/Kinesthetic

    d. Cannot be identified using the given data

2. Omar prefers to sit in front. He takes notes every time he listens to a lecture. He usually recites aloud after reading something. What is Omar's learning style?

    a. Tactile /Kinesthetic

    b. Visual

    c. Auditory

    d. Aesthetic

3. Your student is a kinesthetic learner. Which activity would you give him/her?
    a. Watch a debate.
    b. Perform an experiment on air pressure.
    c. Listen to a radio program “Ating Alamin”.
    d. React verbally to a hypothetical item about height and air pressure.

4. Your students are mostly visual learners. Which of the following class activities is most appropriate to use in teaching the concept of food chain?
    a. Play a cassette tape about a food chain in a forest park.
    b. Bring them to the park and identify existing food chains in different areas of the park.
    c. Let them write a journal about food chain in a forest park.
    d. Let them do a rap about food chain in a forest park.

READ

1.4 Management Tips

One of the major concerns of new science teachers is the management of science classes to ensure that optimum learning takes place in the classroom. Here are some tips which you might find useful.

1. Decide whether the students will work individually or in groups ahead of time.
2. When students are working in groups, make certain that no member is excluded in the activity.

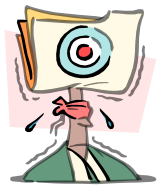
3. Rotate responsibility so that each member of the group has equal opportunity.
4. Circulate among the groups as they work and discuss; listen to the students' contributions and assess their thinking skills as well as their ability to work cooperatively.
5. Require the students to keep their noise to a minimum as they work. Absolute silence, on the other hand, will hamper their learning.
6. After giving instructions, watch to see that students begin their work. If they appear not to understand what is expected of them, ask all students to stop working so you may give additional instructions.
7. If instructions are somewhat complex, give them in short segments. Write the steps on the board or on a transparency on an OHP so students can refer to them as they work.
8. Always give time for questions from the students.
9. Be prepared to provide additional activity for those who finish early to keep them occupied.
10. Plan ahead for each lesson to have the materials on hand and ready for distribution when needed.

LESSON 2

TEACHING STRATEGIES

INTRODUCTION

As discussed in Lesson 1, you may have diverse students with individual preferences for learning; therefore, you have to employ different teaching strategies. Your choice of teaching strategy should take into account such factors as the skills to be developed for a particular class session, learning abilities and learning styles of your students, available facilities, and time allotment for the lesson.



OBJECTIVES

After going through this lesson, you should be able to:

1. describe some constructivist approaches in teaching science;
2. decide which strategy is appropriate for your students; and
3. prepare lesson guides using some of the strategies presented in this module.

READ

Lesson 2.1 Constructivist Learning: A Closer Look

Contemporary science instruction has become highly constructive in nature. It has shifted from an emphasis on **acquiring content knowledge** to **the process of constructing scientific understanding.** As previously discussed, the major theoretical point of this learning theory is that learners generate their own understanding. Learners come to school not as a blank slate but as beings with preconceptions or prior knowledge about the natural world.

Let us see how constructivism works by illustrating its theoretical underpinning.

Principle # 1: Learning is a search for meaning which starts with issues around which students actively try to construct meaning.

Here are two examples of issues/situations around which students may construct meanings.

a. A newly opened cold bottle of soft drink is more pleasant tasting than one that has been opened before storage in the refrigerator.

b. A newly opened cold bottle of soft drink is more pleasant tasting than a newly opened bottle of soft drink at room temperature.

If you ask your students who have not learned about Henry's Law and Claysius Clayperon's Equation to explain the above situations, you will probably get answers such as:

" A newly opened cold bottle of soft drink has *spirit*"

" A newly opened soft drink at room temperature has no *spirit*"

Principle # 2: Meaning requires understanding wholes as well as parts.

Parts are understood in the context of wholes. Meaning requires understanding wholes as well as parts; parts can be understood in the context of wholes.

Thus, when you take up topics on gases, your students will learn some principles about them. Eventually, they would use specific principles about gases to explain the pleasant taste of a newly opened cold bottle of soft drink.

Principle # 3: In order to teach effectively, teachers must understand the mental models used by students to perceive the world and the assumptions they make to support those models.

The prior mental model of the students regarding the pleasant taste of a newly opened bottle of cold soft drink is that it has '*spirit'.* From their knowledge about gases and soft drinks, the students would learn that

1. soft drinks are carbonated beverages;
2. carbon dioxide is added to the mixture at high pressure;
3. some gases are polar while others are non-polar;
4. polar gases dissolve easily in water;
5. some non-polar gases with low molecular mass such as carbon dioxide dissolve and react with water;
6. the product of this reaction is acid. This is the acid that makes soft drink pleasant in taste; and
7. pressure and temperature affect solubility of these gases in water.

So, do not get offended by the answer "*spirit*". Using constructivist approaches will help students reconstruct their prior knowledge based on their new experiences and thus, make their own meaning. You can be sure that they will not say "*spirit*" next time.

Principle # 4: The purpose of learning is for an individual to construct his/her own meaning. Thus, learning must be measured.

Owing to this fact, assessment should be made part of the learning process to provide information on the quality of the students' learning.

Going back to our example on soft drinks, you can ask this question after the lesson to find out if your students have reconstructed their ideas.

Which of the containers filled with water has more oxygen? Explain your answer

a. Bottle of water at 15° C
b. Bottle of water at 20° C
c. Bottle of water at 45° C

If they have reconstructed their idea, they would choose letter a. Their explanation could be: Bottle with water at 15 °C has the lowest temperature. The lower the temperature, the more oxygen dissolves in water (Clasius-Clayperon Equation).

Lesson 2.2 Constructivist Strategies

There are several strategies that can be used to probe, reconstruct and assess the learner's understanding of science concepts, principles, laws and theories. The following discussion will focus on some of these strategies.

2.2.1 The Discovery Approach by Jerome Bruner

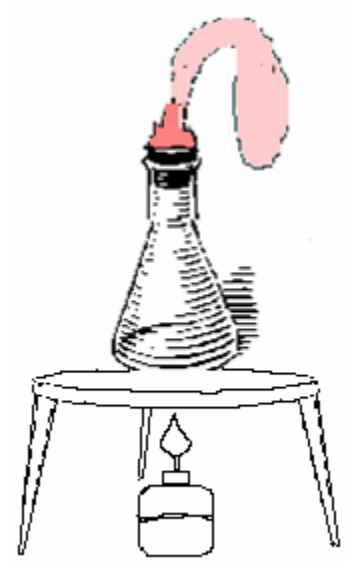
You can increase the motivation of pupils to learn science if they are to experience something different from their day to day activities. In using discovery approach, the teacher decides, in advance, the concept, process, law or piece of scientific knowledge which is to be "discovered" or un-covered by the pupils. The lesson proceeds through a hierarchy of stages which may be associated with Bruner's levels of thought. These stages are the following:

a) Enactive level

At this stage, the students perform hands-on activities directly related to what is to be discovered. The sample activity in Box 1 illustrates the enactive level.

Box 1

Get an empty bottle or an Erlenmeyer flask. Attach a balloon to the bottle and secure it with a rubber band. Apply heat as shown in the illustration.



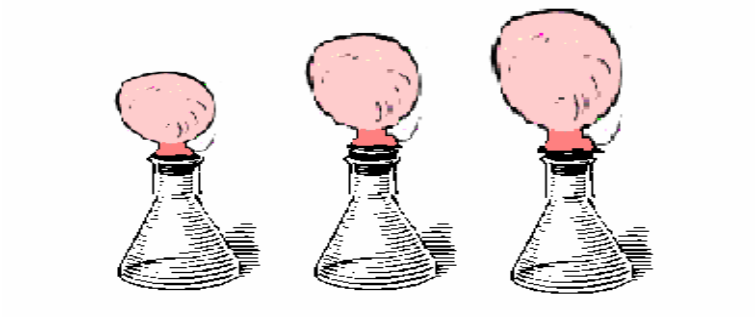
Observe what happens to the balloon. Record your observations.

b) Ikonic level

After the students have done the hands-on activity and gain some experiences, the teacher directs the thinking of the students using experiential situations to the mental images or models of the objects used upon which the discovery is to be based. Box 2 gives an option you can do after an activity or experiment.

Box 2

1. Let the students organize the data and present them to the class
2. Conduct post-laboratory discussion with the students to make the abstract science concepts concrete to the students. You may ask questions such as
   - 2.1 Describe what happened to the balloon when the bottle was heated.
   - 2.2 Why did this happen?
   - 2.3 Given the illustrations below, how will you explain the difference in the size of the balloons?



Heated at 30 °C 40 °C 50 °C

Explain the size of the balloon under different specified temperature.

Expected Answer:

The biggest balloon is at 50^{o} C, because the air inside it has expanded more than the air in the other two balloons.

c) Symbolic level

At this point, the students are guided to replace mental images with symbols to increase generality and abstraction which eventually results in

the discovery planned by the teacher in advance. Box 3 shows how you can do this.

Box 3

In the experiment about the balloon, there are two important variables involved - volume of gas inside the balloon and temperature.

You can conduct further discussions on the effect of temperature on volume of gases. You can use graphs and other related examples which will help you lead the students to the mathematical equation showing the relation between volume of gas and temperature, $\frac{V}{T}$ = K. This means that volume of gas is directly proportional to temperature.

After the mathematical formula had been derived or established, you can give sample problems, exercises and homework.

ACTIVITY 2.1

1. Get your resource book in science class.
2. Choose a topic close to your line of interest.
3. Develop a lesson showing the three stages of the discovery approach, and use it in your class.
4. Include this output in your portfolio together with your reflections on your experiences in doing this activity.

2.2.2 Inquiry Approach

This approach teaches students to handle situations they meet in the physical world. To use the inquiry approach in the teaching of science, you need to prepare activities that will allow students to develop the following skills:

a. recognizing problems;

b. asking questions;

c. applying laboratory procedures; and

d. providing consistent descriptions, predictions and explanations.

There are many strategies for the inquiry approach in the classroom. All inquiry strategies share common features. These are the following:

a. Students do hands-on activities such as experiments.

b. Students are focused on learning some analytical skills and applying the skills gained in the hands-on activities in another situation.

c. The students understand scientific constructs or concepts being developed during the hands-on activities.

We shall demonstrate the two ways of using inquiry as a tool for constructivist learning - the 5-E Learning Cycle and the Discrepant Event as springboard.

A. The 5-E Learning Cycle

The 5-E Learning Cycle is a model that promotes scientific inquiry. Each “E” represents part of the process of helping students sequence their learning experiences to develop a connection between prior knowledge and new concepts. The teacher serves as a facilitator as students construct new knowledge based on thoughtful inquiry and decision making. The 5-E’s are as follows:

1. Engage

The students engage in a task to make connections between the past and present learning experiences.

2. Explore

The students perform a task to get directly involved with key concepts through guided exploration of scientific, geographic, economic, and other data set.

3. Explain

The students give details about the science concepts being developed in the task. Through readings and discussions, the students develop

understanding of the major science concepts and verify answers to questions or problems posed in the engage stage.

4. Elaborate

The students simplify the science concept/s in the lesson, e.g. stating the concepts in their own words, and applying new found knowledge to a different situation.

5. Evaluate

The students take a test, quiz, or any authentic assessment instrument to determine how much they benefited from the lesson or activity.

ACTIVITY 2.2

A sample lesson using the 5-E Learning Cycle is found in Appendix B. Try it in your class and answer the questions below.

1. How did you find the lesson?
2. What difficulties did you meet?
3. How can you overcome those difficulties?

B. Discrepant Event as Springboard for Inquiry Learning

Have you seen or heard of an iceberg in Manila Bay? An iceberg in Manila Bay is a discrepant event. Why? Manila, Philippines is close to the equator and the temperature never reaches the freezing point.

What is a discrepant event? Why use it to teach science? A discrepant event is an unexpected, surprising, or paradoxical event (FriedI, 1997). It creates a strong feeling in the student e.g. feeling of wanting to know. This feeling creates a condition favorable for inquiry learning. Its use in science capitalizes on the curiosity of students and it leads them to better understanding of science.

There are three steps to follow when using the discrepant event strategy. They are as follows:

1. Set up a discrepant event.

Present the event to gain attention, increase motivation, and encourage the students to seek ways of solving the unexpected. Some examples of discrepant events are shown below.

Examples of Discrepant Events	
Dancing salt	Making ice disappear
The appearing coin	Changing liquid to gas to liquid
The four seasons	Melting ice below freezing point

2. Students investigate the event to solve the discrepancy.

Give students the minimum materials as well as simple procedures to start the investigation. The students can go beyond your instruction. However, they should be advised to present their procedure for your approval first.

3. Students solve the discrepancy.

After the students have resolved the discrepancy, evaluate the students. You can do this by asking the students to do the following:

a. Prepare a summary of the lesson.

b. Relate the concept to a similar situation.

c. Cite applications of the concept in the real world.

SCQ 2.1

Choose the letter of the best answer.

1. Carla wanted to find out the relationship between the amount of gases that goes into solution and pressure through an experiment. Which of the following strategies is most appropriate?
    a. Inquiry learning through a discrepant event
    b. Inquiry learning through 5-E learning cycle
    c. Discovery learning
    d. Cooperative learning

2. If the teacher uses inquiry learning through 5-E learning cycle, at what phase can the students simplify the concept in their own language and be able to apply it to another situation?
    a. engage b. explore c. explain d. elaborate

3. In which phase of the lesson do the children learn through their own involvement and action?
    a. Exploration
    b. Evaluation
    c. Concept extension
    d. Concept explanation

4. Do you feel that a discrepant event helps students reconstruct their ideas about science concepts? Why do you say so?

READ

2.2.3 Reflective Teaching

In 1930, John Dewey defined reflection as a proactive, on-going examination of beliefs and practices, their origin and impact. The practitioners of reflection engage in a cycle of observation and self-evaluation in order to understand their own actions and the reactions they prompt on themselves and learners. Reflection can be seen as consciously thinking about analyzing what has been done and what one has done or is doing (Salandanan, 2000).

Reflecting on how you developed a science concept a week or two days ago is important to the improvement of the next teaching session. It makes you a better facilitator of science learning. In turn, students acquire meaningful experience of forthcoming science lessons.

How are your students benefited by reflective teaching? Reflective practice helps students do the following:

- frame a problem, detach from it and analyze it critically;
- bridge the gap between theory and practice;
- understand and influence their own thinking;
- recognize the depth and range of transferable skills learned; and
- become life-long learners.

Reflective teaching can be carried out in several ways. Salandanan (2000) suggested four strategies--journal writing, portfolio, self analysis, and on-the-spot observation of students' response.

1. **Journal writing** allows the students to reflect or process their thoughts about science concepts. Journals may be in the form of workbooks, diaries, logs,or progress profiles. Journals make students look back over their recent learning. In doing so, they can identify their strengths, weaknesses, new levels of understanding about the lesson at hand, and review their attitude towards the latest science concepts learned. The journal entry includes a

description of the learning event, outcomes of the event, worthiness of outcome and causes of failure or success.

2. **The portfolio** is a personal record which includes honest to goodness account of experiences - thoughts, behavior and reactions. This record gives insights to students' learning for a particular science topic. Portfolios may contain a collection of students' work such as homework, projects, written pieces, graphic organizers, tests, reflections, and other artifacts.

3. **Self-analysis** is a record of incidents, problems and issues that transpired while doing a science task/lesson. If the student did right, he would say *"I should remember to do this in another situation"*. If he failed, he could ask *"What went wrong", "I could have done this",* and "*There is room for improvement" or "Better luck next time".*

4. The fourth strategy for reflective teaching is **on the spot observation of the students' responses.** As a teacher, ask yourself the following questions so that you can reflect on the lessons just conducted:

    - Were the students motivated to participate in the activity?
    - Did the students take part in the discussion?
    - Did the students share their views animatedly?
    - Were the students given equal opportunity during the recitation/discussion?
    - Was the topic related to the world of the students?
    - Would the students be able to apply the science concepts discussed to their everyday life?

Do not rely solely on the natural process of reflecting on experience. Instead, you should actively find ways to make reflection a habit. By doing so, you ensure your continuing development as a professional teacher.

Reflecting on your own past performance is one form of feedback. Keeping a reflective diary about your own experiences with your class, students and colleagues, helps you to reflect and learn from experience.

(http:www.ukcle.ac.uk/resources/reflection/you/html).

A sample lesson using reflective teaching is shown in Appendix C. Choose a topic and prepare a similar lesson guide. Include this output in your portfolio. Include with it a short reflection about this lesson.

ACTIVITY 2.3

1. Make a poster of your conception of reflective teaching.
2. Explain your poster.
3. Can you use reflective teaching with a class of 75 pupils? Explain your answer.
4. Of the four strategies presented in this lesson on reflective teaching, which one would you like to use in your class? Why do you like it?

* Include this output in your portfolio.

READ

Lesson 2.2.4 Integrative Teaching

This is a teaching strategy which puts together the parts of a whole in order to arrive at a holistic, complete and more accurate view of reality (Corpus and Salandanan, 2003). It is infused by the multiple intelligences, the varied learning styles and the daily experiences of the learners. It empowers learners to become life-long learners and active makers of meaning.

Integrative teaching is a three-level strategy – **the facts level, the concept level** and the **values level**. Students pick up fragmented terms or facts at facts level. Here, the students move to the concept level when they view and organize the isolated, fragmented and meaningless facts into concepts. Then, the knowledge acquired is applied to the learners' life at the values level.

Integrative teaching involves the practice of recognizing and articulating relationships among subject matters and applying learning from one context to another. It also involves building bridges between the academe and the wider world, between public issues and personal experience.

Integrative teaching relies on connections built between academic setting on campus and other settings in the business community, farms, government, churches and host of other partners.

Advantages of Integrative Teaching

- makes content more meaningful because the content is presented the way it is in the real world
- is student-centered, involves active learning with the teacher acting as facilitator of learning
- allows learners to form their own representations of complex topics and issues
- offers multiple ways for learners to demonstrate the knowledge, skills and attitudes learned
- gives opportunities for students to work in a context where interdependence and cooperation are crucial for getting things done
- helps learners develop a variety of social skills

SCQ 2.2

1. What are the features of integrative teaching?
2. Describe the three levels of integrative teaching?
3. How will students benefit from the use of integrative teaching?

ACTIVITY 2.4

A sample lesson on integrative teaching is given in Appendix D. Using it as a model, choose a topic and prepare a lesson plan showing how you will teach the lesson using integrative teaching.

1. How did you feel when you tried the sample lesson on integrative teaching?
2. What difficulties did you meet?
3. What suggestions can you make to improve the lesson?
4. Include your output for this activity in your portfolio.

READ

2.2.5. Cooperative Learning

Cooperative learning is "the instructional use of small groups through which students work together to maximize their own and each other's learning." Cooperative groups are not the same as students working cooperatively in groups. In cooperative groups, each member has a valued role in the learning process and everyone is responsible for each other's learning. Students take time to reflect on their personal contributions to the group, on how members perform, and on how the group may improve.

There are four basic components of cooperative learning. They are as follows:

- **Positive interdependence**

  This principle emphasizes that the success or failure of the group depends on the success or failure of each member. Thus, each member of the group learns to share and work together to attain the shared goal.

- **Individual accountability**

  This implies that each member of the group is not only responsible for their own learning but also in helping their fellow students to learn.

- **Equal participation**

  This means that each member has his/her own role, work or load to achieve the goal of the group. No member should be allowed to dominate anybody in the group either socially or academically.

- **Simultaneous interaction**.

  This means that students share and openly express their views and suggestions in a group.

Here are some tips that will help you implement cooperative learning successfully.

- Be sure to monitor the group and their activities, taking care to ensure that the groups are functioning as groups and that one student is not dominating the work.
- Give credit to the teams for their collective work, not the work of one individual.
- Rotate the roles among the members of the group.
- Create a new group every now and then.

ACTIVITY 2.5

1. Think of one lesson where you can use cooperative learning.
2. Enumerate the steps you are going to follow.
3. Try–out the lesson in one of your classes and write your insights about your experience in using cooperative learning. Include this output in your portfolio.

There are different strategies for implementing cooperative learning. Some of them are shown in Appendix E. Why not try at least one of them?

SCQ 2.3

Answer the following questions briefly:

1. Can you consider all students working cooperatively in groups as cooperative groups? Explain your answer.

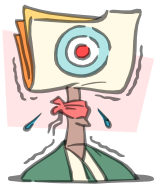
2. Cite some advantages of using cooperative learning.

LESSON 3

OTHER TEACHING STRATEGIES

INTRODUCTION

Other than the teaching strategies discussed in Lesson 2, there are other strategies you can choose from. Remember, there is no one best strategy. Your choice as to what strategy to use depends on the factors cited in Lesson 2. Can you still recall them?



OBJECTIVES

After going through this lesson, you should be able to:

- describe other teaching strategies; and
- prepare sample lessons using some of the strategies discussed.

Lesson 3.1 Lecture and Student Recitation

You can use the lecture method to explain, demonstrate, and present information on the topic to be taken up. It is not necessary for the teacher to do the lecturing all the time. For example, if your lesson is on diversity, you may invite an expert on biodiversity from the National Museum, Department. of Environment and Natural Resources or from a nearby university. Lectures may vary in form. Table 3.1 lists variations of the lecture. Demonstration teaching, practice and drills, and review

are considered variations of the lecture because they are expository in nature. These strategies are all teacher-centered.

Table 3.1 Different Forms of Lectures

Learning/teaching strategies	What it is	How to use it
Lecture and student recitation	Teacher explains, demonstrates, presents, asks questions and student answers	Teacher uses direct delivery to help students acquire information; asks questions to elicit responses from students. Students give responses that provide basis for judging how much the students learn.
Demonstration	It is similar to lecture but allows students to observe real things and how they work.	Teacher demonstrates an action or skill before the students do the action themselves. Demonstration by the teacher or a student provides model of action and establishes expectations. This strategy is used when the activity is dangerous or when the materials are limited.
Practice or drill	It goes over the instructional material, process or skills just learned. Drill involves repeating the information until it becomes permanent memory.	This is done to consolidate, clarify and emphasize what the students learned.
Review	This is re-learning or re-teaching and it is intended to reinforce what was previously learned.	This is done in the form of summary at the end of the lesson, quizzes, games, outlines, discussions, and questioning sessions.

Lesson 3.2 Role Playing and Simulation

Everyday we encounter situations where people are in conflict or faced with a dilemma of some sort. Take the need to have a supply of wood for construction material as an example. This means trees have to be cut from the forests. However, our forest cover is getting smaller. So, we are faced with a dilemma, *"Are we going to ban logging completely?"* or "*Are we going to practice selected logging?"* Role playing can be used to dramatize the situations. Majority of the class members observe and analyze the components of enactment. After the role play, discussion follows.

An alternative to this is a simulation wherein students are placed in a situation that models a real life phenomenon. For example, Barangay A has a population of ten thousand ((10,000). One pressing problem of the barangay is a build up of mountains of garbage. If a person produces three (3) kilograms of garbage everyday how soon can a barangay accumulate a mountain of garbage with a bulk of 20,000,000 kilograms of garbage?

Lesson 3.3 Field Trips

The field trip is a vehicle by which science can be learned and taught. Krepel and Duvall (1981) defined field trip as "a *trip arranged by the school and undertaken for educational purposes, in which the students go to places where the materials of instruction may be observed and studied directly in their functional setting*"(Michie, M., 1998). Biology teachers and students could observe organisms in their native habitat to describe behavior and other biological functions of living organisms. Chemistry teachers can bring their students to industries to observe or experience actual processes which are simulated or discussed in classrooms. Physics teachers can bring their students to theme parks like Enchanted Kingdom to discuss physics in the playgrounds. Science teachers can also carry out field work which indicates formal exercises to be conducted in the field. It is a subset of field trip. An example of formal exercises to be conducted in the field is the relation between dissolved oxygen and the depth and water temperature of a lake, river, or ocean. Another is the distribution of planktons at different times of the year. Field trips are valuable for cognitive and affective development of the students.

There are many places where you can take your students for a field trip. Some of these places are the science museum, science centers, zoos (Manila Zoo, Malabon Zoo, Avilon Zoo, Island Cove Animal Santuary in Cavite,) aquariums, planetariums, field study or nature centers, farms (hydroponics in Tagaytay City), and universities with special facilities such as seed banks and gene banks at the University of the Philippines in Los Banos, Laguna,

Field trips provide the opportunity for hands-on, real world experiences, improved quality of education, motivation and development of positive attitude towards the subject, improvement of the socialization between students as well as development of rapport between teachers and students.

Planning a Fieldtrip

The following are the steps that you should take when planning a field trip:

1. Look at the course syllabus.
2. Match topic with facility to be visited.
3. List the objectives of the field trip.
4. Prepare activities.
5. List places to be visited.
6. Inquire through the phone, e-mail, or visit the place.
7. Make arrangements with the chosen venues.
8. Give formal notice to the school administrators. Present the following papers to the department head, principal, dean, director, guidance councilor, president and other school officials concerned:
    a. three places for them to decide on
    b. safety measures
    c. expenditures
    d. transport
    e. food arrangement

9. Send letters to parents which include parent's permit forms and fieldtrip rules. Both forms are to be signed and returned to teachers on or before a specified date. Without them, the students should not be allowed to join even if they have paid for the fieldtrip expenses.
10. A week before the fieldtrip, conduct an orientation. During the orientation, the students must be informed about what to bring and what to wear. If students have medical problems, clearance from the doctor is important. Without such clearance, the teacher has to prepare alternative activities for these students.
11. If the fieldtrip involves field work, then students must bring with them procedures of activities.
12. Pack the laboratory equipment and chemical reagents needed in the field activities a day or two before the scheduled trip.
13. Prepare the itinerary of travel and distribute it to students a day before the scheduled trip.

SCQ 3.1

1. Using a Venn diagram, compare and contrast review and drill.
2. Before conducting a field trip, the teacher should orient the students. What should you include in the orientation?

Lesson 3.4 Concept Mapping

A concept map is a special form of a web diagram for exploring knowledge and gathering and sharing information. Concept mapping is employed to develop connections among concepts in the unit. A concept map consists of **nodes or cells** and **links.** The nodes contain the concepts and are usually enclosed in a box or circle. The links are represented by arrows. The labels in the links explain the

relationship between the nodes. The arrow describes the direction of the relationship and is read like a sentence.

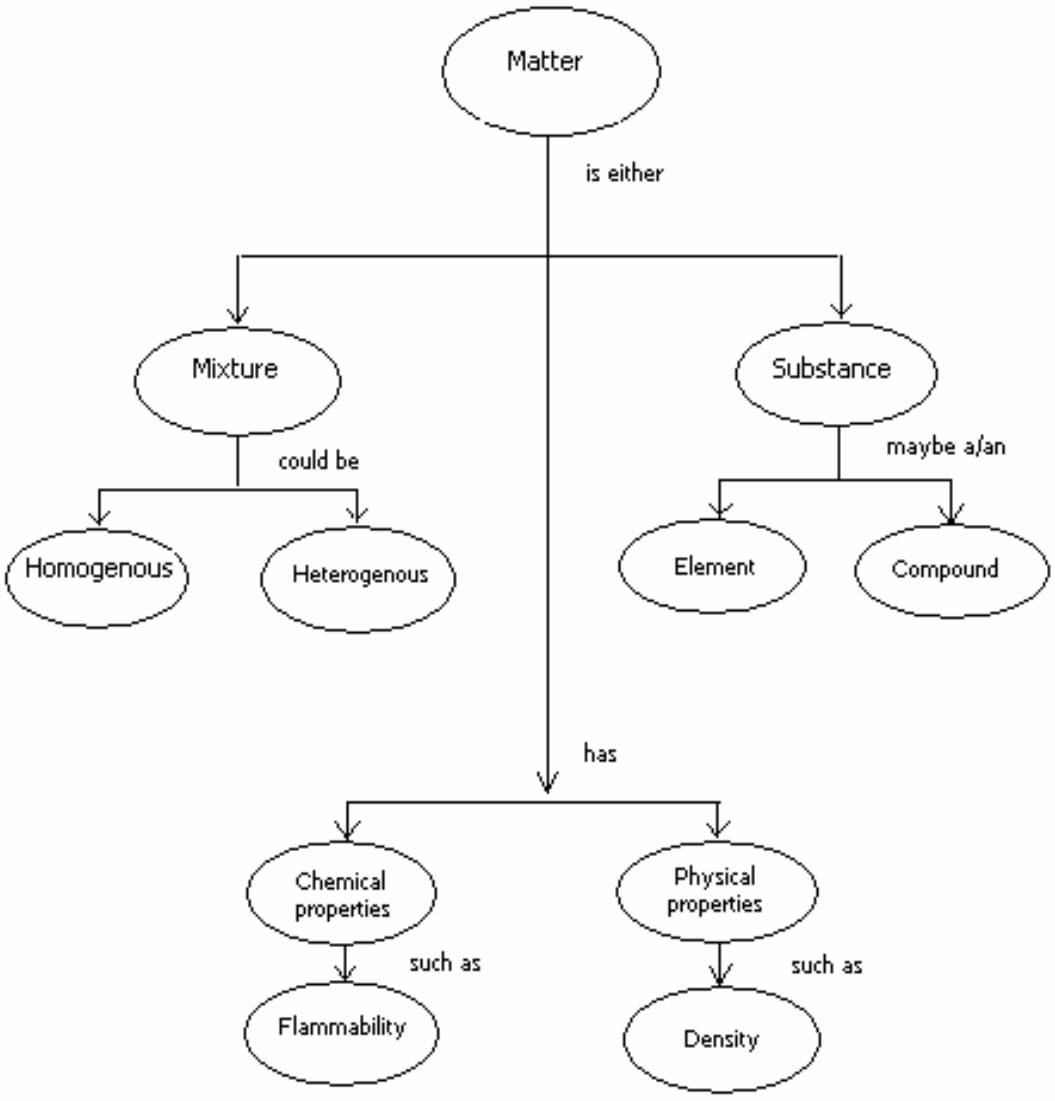
A concept map may be used to:

- develop an understanding of a body of knowledge;
- explore new information and relationships;
- access prior knowledge;
- gather new knowledge and information;
- share knowledge and information generated; and
- organize structures or processes such as written documents, constructions, web sites, web search multimedia presentations.

How would you help students make a concept map? Here are some tips.

1. Identify major and minor concepts of the topic under study.
2. Organize the concepts from most important to less important.
3. Tell them to write the major idea at the center of the paper.
4. Write the next major ideas as the next layer. Connect these ideas to the major idea with lines and proper linking words.

As an assessment tool, the concept map will give you information on how the student relates the identified concepts from the lesson. This way, you can be sure that students understand the lesson. A concept map about matter is shown on the next page.



Notice that the concepts are linked by lines and there are link words between concepts to show the relationship. A concept map can be a group work or an individual activity. You will find other examples of concept maps in Appendix F.

ACTIVITY 3.1

My Concept Map

Materials: An article or a reading material about the thinning of the ozone layer.

What to do

1. Get a reading material in science.
2. Identify major and minor concepts of the topic under study.
3. Organize the concepts from important to less important.
4. Write the major idea at the center of the paper.
5. Write the next major ideas in the next layer. Connect these ideas to the major idea with lines and proper linking words.

3.5 Games

Children love to play games. Games can teach children to work together as a well-coordinated team. It develops coordination skills which are necessary to perform delicate jobs. Basketball can be used to teach motion in physics. Billiards can be used to develop functional understanding about momentum. Tug-of-war is a good analogy for developing concepts about balanced or unbalanced forces either in physics or chemistry.

Puzzles, cartoons, humor, magic, and jokes can also be used in the science classrooms. They make science learning fun and enjoyable for learners.

SCQ 3.2

Directions: Write the letter of the best answer.

1. There are a lot of low-achievers in Mrs. Teodoro's science class. What strategy should be avoided?
    a. Lecture Method
    b. Drill practice
    c. Discussion
    d. Independent research
2. This is a strategy where the students are provided the opportunity to learn an event by observing some of their classmates performing the activity in front of the class under the direction of the teacher.
    a. Project-based learning
    b. Demonstration
    c. Exposition
    d. Lecture
3. In which of the following situations is demonstration likely to be used as a strategy in a science class?
    a. The teacher wants to develop students' interest in science.
    b. The lesson calls for the use of recycled materials.
    c. There is danger in the use of some materials.
    d. The activity is quite long and complicated.
4. For what purpose can a concept map be used?
    a. as an advanced organizer
    b. as an assessment tool
    c. as a summary
    d. all of the three

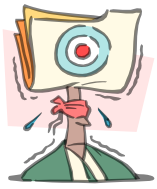
LESSON 4

INCORPORATING RESEARCH IN THE CLASSROOM

INTRODUCTION

Secondary schools may be classified into science high schools and general secondary schools. The students in the science high schools are required to do research. Thus, research I and II are part of the curriculum. The students in general secondary schools do not have research courses. However, they are encouraged to do research in the form of investigative projects so they can participate in the Intel-DepEd (formerly Intel-DOST-SEI Science Fair) and Association of Science Educators in the Philippines Science Fair.

Doing an investigative project or conducting research in science classes is actually the application of the scientific method. This lesson will help you to assist students conduct investigative projects.



OBJECTIVES

At the end of the lesson, you should be able to do the following:

- identify research problems from a body of collected facts;
- formulate hypothesis/hypotheses to explain the identified problem/s;
- design simple investigation to test the hypothesis/ hypotheses; and
- prepare an investigative project proposal.

READ

4.1 What is the scientific method?

The concern of science is the natural world. Its goal is to discover the underlying patterns in it and then use this knowledge to make predictions about what should or should not be expected to happen given certain facts or circumstances.

How does one discover patterns in the natural world or develop new scientific facts? There is no simple way to do it. However, there are guidelines one can use. We shall take a look at these steps through the discovery of Lyme disease, a disease first observed in Lyme, Connecticut, U.S.A.

Step 1. Look for and accumulate facts like a detective

Several decades ago, a scientist by the name of Allen C. Steere noticed that some people were suffering from a non-contagious disease. He noted that the affected adults and children were diagnosed to be suffering from rare rheumatoid arthritis. It is rare for children to get the disease. So, he collected more facts. Some facts collected about the disease were :

1. Most victims lived in heavily wooded area.
2. The disease was not contagious.
3. The symptoms appeared in summer.
4. Victims remembered a strange bull's eye rash occurring several weeks before the symptoms appeared.

Step 2. Develop a working tentative answer to explain the collected facts

From the facts collected, Allen C. Steere thought that the disease was caused by a microbe mostly transmitted by the bite of an insect or tick. What he stated was just a tentative explanation. This tentative explanation to the problem is called **hypothesis.** It guides you in planning what experiment to conduct or what facts to collect. Steere used inductive reasoning because he collected facts to formulate the tentative explanation. However, you can also use deductive reasoning to formulate hypothesis by starting from a general idea to specific ideas/facts.

Step 3. Design an experiment to test the tentative explanation.

Steere tested his hypothesis by getting blood samples from victims. He was not able to find the microbe that could have been transmitted by the tick. In 1977, a victim saved the tick, *Ixodes dammini* that bit him. The tick was submitted to tick-borne diseases expert, Willy Burgdorferi. The expert isolated a spirochete (a bacterium) from the tick. The same bacterium was isolated from the blood of victim. The new spirochete was named *Borrelia burgdorferi*.

Step 4. Accept, modify or reject hypothesis on the basis of extensive testing.

The data collected by Burgdorferi supported the hypothesis that the tick-borne disease is due to a microbe transmitted by tick. The rare rheumatoid arthritis is called Lyme disease, after the place where it first occurred.

The hypothesis about the Lyme disease became a **scientific theory**. A **scientific theory** is a well-tested and widely accepted view that scientists agree on because it explains certain observable facts.

Some concepts in science are formulated into scientific law. A scientific law is a generalization about the behavior and nature from which there is no known deviation after observation or experiment.

It is narrower in scope than a theory and it can be expressed mathematically. Some examples of laws are Newton Laws of Motion, Charles' Law, and the Universal Law of Gravitation.

The process just described is called the **scientific method.** The scientific method is not a standard recipe for studying the natural world. This is an investigative strategy wherein the students learn to apply theories they learned in science classes. It is also a strategy which develops the ability of students to work independently and creatively.

For a detailed discussion on how to conduct science investigative projects, you may read Appendix G. This will be very useful to you when you become a project adviser of students conducting science investigative projects. Who knows, you might produce winners in international science fairs.

ACTIVITY 4.1

Helping students do an investigative project

1. A student wants to conduct an investigative project that has something to do with a rice field. If you are the teacher of the student, how will you help this student?

2. Following the steps discussed in the module, write the steps that you are going to follow to help the said student in conducting an investigative project.

ACTIVITY 4.2

Finding topics in the science text as a starting point for an investigative project

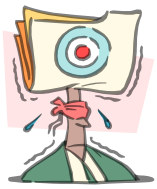
1. Look at your book in science and list down at least 5 topics where you can incorporate scientific research.
2. Advising students how to conduct an investigative project will require extra effort and time from you. Are you willing to be a science project adviser? Explain your answer.

LESSON 5

CLASSROOM ASSESSMENT

INTRODUCTION

While instruction is going on or after teaching a science concept, you may want to gather information about a student's understanding of the science concept just discussed in the class. You may also want to find out how the planned lesson went and how well you have implemented it. How will you do all these? Well, you can conduct a classroom assessment of student achievement. **Assessment** is an information-gathering and a decision making process which includes observing students as they work, listening to their answer during discussions, and examining the results of the teacher-made and standardized tests (Kauchak and Eggen, 2001). What do you assess in your students? How will you go about in assessing them? You will know the answers to these questions as you go through Lesson 5.



OBJECTIVES

At the end of the lesson, you will be able to do the following:

- differentiate assessment, measurement, and evaluation;
- differentiate formative assessment from summative assessment;
- compare and contrast traditional and authentic assessment
- describe the different forms of authentic assessment; and
- explain the merits of authentic assessment.

READ

Assessment may be formative or summative in nature. You do **formative assessment** when you ask questions while discussion is going on. You do **summative assessment** when you give a test at the end of the topic. If you want to know the prior knowledge of the students about the topic as well as their strengths and weaknesses, then you can administer a **diagnostic test** to determine where to start your instruction. Assessment has two components – **measurement and evaluation**.

Measurement includes all information the teacher gathers concerning student performance.

Evaluation refers to the decision teachers make on the basis of measurement. Assigning grades is the most common form of evaluation.

What are the sources of assessment information?

Traditional Assessment
- Fill-in-the blanks
- Matching type
- True or false type
- Multiple choice type
- Short –answer question type

Authentic assessment (Kleinheider, 1996)
- Performance-based Assessment
- Portfolio
- Concept Mapping
- Creative Assessment
- Journals and Oral Interviews
- Problem Tests
- Diagrams or Picture Types of Tests
- Practical Assessment
- Self-evaluation

Traditional Assessment versus Authentic Assessment

Traditional assessment has the following characteristics.

- It focuses on knowledge and recall of information. .
- It tends to reveal only whether the student can recognize, recall or "plug in" what was learned out of context (Grant, 2003).

- It provides little insights into the way learners think.
- It relies on indirect or proxy 'items'--efficient, simplistic substitutes from which we think valid inferences can be made about the student's performance (Atherton, 2003).
- It is usually limited to paper-and-pencil, one- answer questions.
- It asks the student to select or write correct responses, but does not provide reasons for their choice.
- It does not assess student's ability to apply their understanding to real world problems (Kauchak & Eggen, 2001).
- It provides rare opportunity to plan, revise and substantiate responses even when there are open-ended questions.
- It standardizes objective "items"; hence, it has one right answer.
- It is easy for teachers to check.

One commonly used traditional assessment tool is the **multiple choice test**. A multiple-choice test item consists of a **stem** and **options.** The student has to choose from a number of options. In most forms, one of the options is the correct answer and the others are **distractors**. This test is effective for testing knowledge and memory and for problem-solving in convergent subject areas. It is easy to administer to large number of students. However, have in mind that a good multiple choice question is difficult to prepare. Knowledge of a topic that is to be assessed by multiple–choice test may encourage students to memorize discrete items of information, rather than develop an overall understanding of the topic (Atherton, 2003).

Traditional assessment is not the only way to gauge the achievement of the students. There are many classroom situations in which you may need to use non-paper-and-pencil tests to gather information about your pupils' achievement. Some of these are the development of different science process skills, manipulating a microscope, measuring, and social skills such as cooperation, courtesy and leadership. To gather appropriate information about such performances, you need to observe and judge each of your pupil's/student's actual performance or products. Assessment in which pupils/students create an answer or a product that

demonstrate their knowledge and skills are called **performance-based assessment.** This kind of assessment is a form of **authentic assessment.**

Performance-based assessment is concerned primarily with the student's ability to translate knowledge into observable performance or products. It has the following characteristics:

- is concerned primarily with the pupil's/student's ability to translate knowledge into observable performance or products;
- requires pupils/students to manipulate equipment, to solve a problem, or make analysis;
- gives insights of pupil's/student's conceptual and procedural knowledge;
- can be used to chart the progress of each member of the class;
- provides rich evidence of the level of performance skills; and
- is time-consuming to construct and administer but produces rating forms that can be repeatedly used with the same or new pupils/students.

SCQ 5.1

1. Using a concept map, compare and contrast traditional and performance-based assessment.

2. Why do most teachers still use the traditional forms of assessment?

.

Performance comes in many forms – oral contribution in a class, laboratory work, event task, and extended task. The latter forms of performance tasks are described below.

In event task, students are given a set of materials with minimal instruction. The students are told to make predictions first before they perform the activity. An extended task is an activity that allows students to connect the science concepts

learned in the classroom to the home environment. The situations on the next page demonstrate the difference between an event task and an extended task.

Event Task	Extended Task
You just learned that compounds are either acids, bases or salts. Many of these substances are present in food. The tongue contains taste buds. Draw the tongue. Predict which part of the tongue is sensitive to acidic, basic and salty food. Taste the acidic, basic and salty food. Note the part of tongue that senses these foods. Does your prediction agree with the results of the activity? Submit the results of the activity in journal form.	If you eat a lot of green mangoes, you experience stomach indigestion. Which of the following substances is the probable remedy? a. coffee b. milk c. tea d. antacid Explain your answer. What is the scientific basis of your answer? Present your work through a poster, flow chart, or a narrative report.

Your assessment may be based on observations of student's performance or samples of various performances done by the student (Atherton, 2003). How can you obtain observations about your students' performance? You have several options. These include:

1. **Systematic observations**

These are observations obtained when you make notes describing learner's performance according to preset criteria (Eggen, 2001). Box 5.1 shows a typical systematic observation to determine if the student has developed the skill in using a balance.

Box 5.1 Example of systematic observation

Teacher observes how the student uses the balance using the following indicators:

1. Holds the balance with both hands.
2. Holds the balance with one hand and swings it.
3. Places the balance on the table with a bang.
4. Places the balance on top of the table carefully, 3 cm from the edge of table.
5. Calibrates the balance.
6. Places a piece of paper on top of the pan of the balance and gets its mass.
7. Puts the object to be weighed on top of the paper and gets the total mass of the object and the paper.
8. To get the mass of the object, subtracts the mass of the paper from the total mass of the paper and object.

Note:

Observations 2 and 3 manifest bad practice. It may be deducted from over all rating.

2. **Checklist**

The use of a checklist enables you to describe the dimensions that must be present in an acceptable performance and extend systematic observation. A checklist is useful for observing behaviors. An example of a checklist is shown Box 5.2.

Box 5.2 A sample checklist

Tick the skill exhibited by the student in using the balance

_____1. Holds the balance with both hands.

_____2. Places the balance on top of the table carefully, 3 cm from the edge of table

_____3. Calibrates the balance

_____4. Places a piece of paper on top of the pan of the balance and gets its mass

_____5. Records the mass of the paper

_____6. Puts the object to be weighed on top of the paper and gets the mass of the paper and object

_____7. Records the mass of the paper and object

_____8. Calculate the mass of the object by subtracting the mass of the paper from the total mass of the paper and object.

3. Rating Scale

This observation instrument can be used to gather observations just like a checklist. However, rating scales are better to use since there are written descriptions or dimensions and scales of values on which each dimension is rated.

Box 5.3 Example of a Rating Scale

Tick Column 3 if you feel the student has done it very well, 2 if the student has done it well and 1 if the student has done it haphazardly or not well

Observable Skills of students		Rating Scale		
		3	2	1
1. Holds the balance with both hands.				
2. Places the balance on top of the table carefully, 3 cm from the edge of table				
3. Calibrates the balance				
4. Places a piece of paper on top of the pan of the balance and gets its mass				
5. Records the mass of the paper				
6. Puts the object to be weighed on top of the paper and gets the total mass of the paper and object				
7. Records the total mass of the paper and object				
8. Calculates the mass of the object by subtracting the mass of the paper from the total mass of the paper and object.				

ACTIVITY 5.1

Observation Instrument

1. Choose a skill that you want to assess among your students.

2. Using the samples given in this lesson, prepare the following observation instruments which you can use in your class:

a. systematic observation b. checklist c. rating scale

3. Include them in your portfolio.

Portfolio

A portfolio is another assessment tool that you can use to gather information about your students. Students put together the materials they have produced about a science concept, e.g. heat transfer in a student portfolio.. The student portfolio includes products such as worksheets, pictures, assignments completed, data sheets, written conclusions, experiment reports, maps, stories, plans, tapes, videos, and other written materials related to the work completed for a unit or course. The portfolio is highly individualized and students can use it to evaluate themselves and gain a realistic picture of what they have accomplished in a unit, quarter, semester or year. According to Atherton (2003), the portfolio

- can be used for other types of assessment such as interview with student and conference with parents;
- illustrates specific requirements for grade completion;
- can be used as a means of summative evaluation of the student's learning;
- reflects the nature of the curriculum and the student's success; and
- enhances social skills of the pupils/students.

Anecdotal Records

These are written accounts of significant individual student events and behaviors that the teacher has observed. It provides information about the learner, the date of observation, name of the teacher observing, and a factual description of the event. These records can provide you with quick, written refresher of the progress, problems, and activities of students.

SCQ 5.2

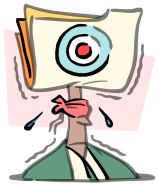
1. Which of the following is administered at the end of the unit?
   a. survey test
   b. summative test
   c. diagnostic test
   d. periodic test
2. Which of the following is a means of knowing whether the student understands the science concepts?
   a. Listening to student's responses to a question asked during discussion
   b. Examining the result of the test given at the end of the discussion
   c. Observing while the student is doing an experiment
   d. all of the above
3. Which of the following is a manifestation of evaluation?
   a. Mr. Reyes rates the portfolio of Omni using a checklist.
   b. Mr. Reyes puts together the works of Eric.
   c. Mr. Reyes gives comments on Eric's work.
   d. None of the above
4. Which of the following is used to visualize relations between ideas?
   a. portfolio
   b. journal writing
   c. concept mapping
   d. creative assessment
5. Ms. Cruz would like to find out if Paolo could use the platform balance accurately. Which would be the most appropriate assessment tool that Ms.Cruz could use?
   a. performance-based assessment
   b. creative assessment
   c. journal writing
   d. oral interview

LESSON 6

SCORING AUTHENTIC ASSESSMENT THROUGH RUBRICS

INTRODUCTION

. If you use authentic assessment, you should also use an authentic way of scoring the work of your students. One authentic way of scoring evidence of student learning is through the use of a **scoring rubric**. What is a scoring rubric ? A scoring rubric is a scoring guide that uses criteria to differentiate between levels of student proficiency (MacMillan, 2001). The use of a scoring rubric is an innovation for assessing the accomplishment of student learning at its highest level, with progressively lower levels further and further from the ideal achievement (Nott, et.al, 1992). It is used to prepare students for the assessment and to assign final grades.



OBJECTIVES

At the end of the lesson, you should be able to do the following:

- give criteria to be used in preparing rubric;
- differentiate the different forms of rubrics; and
- make your own rubric.

READ

Scoring Rubrics

A scoring rubric has several components. It includes one or more dimensions on which the work of the students is rated, as well as definitions and examples to clarify the meaning of each trait or dimension. The scoring rubric rating scales may be numerical, qualitative or a combination of the two. Qualitative rubrics may have scale points with labels such as:

- Not yet, developing, achieving
- Emerging, developing, achieving
- Novice, apprentice, proficient, distinguished
- No evidence, minimal evidence, partial evidence, complete evidence

A rubric has a uniform set of precisely defined criteria or guidelines that will be used to judge student work. Examples of criteria are:

1. has knowledge of places where to collect rocks
2. knows what tools to bring for rock sampling
3. identifies rocks through physical and chemical properties

There are many forms of rubric. A rubric with two or more separate scales is called an analytic rubric. If a rubric uses only a single scale, it is a holistic rubric. Table 6.1 is an example of a holistic rubric. You can find an example of an analytic rubric in Appendix G.

Holistic Rubric by Barbara Schaner (www.gsu.edu/~mstnrhx/457/rubric.htm)

Proficient-3points	The student's project has a hypothesis, a procedure, collected data, and analyzed results. The project is thorough and the findings are in agreement with the data collected. There are minor inaccuracies that do not affect the quality of the project.
Adequate-2points	The student's project may have a hypothesis, a procedure, col\lected data, and analyzed results. The project is not as thorough as it could be; there are a few overlooked areas. The project has a few inaccuracies that affect the quality of the project.
Limited - 1 point	The student's project may have a hypothesis, a procedure, collected data, and analyzed results. The project has several inaccuracies that affect the quality of the project.

Table 6.2. Holistic Scoring rubric for acid/base experiment

Score	**Accomplishment**
3 pts	Understands the procedure before coming to the laboratory. Notes the color of the unknown solutions and indicator Transfer a specific volume of the solution to a test tube with the use of pipette. Introduce indicator drop by drop until the solution changes color. Reads the pH of the solution by matching color change with the accompanying color chart of pH paper. Records observation in tabulated form. Draws appropriate generalizationr
2 pts	Reads the procedure of the activity before borrowing glasswares from the resource center. Does not use the glasswares properly. Makes correct observation. Draw appropriate generalization with guidance from the teacher.
1 pt	Does not read the procedure. Has little idea about the experiment. Depends on classmates on what to do next. Can collect correct observation but unable to draw conclusion without help from teacher or classmates.

Now, let us see if you can make your own rubric. Please do Activity 6.1

ACTIVITY 6.1

My rubric

1. After going through this lesson , examine the sample rubrics provided in this lesson and in Appendix G

2. Get one class activity that you want your students to do in class, e.g. volcano model, and make a rubric for the particular task.

A good rubric helps teachers define excellence and design ways for the students to achieve excellence. It communicates to students how to evaluate their own work. It tells parents and other school stakeholders how students are evaluated in the schools. The procedures used to judge students' work in school is documented to enable learners, teachers and parents to be aware of the learner's progress.

SCQ 6.1

1. What is a rubric?

2. What are the advantages of using rubric for assessment?

Congratulations! You have finished all the lessons in this module. Are you ready to take the post test? If you feel you need to take another look at some of the lessons, then you may do so. If you feel you are ready, please answer the post test, which will be administrated by your TIP Coordinator.

Good luck! We wish you success in your teaching profession.

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APPENDICES

Appendix A

Science Process Skills

Science Process Skills	Descriptions	Examples
Observing	Gathering information about an object or event by using the different senses.	Taking note of what happens when an ice cube on a saucer is left on the table.
Inferring	Making a conclusion based on reasoning or past experiences to explain observations	Explaining why the ice cube melted when left on the table
Formulating Hypothesis	Stating a tentative and testable answer to a problem	Beer enhances the growth of orchids
Identifying variables	Recognizing factors that may affect the result of an experiment	Listing factors that are thought to, or would, influence the rate of dissolving
Making decisions	Identifying choices and choosing a course of action based on justifiable reasons	Analyzing the cost and effects of the different methods of disposing garbage and using justifiable reasons for making a choice from the alternatives
Making Models	Concretizing information through the use of graphics illustrations or other multi-sensory representations	Constructing a model of an atom, constructing a three-dimentional model of a cube
Measuring	Making quantitative observations by comparing objects to a standard	Determining the dimensions of a rectangular box
Predicting	Making forecast of future events based on observed information	Stating that a 50 ml of water will require more time to boil than a 20 ml of water.
Using Numbers	Applying mathematical rules on formulas to calculate quantities or determining relationships from basic measurements	Computing the average time for different amounts of water to boil

Appendix B
Sample Lesson Using 5- E Learning Cycle

Objectives

After performing the planned activities, the students should be able to:

1. prepare acid-base indicators from plant pigments;
2. identify acidic and basic substances using the plant pigments;
3. give examples of acids and bases found at home and their uses; and
4. practice safety precautions in handling and using acids and bases.

Subject Matter

Acids and Bases

Engage

Recall the following:

1. Compounds are classified into acids, bases, and compounds.
2. Some acids and bases are strong; some are weak
3. Indicators such as litmus paper and phenolphthalein can be used to identify acids and bases.

Present the situation below to your students.

Suppose you want to find out which among the substances in your home are acids and bases. You don't have any litmus paper or phenolphthalein. What will you do?

Explore

Let the students do Activity No. 1 Acid-Base Indicators from Plant Pigments.

Activity 1

Acid-Base Indicators from Plant Pigments

Materials : shampoo, tea, test tube, alcohol, detergent, baking soda, test tube rack, plastic spoon, milk, toothpaste, medicine dropper, grains of sand, coffee, bleaching agent, mortar & pestle, plant parts such as

- gumamela flower (GF)
- red cabbage (RC)
- periwinkle flower (PF)
- balete fruit (BF)
- purple camote top (PCT)

Procedure:

1. Collect colored parts of plants as listed.
2. Cut it into pieces and place it into the mortar with some grains of sand.
3. With the use of a pestle, grind the plant parts.
4. Add 25 mL 95 % ethanol. Mix well with the use of a spatula or plastic spoon.
5. Prepare standard solution (hydrochloric acid and sodium hydroxide) from pH 1–14. Get 14 test tubes and label them 1–14. Transfer 1 mL of each solution into each test tube. Add 3-5 drops extract of plant part in each of the test tubes. Note the color of extract in each solution. Record your observation in a table as shown below.

Plant	Color Change of Plant Extract at Specific pH of the Standard Solution													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
GF														
PF														
PCT														

6. Prepare a 2 % aqueous mixture of each substance to be tested and transfer one mL of the mixture into a test tube. Place the test tube in a test tube rack.
7. Using a medicine dropper, add 3-5 drops of the plant extract into the test tube.

8. Note the color change as soon as you drop the plant extract. Get the pH of the solution by comparing it to your standard (Step 5).
9. Repeat steps 6 -8 for each substance listed under materials.
10. Once you have tested all the substances, prepare a table as shown below.

Name of substances	Color change with the plant extract	Sour (Acid)	Base (bitter)
Shampoo			
Milk			
Detergent			
Tea			
Coffee			
Baking soda			
Bleaching agent			
Toothpaste			

Explain

Which of the household substances are acidic? Which substances are basic ? You can answer the questions by comparing the color change of the extract in solutions found in the second table with the color change of extract in hydrochloric acid solution/sodium hydroxide solution. From these two tables you can deduce that milk, tea, coffee and bleaching agent are acids. Shampoo, detergent, baking soda and toothpaste are bases.

Elaborate

Present the situation below to the students

Some of us suffer from indigestion or stomach problem in the morning. Our parents would tell us to drink milk, coffee, or tea. Is this a good advice or practice?

One cause of indigestion or stomach problem in the morning is hyperacidity. At first coffee, milk or tea may help. In the long run, the problem will worsen. Why? Tea, milk and coffee are acidic.

What is the best remedy for indigestion? You are supposed to take antacids. Antacids are basic substances. When taken, it combines with acid to produce neutral substance. So you are relieved of discomfort in the stomach.

What do shampoo, detergent, and toothpaste have in common? The three products are cleansing agents. The toothpaste reacts with acids produced in the mouth by microorganism when they feed on sugary foods left between the teeth. If these acids are not removed, plaques will grow, and will result in tooth decay. Shampoo removes greasy dirt from the hair while detergent removes the dirt from dirty clothes and greasy plates.

Evaluate

You may use a pencil and paper test (traditionals) or performance-based assessment (authentic). Below is an example of performance-based assessment.

You are given the following solutions:

5 % table sugar solution
5 % table salt solution
ampalaya or bitter gourd extract
fresh calamansi/lemon juice
tongue spatula or depressor

Instruction

1. Draw a human tongue. You may copy the drawing of a tongue from a book.
2. Dip the spatula in the sugar solution.
3. Touch any part of your tongue with the spatula dipped in sugar solution. Note the part of your tongue that is sensitive to sweet taste.
4. Mark the part of the tongue that sensed the sweet taste.
5. Gurgle with clean water to wash your tongue.
6. Repeat steps 2-5 for salt solution, ampalaya extract and lemon juice.
7. Which part of your tongue enables you to detect sour, bitter, salty or sweet - tasting foods?

There are many ways to evaluate the performance of the students in this activity. You can rate them on how they performed the activity, how they organized the data, and how they drew the tongue.

Appendix C

Doing Reflective Learning in the Classroom

Topic: The use of radioactive substances

Objectives:

1. Give examples of useful radioactive substances.
2. Indicate the use of the radioactive substances given.
3. Consider the risks and benefits derived from the use of radioactive substances.
4. Manifest values such as awareness, safety, and cooperation.

Working group: Group students into three, each consisting of 4-5 students. Each group is given a study material such as the one shown in the box.

Study material: Useful radioactive material

A radioactive substance can be used to study reaction mechanism. A good example of this is Oxygen–18. The radioactive oxygen in the form of water or carbon dioxide was used by Calvin to find out the source of oxygen gas released by plants during photosynthesis.

Radioisotopes are also used to determine the age of artifacts or fossils. Carbon-14, Uranium-238 and Potassium-40 are commonly used in radioactive dating techniques.

These are also used to determine the structure of substances. The energy released during reactions involving the nucleus of radioactive substances is harnessed to generate electricity.

The most profound application of radioactive substances is as diagnostic or therapeutic tool in medicine. Sodium-24 is injected into the bloodstream as salt solution to trace the flow of blood and detect constrictions or obstruction in the circulatory system. Iodine-131as sodium iodide is given as drink to a patient and is used to test the activity of the thyroid gland. Iodine-123 is used to image the brain. Solution of Technetium –m99 , introduced into the patient as drink or intravenous injection, provides images of the organs such as the heart, liver or lungs.

The application of radioisotopes in medicine, agriculture, industry and research has benefited mankind. However, radiation has created problems, too. It damages tissues and can cause cancer.

What to do: Give time for each group to do the assigned tasks.

Group 1 Members express their ideas about the risks and benefits of radioactive substance through journal writing. If anyone in the group has been exposed to radioactive substance, let them recount their encounter.

Group 2 Members tell the many uses of radioactive substances through a poster or drawing. A representative of the group explains poster to the class.

Group 3 Members prepare a role play about accidents involving radioactive substances.

Abstraction about the lesson/topic

1. Class discussion
    a. Give examples of radioactive substances.
    b. Give the characteristics of radioactive substances.
    c. Enumerate the uses of radioactive substances.
    d. Cite the dangers of radioactive substances.
    e. React to the following:
        e.1. preserving food through irradiation
        e.2. buying irradiated food
        e.3 undergoing radiation therapy if the doctor prescribes it.
2. Lesson summary

Values Integration: Use of questionnaire

1. How many times do you think should an individual normally undergo X-ray exposure per year?
2. Who should decide whether an individual should undergo X-ray exposure?
3. Will you be willing to undergo radiation therapy if you have cancer? Explain your answer.

Assessment: The output of the student will be assessed and scored through rubrics.

Appendix c.1.

A Sample Lesson on Reflective Learning for Elementary Science

Objectives:

At the end of the period, the students should be able to:

1. count the number of calories of the food they have eaten for the last 24 hours;
2. compute for the daily required number of calories based on their weights and activity; and
3. evaluate if they eat the right kind of food everyday.

Subject Matter:

Calorie Counting

References:

Food Pyramid
Nutrition Guide
Textbook in Science

Planning:

1. A day before this lesson, tell the students to do the following:
   1.1. List down the food they have eaten for
   - Breakfast
   - Morning Snack
   - Lunch
   - Afternoon snack
   - Dinner

   1.2. Note the quantity of each food taken

What to do in the class:

1. Post the Nutrition Guide on the Blackboard

2. Tell the pupils to:
   2.1. List down the activities they frequently do and classify them into active, moderately active and very active.

2.2. Compute their daily calorie requirement according to the following formula:

Calorie needs of inactive person = weight x 12

Calorie needs of moderately active person = weight x 16

Calorie needs of very active person = weight x 20

Example:

A basketball player weighs 120 lbs. His calorie requirement can be computed by multiplying his weight by 20. Thus,

120 lbs x 20 = 2,400 calories

2.3. Given the following data, let the pupils determine their calorie intake

Food item	Calories *	Food Item	Calories *
1 cup rice	*60*	*6 pcs. biscuits*	*10*
1 pc. banana	*30*	*1 serving of meat*	*65*
1 pc. hotdog	*20*	*1 reg. sized fish*	*30*
1 cup veg.	*25*	*1 pc. hamburger*	*70*

2.4. Let the pupils answer the following questions in their journal

a) Did you exceed your required number of calorie intake?
b) What do you think will happen if you often exceed the required number of calories?
c) Will a person need the same number of calories everyday? Why do you say so?

Appendix D

Sample Lesson on Integrative Learning in the Classroom

Topic: Charles' Law

Learning Objectives:

After performing the planned activities, the students should be able to:

1. describe the relationship between temperature and volume of gas at constant pressure.
2. state and explain Charles' Law with the use of a graph.
3. Solve problems involving Charles' Law.
4. identify situations where Charles' Law is applied in our day to day activities.

Motivation: "Name dropping madness"

Teacher: "I have pictures posted on the board. From the first letter of the word associated with the picture, form a word or words that has/have something to do with gases

Car	Hot air ballon	Astronaut	Rain	lightning	Erlenmeyer flask	sun	Leaves	atom	Water molecule
									
C	H	A	R	L	E	S	L	A	W

Note: Pictures should be posted so that the letters are jumbled.

ACTIVITY

1. Get three balloons of the same size. The balloon should be a sphere when inflated with air.
2. Get three clean glass bottles and three small basins.

3. Attach the balloon to the mouth of the glass bottle e.g. coca cola bottle. Secure the balloon with a rubber band.
4. Stand each bottle in a small basin.
5. Pour hot water into the first basin, very cold water into the second basin, and lukewarm water into the third basin. Observe.
6. With a string, measure the circumference of the balloon. Get the radius of the balloon from the circumference.
7. From the radius of the balloon, compute the volume of gas inside the balloon.
8. Graph data and interpret the graph.

Post-activity

1. From the graph, describe how the volume of the gas inside the balloon varies with the temperature.
2. What principle is shown in the activity?
3. Express mathematically the relationship between the volume of gas inside the balloon and the temperature.
4. Solve some problems about relationship between gas volume and temperature.

Concepts Learned:

- Gases expand when heated.
- The volume of a fixed amount of gas increases with temperature

Integration Activities

Let each group perform the following activities:

Group I – Compose a jingle/rap on Charles' Law

Group II – Write a poem about Charles' Law

Group III – Write a letter to a friend about Charles' Law

Group IV – Draw a poster showing the applications of Charles' Law

Note: A rubric may be used to rate each presentation.

Appendix E- 1
Sample Lesson Using Cooperative Learning
(Jigsaw II)

Objectives:

At the end of the period, the students should be able to

1. describe the different layers of the atmosphere;
2. locate the ozone layer;
3. give the importance of the ozone layer;
4. discuss how people's activities affect the ozone layer; and
5. suggest ways by which the ozone layer can be protected

Planning

1. Topic: The Importance of the Ozone Layer
2. Assign a topic to each group. The topics may include the following:
    a. layers of atmosphere and the location of the ozone layer;
    b. graph of temperature variation with altitude;
    c. action of ultraviolet radiation on oxygen and ozone;
    d. depletion of ozone layer
        d.1. substances that deplete the ozone layer
        d.2. mechanism of ozone layer depletion;
    e. effects of the depletion of ozone layer; and
    f. people's action to protect ozone layer.
3. Resources
    a. encyclopedia
    b. newspaper
    c. time magazine
    d. *Chemistry* by Brown and LeMay
    e. Internet materials
4. Expert worksheet or chart
    a. Chemical Composition of Ozone
        1. What elements make up the ozone?

2. What is its chemical formation?

b. Chart of the layers of atmosphere

1. Where do we find the ozone layer?
2. How high is it from the ground?
3. How thick is the ozone layer?

c. Graph of temperature vs. altitude

1. Describe the temperature at the following layers:
   a. troposphere
   b. stratosphere
   c. mesosphere
   d. thermosphere
2. Explain the observed temperature range at the following layers:
   a. troposphere
   b. stratosphere
   c. mesosphere

d. Role of Ozone Layer

1. Give the importance of the ozone layer to Planet Earth.
2. Describe the manner by which ozone layer performs its function.

e. Condition of ozone layer

1. Describe the condition of the ozone layer.
2. What are the factors that destroy the ozone layer?
3. How is ozone layer damaged?
4. Name the consequences of a depleted ozone layer in the atmosphere.

f. People's action to minimize damage to ozone layer

1. Find out what has been done to preserve the ozone layer.
2. As a student, what can you do to help preserve the layer?

How to do it:

1. Divide the class into groups of 6 members each.
   This will be their "mother "group.
2. Assign a number (1-6) to each member of the group. Each member gets a topic to master. An example is shown below.

Student 1:A. Chemical Composition of Ozone

1. What elements make up the ozone?
2. What is its chemical formation?

B. Chart of the layers of atmosphere

1. Where do we find the ozone layer?
2. How high is it from the ground?
3. How thick is the ozone layer?

Student 2 : Graph of temperature vs. altitude

1. Describe the temperature at the following layers:
   a. troposphere
   b. stratosphere
   c. mesosphere
   d. thermosphere

Student 3: 2. Explain the observed temperature range at the following layers:

a. troposphere
b. stratosphere
c. mesosphere

Student 4 : d. Role of Ozone Layer

1. Give the importance of the ozone layer to Planet Earth.
2. Describe the manner by which the ozone layer performs its function.

Student 5: e. Condition of the ozone layer

1. Describe the condition of the ozone layer.
2. What are the factors that destroy the ozone layer?
3. How is the ozone layer damaged?

4. Name the consequences of a depleted ozone layer in the atmosphere.

(Student 5 is the leader and fast learner)

Student 6: f. People's action to minimize damage to the ozone layer

1. Find out what has been done to preserve the ozone layer.
2. As a student, what can you do to help preserve the layer?
3. Ask the students with the same number to group together. The new groups are the "expert" groups.
4. The members of the "expert" group share information and put information together.
5. Then, ask the members of the "expert" group to go back to their "mother' group and discuss with their members the topics they have mastered. All share their expertise.

Evaluation

1. Make a concept map about the ozone layer.
2. Answer the teacher-made test items:

Appendix E- 2
Sample Lesson Using Cooperative Learning
(Student Teams Achievement Divisions)

Note to the teacher:

STAD is the most basic cooperative- based team learning. It uses teams with 4-5 members of mixed abilities to master basic skills or topics. Students may use a variety of methods to master the materials such as quizzing each other and answering worksheets. This is usually done after the teacher has given a lecture or has made a presentation on a topic.

Objectives:

After performing the planned activities, the students should be able to:

1. give examples of dietary fibers;
2. discuss the importance of dietary fibers to our health;
3. state the consequences if they miss dietary fibers in their meals regularly; and
4. enumerate diseases caused by the lack of dietary fibers in their daily meals.

What to do:

1. Review the different food groups and their role in our body.
2. Give a lecture on dietary fibers. Use pictures of food rich in fibers, consequences of not eating high fibers, and diseases suffered by people who do not eat high fiber foods.
3. Set up Teams
4. Provide teams with worksheets containing questions about
   - 4.1 the different food groups
   - 4.2 the examples of food for each group
   - 4.3 the importance of each food group in our body
   - 4.4 the food group rich in fibers
   - 4.5 the importance of fibers to the body
   - 4.6 the diseases caused by the lack of fibers in the diet
5. Let each team work on their worksheet.
   - 5.1 Every member of the team answers the worksheet individually.

Sample Worksheet

1. Below is a list of food we usually eat. Add at least six more items to the list.

   Ham pasta
   Cooked rice boiled sweet potato

2. Group the food in the list into processed and unprocessed food.
3. Which food samples contain fibers?
4. Why do we need to eat food rich in fibers?
5. Give your own list of foods rich in fibers.
6. What are the consequences of not eating foods rich in fibers?
7. Give your own experiences when you did not eat foods rich in fibers.
8. Do you have relatives and friends suffering from diseases due to absence or lack of fibers in their diet?

5.2. Members ask each other to develop mastery of the subject matter in pairs, triad, and so on.

6. Team is given a quiz.

Quiz

I. Direction: Encircle the letter that best answers the question

1. Which of the following is a processed food?
   a. cassava b. boiled banana c.fried banana d. pandesal

2. Which of the following foods have lots of fibers?
   a. slice of guyabano c. slice of pineapple
   b. sweet potato d. all three have fibers

3. What kind of food groups are present in cassava?
   a. lipid c.carbohydrate
   b. protein d. all three are present

II. Answer as directed

1. Why do we have to include dietary fibers in our diet?

7. Calculate improvement points to recognize individual and team with highest improvement points.

Key to correction

I

1. d **2**. d **3**. c

II

1. dietary fibers in our diet act as a broom in the large intestines. They also prevent undigested matter from being well-dehydrated and hardened to avoid constipation.

Appendix E.3

Cooperative Learning for the Elementary Level (Jigsaw I)

Objectives:

At the end of the period, the students should be able to do the following:

1. identify plant parts;
2. give the function/s of each plant part;and
3. indicate the uses of plants to
    a. man
    b. other living things
    c. environment

Topic : Parts of the plant

Planning

1. Draw the parts of the mongo plant on a white cartolina.
2. Cut the plant parts into 5 pieces each.
3. Place the cutouts of each plant part in separate envelopes.
4. Seal the envelopes.

Note. If the class is composed of 25 pupils or less, only one set per plant part may be prepared. Prepare two or three sets per plant part for a class bigger than 25 pupils/students.

Resources

a. encyclopedia
b. textbook in Science and Health

Materials

a. Crayons
b. Paste/glue
c. Bond paper

Implementation

1. Divide the class into groups of 5 members each. Each group is composed of 5 pupils.
2. Give an envelope to the leader of the group.
3. Let the leader distribute the cutouts to members of the group.
4. Instruct all the groups to put together the pieces to form a figure. Give the group 2 minutes to come up with the figure
5. Give corresponding points to the group that completes the task in less than two minutes.
6. Ask each group what plant part they formed.
7. Tell each group to do the following:
   a. give the unique characteristics of the part of the plant shown in the figure;
   b. paste the figure on a bond paper and color the figure appropriately;
   c. indicate the role of the plant part;
   d. enumerate the specific use/s of the plant part to humans; and
   e. identify the plant according to the shape of the plant part the group formed.
8. After completing the task, each group posts the figure on the board to complete the whole plant and shares the work with the whole class.
9. Let the whole class identify the plant.
10. Summarize the work of the class.
11. Emphasize the roles of plants to
    a. humans
    b. environment

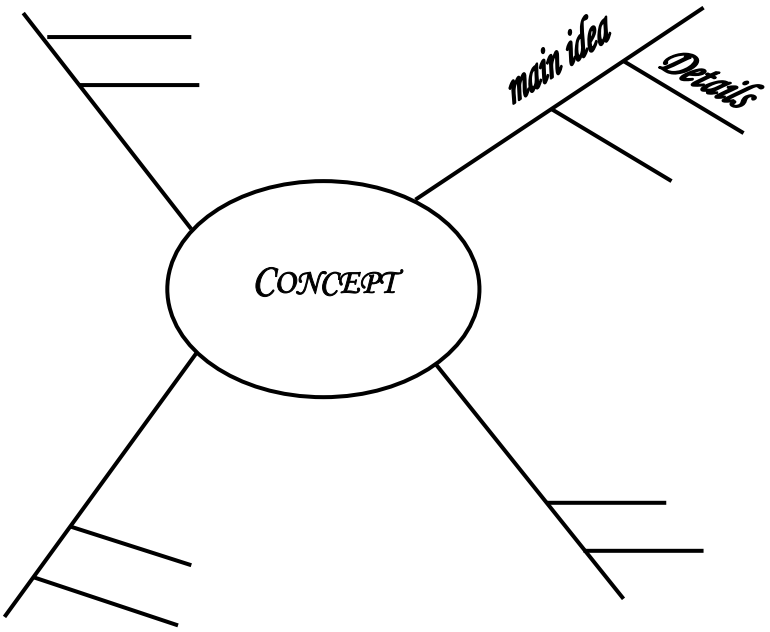
Evaluation

1. Post a drawing of a whole plant.

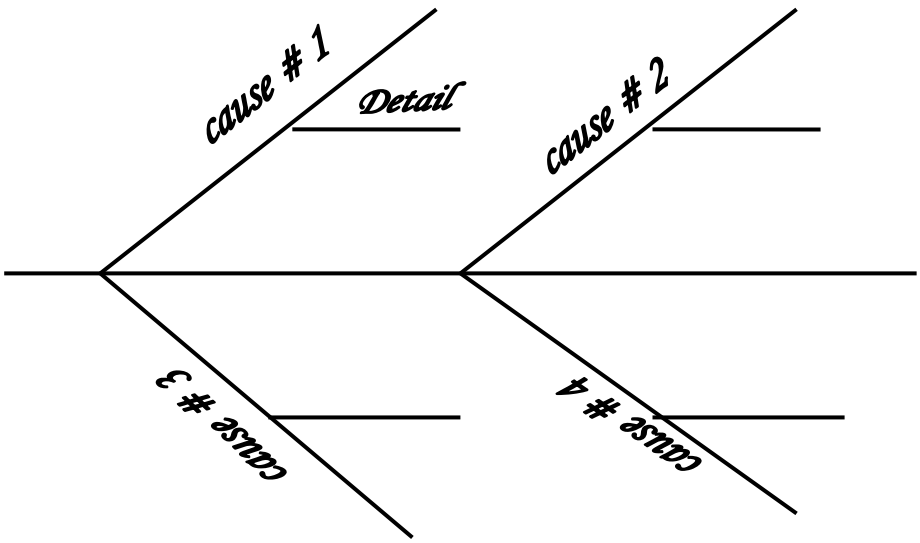
2. Let them do the following:
   a. label the parts of the plant;
   b. give the function of each part;
   c. name the plant shown in the picture; and
   d. give one use of the plant to you.

Appendix F

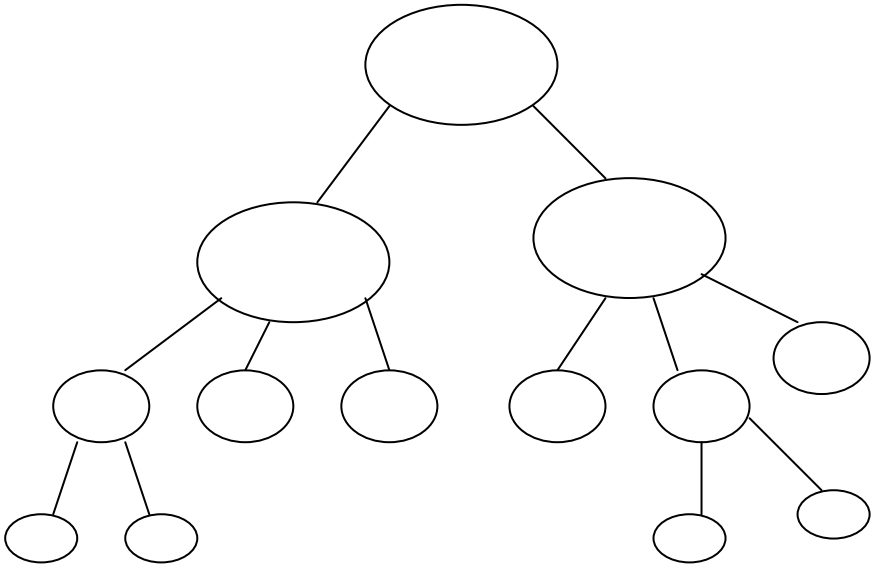
Other Types of Concept Maps



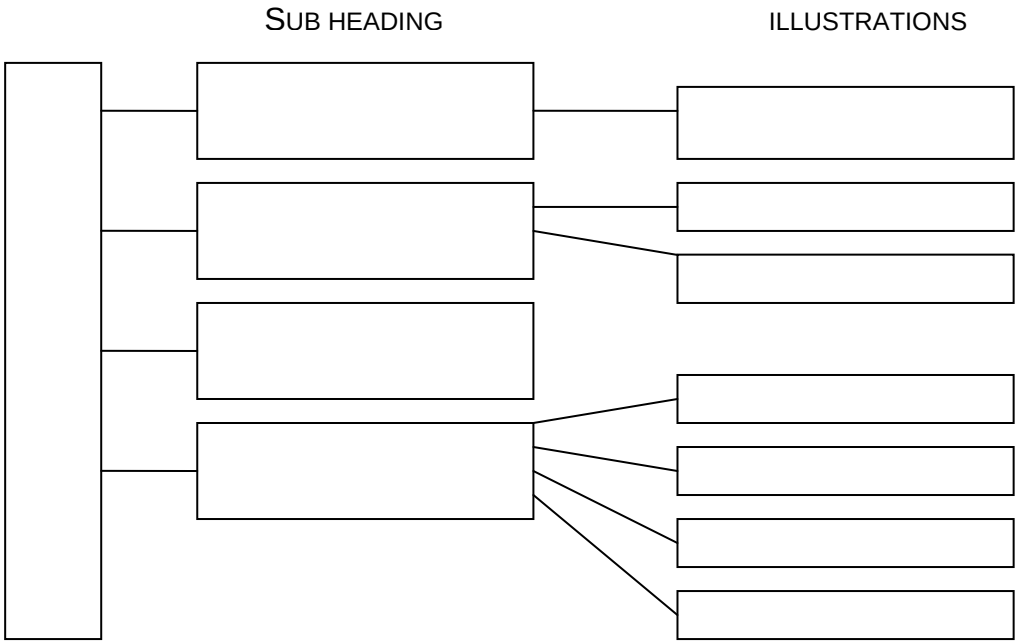
Spider map



Fish Bone map

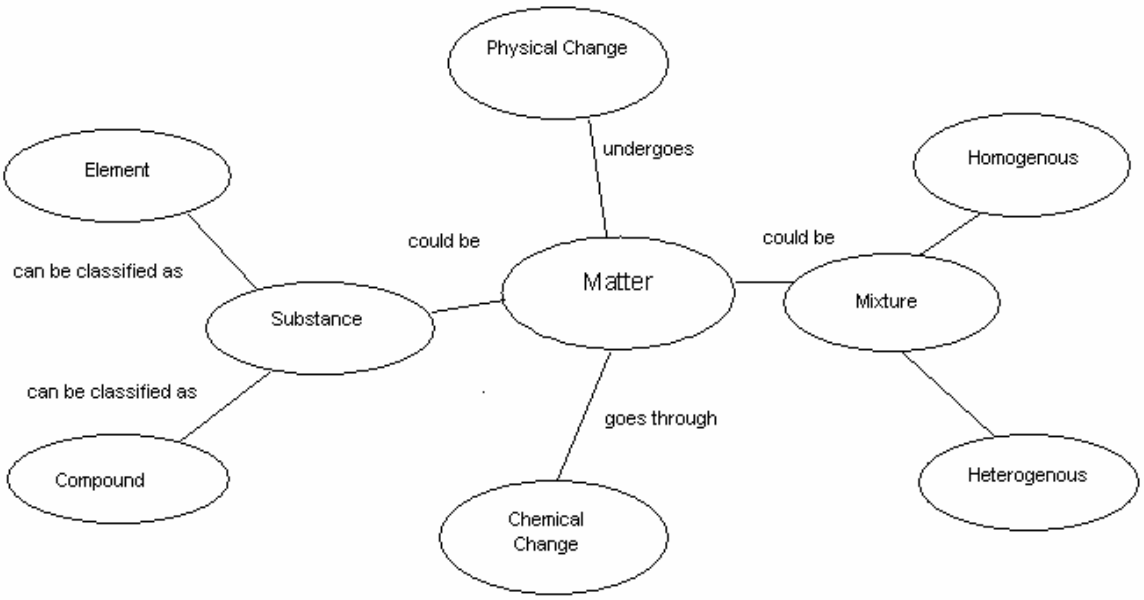


Network Tree



Graphic Outline

Another Example of a Concept Map

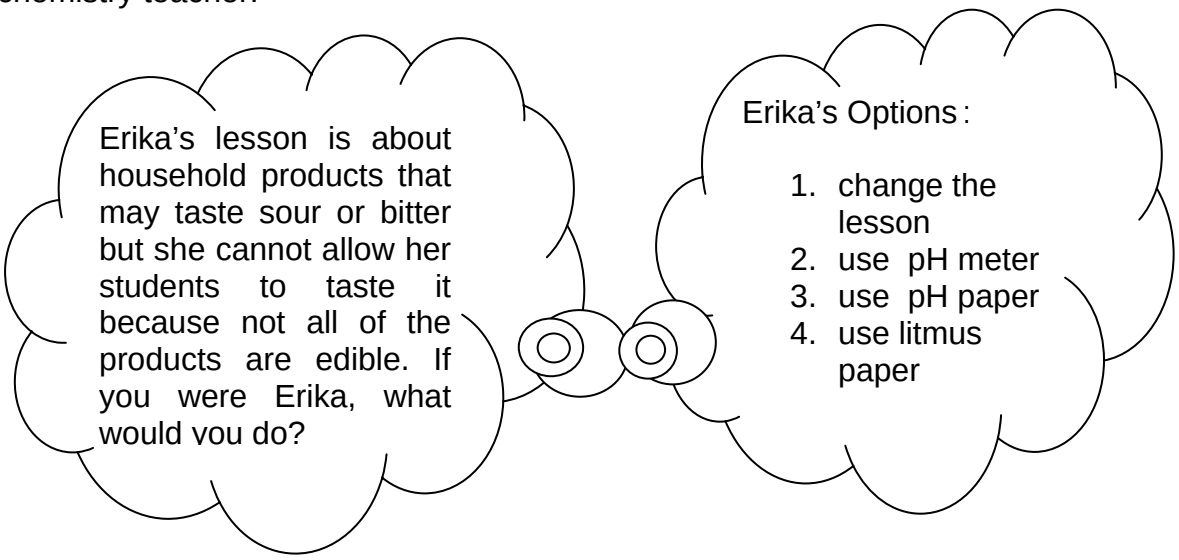


Appendix G

Doing an Investigative Project in the Classroom

How to Collect Facts

This can be done in many ways. Let us use the case of Erika, a newly hired chemistry teacher.



Erika did not want to abandon the lesson. So, she went to the stockroom to find out if the school had instruments to determine if household products were either sour or bitter. To her dissapointment, the school did not have pH meter, pH paper, or litmus paper.

Erika looked at the school ground. She thought of investigating the vegetation in the school ground. We shall do an activity, entitled "Erika's Trail" to get facts for her needs.

Activity1. Erika's Trail

What to bring: pencil
notepad

What to do

1. Move around the school ground.
2. Note the plants with brightly colored leaves and flowers.
3. Get the names of these plants. For the moment, local names will do.
4. List these plants in your notepad.

Guide Question:

1. Why can Erika use the plants for her lesson?
2. What are the plants that may help solve Erika's problem?
3. What parts of the plants can Erika use for her lesson?

You have learned one way of getting facts. Books, journals, newspapers, and surfing through the net help you get facts for an investigative project. You may also look at the recommendation part of the investigative projects of other students.

Identification and statement of the problem

From Activity I, you learned how and where to get facts. You are now ready to learn the most important step of the scientific investigation – the identification and statement of the problem. Below could be the list of plants from your campus trail which might help Erika. These plants contain pigments which can be used as alternative for pH meter, pH paper pr litmus paper.

Plant	Part of the Plant
1. santan	flower
2. Rhoeo discolor	leaf
3. gumamela	flower
4. yellow bell	flower
5. bougainvilla	specialized leaf

The selection of a research problem involves reading, discussing, and conceptualizing. The process is one of successive approximations to the problem as factors related to the problem are considered (Weirsma, 1995).

What is Erika's research problem? How do we state the problem? We shall first define a research problem.

A research problem is a special kind of question that arises in areas in which knowledge is needed. It may ask questions of practical concern or it may refer to the development or refinement of basic theory (Weirsma, 1995).

A research problem may be stated in a question form or declarative form. The question form is preferable because it aids in focusing the problem and is effective when subproblems are included within the larger research problem. A subproblem is a component of the larger research problem.

Major or larger problem

The present investigative project attempts to identify locally available plants that contain pigments sensitive to the presence of sour and bitter substance.

Sub problems

1. Which plant can be used as source of pigment sensitive to sour/ bitter substances?

2. What part of the plant is a good source of pigment?

How do you know that the above problem is good? A good statement of a problem should provide the researcher with direction in pursuing the research. It indicates the general focus. The key factors are clearly identified

The statement of the problem should be concise and should identify the key factors (variables) of the research study

A. CONSTANTS AND VARIABLES

We learned how to select and state the research problem. This time we have to define important terms. The first term is constant. A constant is a characteristic or condition that is the same for all units in the study. Box 1 lists examples of constants of the stated problem. .

Box 1. Examples of Constants

1. technique to extract the pigment

2. solvent to extract the pigment.

Another term we should define is variable. A variable is a characteristic that takes on different values or conditions for different units. One descriptor of a variable is the independent variable. The independent variable is the cause of an effect. It is being manipulated or changed. The second descriptor is the dependent variable. The dependent variable is the outcome of changing the independent variable.

Box 2. Independent and Dependent Variables

Independent variable	Dependent variable
Kinds of plant Part of the plant	color change of the pigment when dropped into sour/bitter substance

Your variables may be classified as discrete or continuous data. It may be qualitative or quantitative data. How are variables measured? There is a hierarchy of measuring scales. Table 1 shows the various levels of measurement and conditions.

Table 1. Measurement scales and their conditions

Scales	Conditions	Examples
Nominal	Measures without order: indicates that 2 or more classifications are different	Brands of toothpastes : Colgate, Pepsodent, and Closeup Gender : male or female
Ordinal	Measures with order: indicates that the measurement classifications are different and can be ranked	Leaf quality: wilted, less wilted, very wilted
Interval (or equal unit)	Measures with order and establishes numerically equal distances on the scale. There is a zero value but it is not absolute.	Temperature in Celsius scale
Ratio	Contains an absolute or true zero point in addition to an equal unit	Height Temperature in Kelvin scale

Nominal and ordinal data are qualitative data. It is a count data. Interval and ratio data are quantitative data. They are measured data.

We shall now classify our independent variables and dependent variables according to the above scale of measurement.

Independent variable	Scale of measurement
Kinds of plant	nominal
Parts of the plant	nominal
Dependent variable	
Color change	nominal
pH	interval

Formulating Hypothesis

1. We shall now give the tentative answer to our problem. How do we call the tentative answer to a problem? It is called ***hypothesis*.**

A hypothesis is a conjecture or a guess at the solution to a problem or the status of the situation, the relationships of two or more variables or the nature of some phenomena (Daniels, 2000).

How should a hypothesis be written? There are many types and forms. We shall look at some of them.

1. Research or substantive hypothesis

   This is tentative statement about the expected outcome for the variable of the study.

   e.g. Pigments from plants can be used to determine sour /bitter substances.

2. Statistical hypothesis

   This type of hypothesis is

   - a statement about one or more parameters that measures the population under study.
   - a hypothesis of no difference.
   - referred to as null hypothesis.

   e.g. The color change of pigments from plants in the presence of sour/bitter substances is as good as that of Ph paper

Borg and Gail (1989) gave four criteria that hypothesis should satisfy.

1. The hypothesis should state an expected relationship between two or more variables.

2. The hypothesis should have a definite reason based on theory or evidence.
3. A hypothesis should be testable.
4. A hypothesis should be brief.

Review of Related Literature

Review of literature is a systematic process that requires careful and perceptive reading and attention to detail. In the review of literature, the researcher attempts to determine what others have learned about similar investigation. The guiding principle in literature review should be the location of information relevant to the study. Where does one get this information? The researcher may get this information from preliminary studies; carefully described observations made by the researchers and published information that suggests support for relevant relationships that might be useful in developing the background for the study. Expert opinions and speculations, theory and theoretical perspectives can all contribute to the basis for the study.

The literature is reviewed for information related to the research problem, to clarify problem, to improve the hypothesis, to suggest possible methodology for conducting the research and to compose the introduction of the paper. It tells us what others have done that might be useful. Review of literature provides a backdrop for interpreting the results of the investigation.

In order not to waste time and effort, the review of literature should be done following a sequence of activities. You should list the key terms.

With the problem on what to use in determining if household products tasted bitter or sour, and knowing that the school had no available instruments such as the pH meter, pH paper, or litmus paper, Erika wanted to know what other materials could be used. She got the idea that some plants might be used to test the household products. The key terms in Erika's problem are listed in Table 2.

Table 2 Key terms in Erika's Problem

Problem: Which plant part is a good source of pigment sensitive to sour/bitter substances?

Some of the key words or phrases relevant to Erika's investigation		
Plant part	Bitter substance	Solvent
Pigment	PH	Method of extraction
Sour substance	Indicator	Acidity
Sensitivity of pigment to acids, bases	color change	Alkalinity

With key terms on hand, where would you get information? You could go to the library or surf through the internet. The key terms will help you do the following activities:

- identify titles of potentially relevant reports
- identify sources of information
- locate copies of reports to be reviewed
- separate reports in order or into categories of relevance or importance, and delete non-relevant report
- prepare abstracts of summaries for the reports containing relevant information
- write the review of the literature
- prepare a complete bibliography

What will you do with all the literature materials you have collected? You can use these in many ways. Use it to compose the introduction of your investigative project proposal. Samples of an introduction of an investigative paper and review of related studies are shown on the next page.

Questions	Sample Introduction
1. Why do you conduct the experiment? (background or rationale)	Office canteens and restaurants serve soft drinks to their clients. Softdrinks are also regularly consumed at home. Softdrinks are said to cause gastric hyperacidity.
2. What do you hope to learn? (problem)	The present study aims to identify the brand of soft drinks that is acidic. Specifically, it seeks answers to the following problems: **Sub problem:** 1. Which brand of soft drink is more acidic? 2. How does acidity change with decreasing temperature?
3. What do you think would happen? (hypothesis)	All soft drinks are acidic. The acidity increases with decreasing temperature.
4. What is the relevance of the study?	The results of the study may help reduce the number of individuals suffering from hyperacidity.

RELATED STUDIES

Soft drink is an example of carbonated beverages. Carbonated beverage is an effervescent drink that releases carbon dioxide under conditions of normal atmospheric pressure (Wyshak,1999). Carbonation can occur naturally in spring water. As it passes through calcium carbonate rock, it absorbs carbon dioxide at high pressure underground. It can also be a by-product of fermentation. Beer and champagne are carbonated beverage, produced by microbial action on carbohydrate. It can also be carbonated artificially by addition of carbon dioxide under pressure or addition of chemicals, when combined with acid in the beverage, give off bubbles of carbon dioxide. Soft drinks such as soda, pop, seltzer and cola belong to artificially carbonated beverages (http/:www.food consumption.com).

Many curative properties have been attributed to effervescent water such as aiding digestion and calming nerves (Wyshak, 1999). Consumption of carbonated beverages is also associated with bone fracture .There is a correlation between bone fracture among physically active girls and cola consumption.(Wyshak,2000).

Carbonated beverages become attractive to consumers when they are cold. The taste has something to do with carbon dioxide that goes into solution at low temperature and high pressure. The dissolved carbon dioxide reacts with water as shown below (Manahan, 1993).

$$CO_2\,(g) + H_2O\,(l) \longrightarrow H^+\,(aq) + HCO_3^-$$
$$HCO_3^- \qquad\qquad H^+ + CO_3^-$$

Thus, water becomes slightly acidic in the presence of carbon dioxide. It is also claimed that colas and other soft drinks are acidic due to the presence of citric acid and phosphoric acid. It is claimed that soft drinks cause hyperacidity. Some soft drinks contain caffeine. Caffeine in beverages leads to excretory calcium loss.

Designing your Experiment

To avoid pitfalls commonly encountered by beginners and seasoned researchers, you must have a plan of action. This plan of action is called research design. There are many kinds of designs. There is no blue print for a research design. But for every problem, there is an appropriate research design.

The research design suitable to science people is the experimental research design. It is the structure by which variables are positioned, arranged or built up into an experiment. It includes the experimental variable (independent variable), dependent variable and other variables. Experimental designs are often diagrammed with symbols to indicate the arrangement of the variables and conditions. We call this diagram as ***experimental research design diagram***. Below is a good example of an experimental design diagram which summarizes the independent variable, dependent variable, constants, control, number of repeated trial, problem, and hypothesis.

Sample of an experimental design diagram

Problem: What are the locally available plants that contain pigments sensitive to sour/biter substances

Hypothesis: The color change of pigments from plants in the presence of sour /bitter substances is as good as that of pH paper

Independent variable					
Kinds of plant	Gumamela	Santan	Cabbage	periwinkle	univ.indicator
Replication	3	3	3	3	3

Total replications: 5 x 3 = 15

Dependent variable: color change at specific pH

Constants : method of extraction of pigment solvent
number of drops of extract per test test solutions

After you have prepared the diagram of your experiment, translate the diagram into a procedure. The procedure is written in paragraph form, future tense and passive voice. Box 5 shows the procedure for the extraction of pigments from plants which could be used as alternative of pH paper or litmus paper.

Box 5

PROCEDURE

Plant Sample

Santan flowers, specialized bougainvilla leaves and fruit of the balete tree will be collected from the field.. The collected plant parts will be washed thoroughly with water. The clean leaves and flowers will be cut into smaller pieces and placed individually in a plastic bag. The exocarp of the balete tree fruit will be removed and placed in another plastic bag

Extraction of the pigment

About two (2) grams of the cut up leaves will be weighed and placed in a mortar. A few clean grains of sand will be added into the mortar. The pieces of leaves will be ground with a pestle. With the use of a pipette, ten (10) mL of 95 % ethanol will be added to the ground leaves. The mixture will be mixed with a stirring rod. The mixture will be decanted into an amber bottle. The bottled extract will be refrigerated.

Preparation of test Solutions

Following the dilution procedure, test solutions with pH 1 – 14 will be prepared and will be stored in individual reagent bottles.

Testing the pigments

Fourteen clean, dry test tubes of the same volume will be labeled 1-14 and will be arranged in a test tube rack. Two (2) mL of each solution will be placed into the test tube. About 3-5 drops of the leaf extract will be added to each test tube. Color change in each test tube will be noted and recorded.

The same procedure will be followed with the fruit exocarp and flower extracts.

Investigative Project Proposal

You can now prepare your investigative project proposal. An investigative project proposal is a declaration of your intention to do the study. What are the components of an investigative project proposal? It includes the following:

- Cover page where one sees the title of the paper and the author
- Table of Contents
- Introduction
  - Background of the study
  - Statement of the problem
  - Hypothesis
  - Significance of the study
  - Scope and limitation of the study
  - Definition of terms
- Review of Literature
- Methodology
- Bibliography
- Schedule of activities
- Expected expenses

If you are a student, you can submit this to your teacher. If you are a teacher, you can submit this to your principal or department head.

The teacher, head or principal examines the proposal and gives some comments. Based on the comments and suggestions, you can revise the proposal. This may require a second look before approval is granted. Once your proposal is approved, you can start the experiment and collect data to be used in answering your research problems. Write all data in a data notebook.

Finding Patterns of Collected Data

Data collected are raw data. It has no meaning at all. What will you do? You have to organize the data, e.g. table form. You may construct a graph appropriate to

the data. Use a pie chart if data are percentages or proportions. Bar graph is used for count data. Histogram and line graphs are suitable for measured data.

Once data are organized into tables and graphs, you may now find meanings and patterns, e.g. whether the data support the hypothesis. If there are differences in the data collected, you have to determine if the differences are significant. You can do this with the use of statistics. If you are not skilled in that line, you can ask help from mathematics teachers or experienced researchers.

Communicating results of the study

With data organized and analyzed/interpreted, you can write a scientific paper or technical report of the study. The procedure is now written in the past tense. The procedure is followed by results and discussion of results. After the discussion of results, you compose the summary, conclusion and recommendation of the study. Improve the bibliography. If you have appendices, computations, pictures, and other related materials, place them after the list of references.

The last one you will write is the abstract. It is about 250-words. Prepositions such as of, the, a, etc are counted as one word. You will find in the abstract the statement of the problem, samples, selection of samples, replications, procedure, findings, conclusion and recommendation.

Appendix H
Data Organization Table (Analytic Rubric)

Name _____ Date _____ Course/Class _____
Task/ Assignment _____

	Organization of Table	Entering the Data Into the Table	Clarity and Neatness of Table
Expert (4)	The data organization table is expertly designed either by computer or graphic tools and is appropriate for the types and quantities of data being collected. A key or legend for the table is provided if needed to interpret the data. Both the independent and dependent variables are clearly defined within the table and in the title. The cells within the table are appropriately scaled, consistent in size, with the data fitting completely and clearly within the cells.	The information in the data table columns and rows is appropriately organized and labeled. The set of data is recorded within the appropriate cells. All measurements are labeled with the correct magnitude (numerical value) and metric unit. The data have an appropriate number of significant figures. The data are amazingly accurate based upon the measuring equipment or instrument being used. Data from multiple trials at each level of the independent variable are clearly shown.	The data table is complete, neat, attractive, and graphically appealing.
Proficient (3)	The design of the data organization table is appropriate for the types and quantities of data being collected. Both the independent and dependent variables are clearly defined within the table and in the title. The data organization table is appropriately sized and clearly displays all the collected data.	The information in the data table columns is appropriately organized and labeled. The set of data is recorded within the appropriate cells. All measurements are labeled with the correct magnitude (numerical value) and metric unit. The data have an appropriate number of significant figures. Accuracy of the data is appropriate to the measuring equipment or instrument being used. Data from multiple trials at each level of the independent variable are clearly shown.	The data table is neat and presentable.

	Organization of Table	Entering the Data Into the Table	Clarity and Neatness of Table
Emergent (2)	The design of the organization table is somewhat appropriate for the types and quantities of the data being collected. There is some confusion about the independent and dependent variables. The data organization table is inappropriately sized and some of the collected data are missing .	The information in the data table columns lacks organization and some labeling. Some of the data are recorded within the appropriate cells. Some measurements are labeled with the correct magnitude (numerical value) and metric unit. Some data have an appropriate number of significant figures, the accuracy of the data could be improved with the measuring equipment or instrument being used. Multiple trails at each level of the independent variable are lacking.	The data table is neat and presentable.
Novice (1)	Major flaws exist in the design of the data organization table. The identification of variables is unclear. The size and structure of the table are not appropriate for the types and quantities of the data being collected.	Data columns and rows are not accurately labeled nor comprehensively completed. Data units are missing.	Data organization table is neither neat nor presentanble.

Source: Rubrics for Assessing Student Achievement in Science Grades K-12 ,by Hays B. Lantz, Jr .Thousand Oaks,CA: Corwin

Appendix I

Performance Task
How to Use a Pipette

Steps

1. Check the graduation of the pipette.
2. Rinse the Pipette with distilled water.
3. With a rubber pipette bulb, withdraw 2-3 ml of the solution to be measured. Hold the pipette in a horizontal position.

Turn and tip the pipette until all inside surfaces have come in contact with the solution. Drain out and discard this solution.

4. Hold the pipette with your left hand and position the index finger toward the upper part of the pipette enough to cover the opening. Refer to the Fig. 1

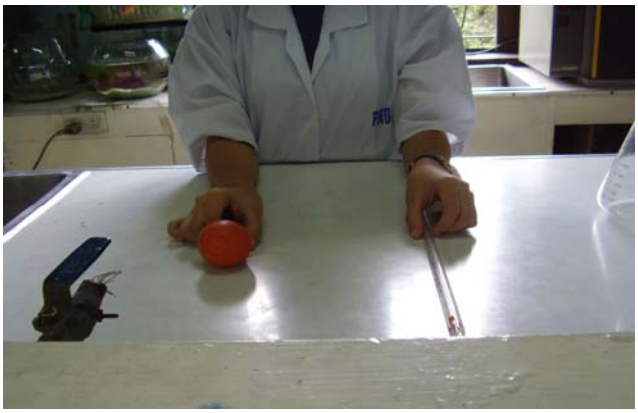


Fig. 1

5. With the right hand, place the rubber pipette bulb on the end of the pipette. Squeeze the bulb to empty out the air.

Fig. 2

6. Place the pipette into the solution. Slowly release the pressure on the bulb but maintain a seal between the bulb and pipette. This allows the liquid/solution to rise into the pipette up to desired calibration mark.

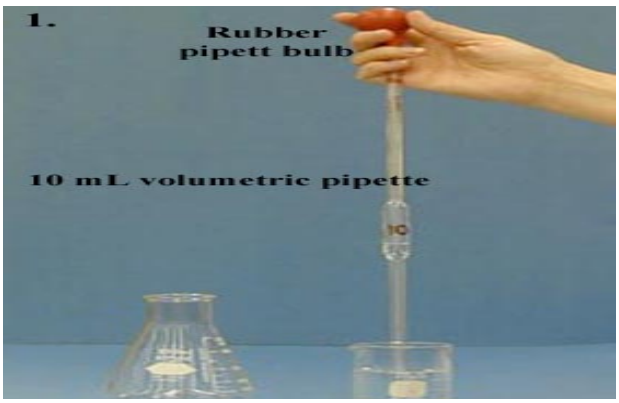


Fig. 3

Watch the solution rise in the pipette, do not let any solution get into the bulb.

7. Once the solution is above the desired calibration mark on the pipette, quickly remove the bulb and press down on the end of the pipette with your index finger. Dry the outside walls of the pipette with a tissue. Release pressure from your finger very slightly so that the liquid level slowly drops. If some liquid leaves the pipette decreasing the volume, repeat steps 6-7.

Once the bottom of the meniscus has reached the calibration mark on the pipette, press down firmly with your finger.

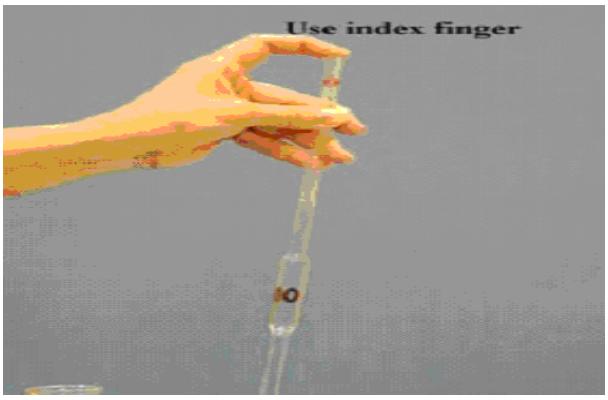


Fig. 4

8. Transfer the pipette to the Erlenmeyer flask and remove your finger from the pipette. Allow the solution to drain at its own rate. Once it stops draining touch the tip of the pipette against the wall of the Erlenmeyer.

Fig. 5

Do not blow out the remaining solution. The pipette has been calibrated with the last drop left inside.

Caution:

1. Do not press the bulb if its tip of the pipette has touched the liquid. This creates bubbling and may splutter some liquid.
2. Do not release the bulb quickly. This may cause an overflow. If the substance is concentrated acid, base or dangerous /toxic substance, it endangers your life.

Note to the Inductee:

If the student followed the steps as sequenced correctly, they would be able to transfer a correct volume without difficulty. This is performance. You can score the performance of your student with a scoring rubric.

You can also make a rubric for this. The rubric may be specific or general.

(The steps were modified from Web Site Created by Debbie Owen, Prelab Presentations by Sophie Lavieri (June 2004)

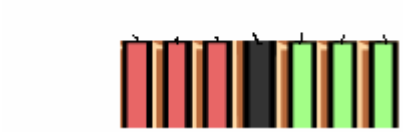
Appendix J

Example of a picture or diagram assessment

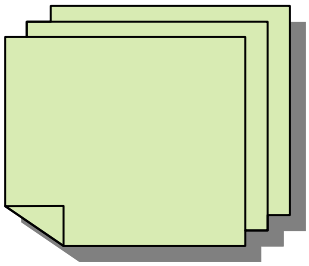
This item assesses student's concept about physical change and chemical change.

In the box are pictures of objects which are found in our environment. Predict the products if these objects would undergo a chemical change.

fresh egg



candle

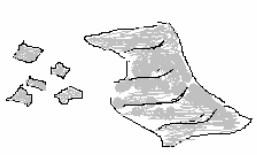


paper

Identify the kind of change shown in the pictures below:

A

B



C

D

E

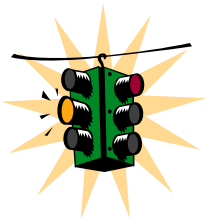
Answers:
A. chemical change
B. physical change
C. chemical change
D. physical change
E. chemical change

ANSWER KEY

PREASSESSMENT

MULTIPLE CHOICE:

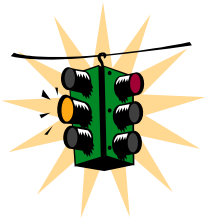
1.	**D**	**11.**	**B**
2.	**A**	**12.**	**D**
3.	**C**	**13.**	**C**
4.	**B**	**14.**	**C**
5.	**A**	**15.**	**C**
6.	**B**		
7.	**C**		
8.	**A**		
9.	**B**		
10.	**A**		



ASCQ 1.1

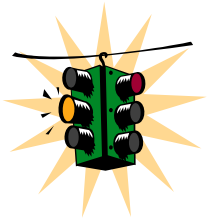
1. The science teachers should also include the teaching of the process skills and scientific attitudes.
2. Science process skills are called life-long learning skills because these are the skills that will enable the students to cope with the challenges of life.

Reflections (Answers may vary but it is preferred that a science teacher should give more emphasis to the development of science process skills because once the students have developed these skills, acquisition of facts will be easy for them.)



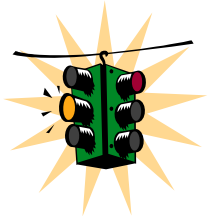
ASCQ 1.2

1. B
2. C
3. B
4. B



ASCQ 2.1

1. C
2. D
3. A
4. Reflection (Answers may vary) Probable Answer: Yes, through this approach, students are given the opportunity to correct their misconceptions through first-hand experiences.



ASCQ 2.2

1. Integrative teaching has the following features:

- It involves the practice of recognizing and articulating relationships among subject matters.
- It involves applying learning from one context to another.
- It presents the content the way it is in the real world.

- It is student-centered and involves active learning
- Teacher acts as facilitator of learning
- It gives opportunities for students to demonstrate learnings in several ways.

2. The three levels of integrative teaching are:

   a. Facts level - It is at this level where students pick up fragmented terms or facts.

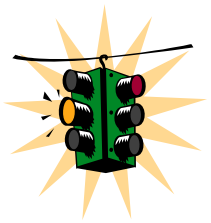
   b. Concept level - At this level, the students view and organize the isolated, fragmented and meaningless facts into concepts.

   c. Values level - It is at this level where students apply what they have learned to actual life situations.

3. Through integrative teaching, students realize the relevance of what they learn in science to their daily lives.

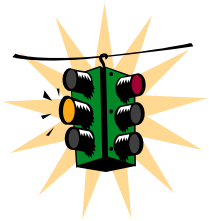
4. Reflections

   Answers may vary.



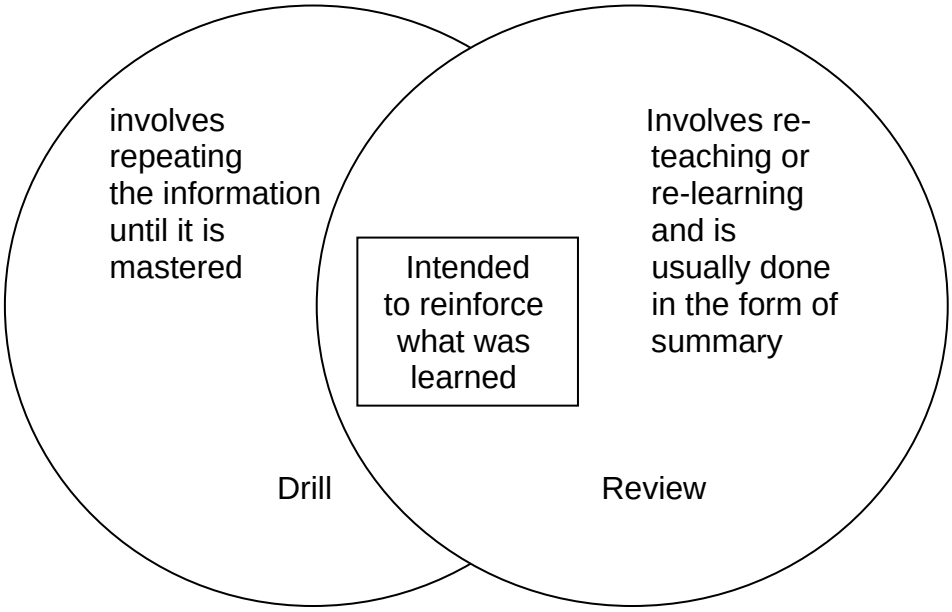
ASCQ 2.3

1. No, because we can only consider a group of students a cooperative group if each member has a valued role in the learning process and takes responsibility for each other's learning.
2. Through cooperative learning, students will develop positive interdependence, individual accountability, concern for others and cooperation.



ASCQ 3.1

1.



2. The orientation for a field trip should include the following:

   a) Objectives of the field trip

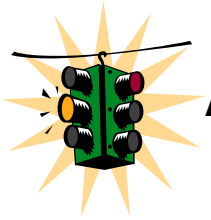
   b) What outputs are expected from the students

   c) Precautionary measures and proper behavior that should be observed

   d) A brief description of the places to be visited

   e) Materials / things that should be brought

   f) Proper attire for the activity

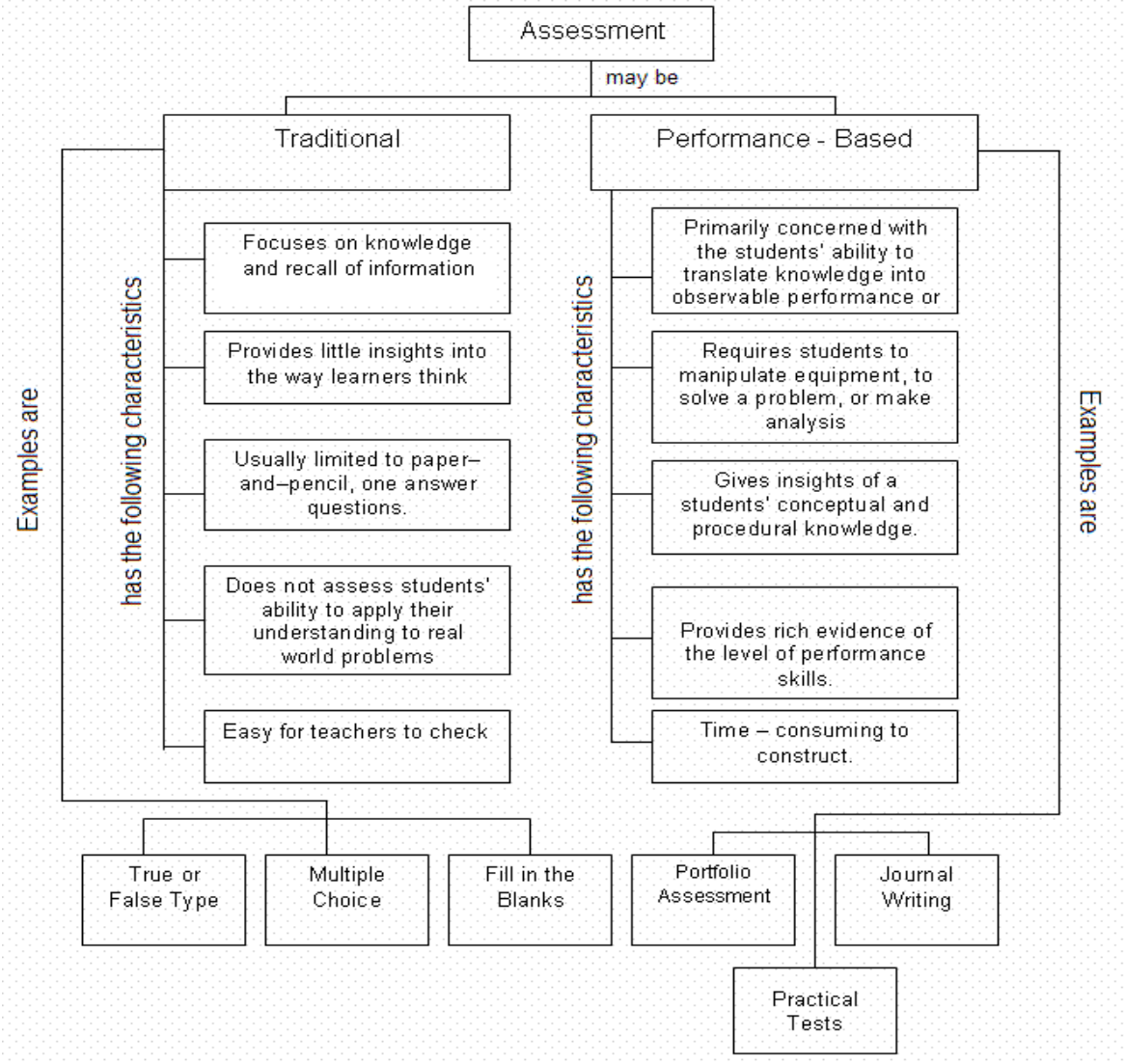


ASCQ 3.2

1. D
2. B
3. C
4. D

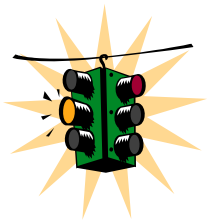
ASCQ 5.1

1. Concept maps may vary. Below is an example response.



2. Most teachers still use the traditional forms of assessment because they are easy to check.

3. Answers may vary:



ASCQ 5.2

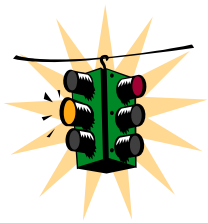
1. **B**

2. **D**

3. **A**

4. **C**

5. **A**



ASCQ 6.1

1. A. rubric is a scoring guide that uses a set of criteria to differentiate between levels of student proficiency.

2. Through the use of rubrics, the teacher can; (a) judge or rate the students' work more objectively; (b) keep track of the students progress in performing a specific task; and (c) make the students, parents and other stakeholders aware of how the students' work and performance are judged and documented.