Module #5

Techniques of Instruction and Assessment in Mathematics and Science

DRAFT

Glossary

Constructivism	A theory of learning which argues that people learn best not when they listen passively to lectures or simply answer questions on readings, but when they are engaged in active learning. Constructivism suggests that students learn best when they can connect new information with their personal lives and experiences as well as with what they already know (background knowledge); are given opportunities to make sense of new knowledge, information, or skills (construct meaning); and asked to reflect on new learning and apply it to new situations (evaluate and apply).
Activating background knowledge	First phase of a constructivist framework for learning and teaching in which students are helped to recall what they already know about on a topic under discussion.
Constructing meaning	Second phase of a constructivist framework for learning and teaching in which students are helped to make sense of new information as they learn it.
Evaluating and applying information	Third phase of a constructivist framework for learning and teaching in which students are helped to think about what they have learned, examine, assess and evaluate new information, and/or apply it in new contexts or to new problems, issues, or topics.
Graphic Organizer	A Graphic Organizer is a visual representation of knowledge, concepts or ideas. They are known to help engage students and relieve boredom; enhance recall of new information, concepts, and ideas; motivate students; clarify information; assist students in organizing their thoughts; and promote deep understanding.
KWL technique	The KWL strategy is a technique that helps students activate what they already know before they begin the lesson ("Know"), think about what they would like to know about a topic under study ("Want to Know") and then reflect on what they have learned after the lesson ("Learned").
Think Aloud	A Think Aloud involves a teacher or student "thinking out loud," talking through his or her ideas as he or she completes a task or solves a problem. This makes one's thinking visible to others so they can share, reflect on, and evaluate the thinking process.
Concept Web	The Concept Web helps students organize ideas and information, and to see similarities and differences between different ideas or different pieces of information. A Concept Web includes a word or phrase in the center with related words arranged around the central word or phrase, connected to it with lines.
Venn Diagram	A Venn Diagram helps students compare and contrast information. It can be used as a prediction technique, as a graphic organizer, or as a means for students to show what they have learned. A basic Venn Diagram has two overlapping circles. Each outside section tells how the two things being compared are different; the similarities are written in the overlapping center of the two circles.

Value-Line	The Value-Line strategy provides a way for students to think about and express opinions about a subject. A Value Line presents opposite responses to a new idea or issue (such as "Agree" and "Disagree" or "Yes" and "No") and asks students to take a stand somewhere between the two extremes.
Anticipation Guides	Anticipation Guides are tools teachers use to activate background knowledge and to engage students' interest by encouraging them to "anticipate" what they will learn in the lesson. There are many kinds of Anticipation Guides, which help students prepare their minds for new ideas and concepts.
Classification	Classification helps students approach new problems and issues. Classification teaches students to use a set of criteria to organize new information, concepts, and ideas.
Inquiry	Inquiry is a strategy in which students conduct independent research about a topic. They may use a variety of sources: the Internet (if available), encyclopedias, books or magazines, or even short pieces of text written by the teacher. Before the students begin their Inquiry, the teacher helps them determine two to four questions that they will answer with their research. What is important about Inquiry activities is that the teacher helps students set it up, but then the students do their own investigations while the teacher monitors their progress and offers support as needed.
Jigsaw	A Jigsaw activity is performed with students formed into groups. Questions or topics are posed and each group sets about gathering information on a subset of questions or topics; in this way, each group becomes the "Expert Group" for its subset. Once each group has gathered information, they share their information with the rest of the class. Depending on the classroom context and the teacher's preference, each Expert Group can share its knowledge in a variety of ways.
Think, Pair, Share	Think, Pair, Share is a way for members of a large group to first think independently about an idea, then share with one other person in a quiet conversation, and then hold a large-group discussion. In this way, people can be made comfortable developing their ideas first alone, then with a trusted partner, and finally sharing them with a whole group.

Part I
Techniques for Instruction and Assessment in Mathematics

PURPOSE OF THE MODULE -- MATH

Introduction

This module contains teaching techniques and strategies that will support lessons in current textbooks at government schools, and will draw upon principles of reflective practice and constructivist models of teaching. These techniques and strategies are designed to encourage students to become more active and independent learners.

Teachers have many topics to cover in teaching mathematics in the primary grades. They must teach numbers, geometry, measurement, and many others. It is not possible to cover all mathematics topics in this module. It is the purpose of this module to introduce teachers to a *way* of teaching mathematics that they can use with many mathematics topics. This way of teaching, called **constructivism**, will be shown with the demonstration lessons in this module. The demonstration lessons will include the following topics: simple addition, basic geometry shapes, and highest common factors.

Framework of Learning

This module is based on constructivist ideas about how students learn. When we lecture to children from a textbook, they are passive learners. For some lessons and topics this is appropriate, but for most lessons and topics, teachers can use constructivist strategies to activate students' curiosity, ask students to share what they think, and engage students so that they become active learners.

Constructivist ideas suggest that students learn best when teachers first help them **activate background knowledge** about a topic, then support them **construct meaning** from new knowledge or a new skill, and finally teach them to **evaluate and apply** what they have learned in the lesson. The lessons in this module are based on these three phases of a teaching session or unit.

PHASE I: Activate Background Knowledge	**PHASE II: Construct Meaning**	**PHASE III: Evaluate and Apply**
During this phase of the lesson, the teacher helps students recall knowledge that they may relate to the new topic.	During this phase of the lesson, the teacher presents activities that introduce new knowledge or skills and help students discover what the knowledge or skills mean to them.	During this phase of the lesson, the teacher helps students think deeply about what they have learned and how to apply what they have just learned to new situations or to further learning.

PHASE I : Activate Background Knowledge

In this phase, techniques are used to remind the students of the knowledge they already have on the topic and to encourage students to develop a real purpose for learning new information. It is also possible to show the students how mathematics is connected to their own lives and the knowledge they use every day. For example, Mrs. Badar might ask Sajida how many brothers she has and how many sisters she has. When Sajida says she has two brothers and one sister, Mrs. Badar might use marks on the board to show that this means Sajida has three siblings. This phase is an opportunity to motivate the students to be actively involved in learning new information.

PHASE II: Construct Meaning

In this phase, the teacher engages the students in constructing meaning from new knowledge or skills presented in this lesson. Teachers encourage and support students as they find answers to questions in textbooks, questions from the teacher, and finally, as they learn to answer their own questions.

PHASE III: Evaluate and Apply

This phase includes techniques that help the teacher and the student work together to evaluate the learning that has taken place. The strategies help the students to remember and reorganize important information, ideas, and their relationships that they have learned from the lesson. This phase is enhanced if the teacher can help students connect what they have learned to their daily lives and reflect on their learning. In this phase, the teacher should also help students monitor their own learning and give students feedback on their learning.

Why is this topic generally important?

Mathematics is the science of measuring. It uses numbers and shapes. Mathematics includes such topics as addition, subtraction, multiplication, and division. It also includes geometry, in which we study shapes like triangles and circles, and calculate such formulas as the area of a rectangle.

Constructivism is a good way to teach mathematics. Children are naturally curious about the world around them. There are numbers and shapes everywhere in the world, so there

are many ways to show students how to practice mathematics in their daily lives.

Through constructivist learning activities in mathematics, students can learn mathematics and can develop good attitudes about mathematics.

Constructivist learning activities in mathematics:

- Allow students to monitor their own learning;
- Help students see the purpose for learning mathematics;
- Often draw upon objects and situations in students' daily lives;
- Encourage students to be creative and curious;
- Build upon students' background knowledge;
- Are active, so that students do activities rather than just answering questions from the textbook;
- Ask students to take risks and try new things; and
- Give opportunities for sharing, discussion, and reflection.

Objectives of the Module

Participants should complete the module with the following outcomes:

- Demonstrate understanding of techniques and strategies thorough planning and teaching mathematics lessons;
- Demonstrate understanding of techniques and strategies thorough planning and teaching science lessons; and
- Show a responsible attitude towards his/her learning and his/her students' learning.

Demonstration Lessons

Demonstration Lesson # 1

Developing Skills of Simple Addition Up to Three Digits

Using the K-W-L and Think Aloud Strategies

Objectives

Through this demonstration lesson the participants should be able to:

- Understand constructivist strategies including K-W-L and Think Aloud; and
- Acquire skills of teaching the concept of addition to primary learners using the K-W-L and Think Aloud strategies.

Outcomes

Learning through the model of constructivism, student(s) should be able to:

- Understand and recognize the concepts of unit, ten, and hundreds; and
- Count numbers one through nine, add these numbers successfully, and learn a simple method of solving addition problems with three-digit numbers.

Introduction

This lesson will use the topic of simple addition to present constructivist strategies called "Know – Want to Know – Learn" (KWL) and Think Aloud. The KWL strategy helps students activate background knowledge by first asking them what they know about a topic. The teacher can then focus students' attention on what they know about numbers and addition. Next, the strategy increases students' interest by asking them what they

Demonstration Lesson # 2
Developing an Understanding of Triangles
Using Concept Web and Think Aloud Strategies

Objectives

Through this demonstration lesson the participants should be able to:

- Understand constructivist strategies including Concept Web and Think Aloud; and
- Acquire skills of teaching the concepts of right angles, acute angles, obtuse angles, right triangles, equilateral triangles, and isosceles triangles.

Outcomes

Learning through the model of constructivism student(s) should be able to:

- Understand and recognize three types of angles: right, obtuse, and acute;
- Understand and recognize three common types of triangles: equilateral, isosceles, and right; and
- Describe how right triangles, isosceles triangles, and equilateral triangles are alike and how they are different.

Vocabulary:

right angle, obtuse angle, acute angle, right triangle, equilateral triangle, isosceles triangle

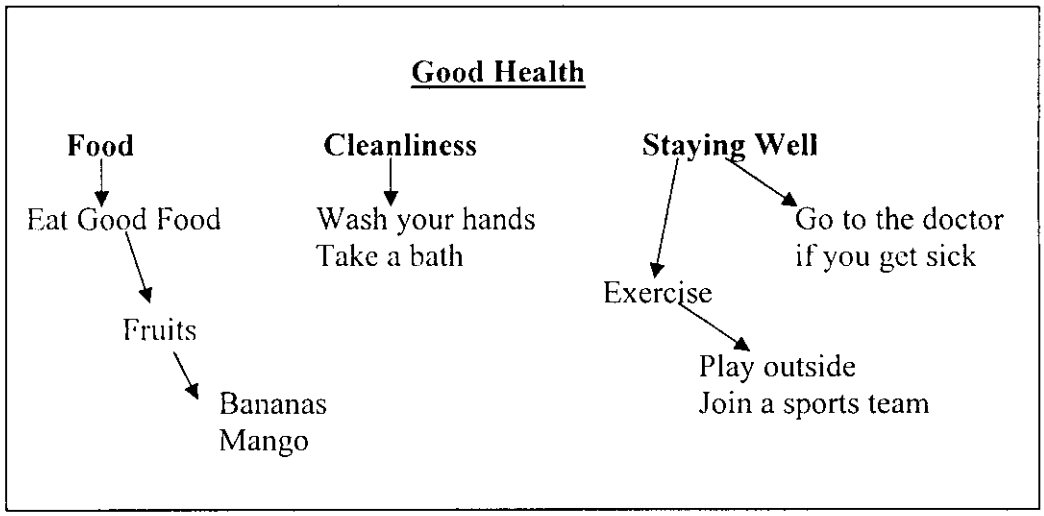
What You Will Need:

Pictures or photographs of objects that students can identify as shapes (such as a picture of a clock [circle] or a building [rectangle]). Pictures of different kinds of triangles: a right triangle, an isosceles triangle, and an equilateral triangle. Rulers (if available).

Introduction

This lesson will use the topic of geometry to present constructivist strategies called Concept Web and Think Aloud. The Concept Web strategy helps students organize ideas and information, and to see similarities and differences between different ideas or different pieces of information. To create a Concept Web, write a word or phrase and either draw a circle around it or underline it. Write related words around the central word or phrase, connecting related ideas and information with lines.

For example, a teacher may have her students create a Concept Web about how to have good health. She may ask the students for ideas, and then she will organize them on the board in a Concept Web:



The Think Aloud strategy helps students understand how to think through problems. In a Think Aloud, a teacher "thinks out loud," talking out loud and explaining her or his thinking as she or he solves a problem on a chart or blackboard (if available). The teacher may then ask a student to talk out loud, sharing her or his thinking as the student solves a problem.

Phase 1: Activating Background Knowledge

Step 1: Select photographs or draw pictures that include basic geometric shapes including rectangles (for example, a box or a building), circles (for example, a clock or a ball), and triangles (for example, a pyramid, a slice of pie, or a boat's sail). Show them to students and ask students to identify the shapes that they see. Write the names of the shapes on the chart or blackboard (if available) and draw the shapes next to them. For example: circle square

Step 2: Say, "All shapes are made of lines – sometimes curved, as in a circle, and sometimes straight, as in a square. When shapes have straight lines that come together, the place where the lines meet is called an *angle*. If students already have studied angles, then hold a short discussion in which students share what they know. If they have not, then point out the angles in the shapes on the board.

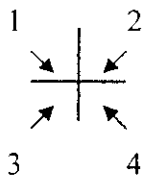
Phase 2: Constructing Meaning

Step 3: Some students may understand *acute angle, obtuse angle,* and *right angle*. If so, allow students to work in groups and for these students to share what they know with other students. Hold a whole-class discussion so that everyone has an understanding of these types of angles.

If students are not yet familiar with *acute angle, obtuse angle,* and *right angle*, then teach these simple concepts using Think Aloud. "Think out loud" as you draw on the board and explain what you are doing.

First, draw two lines on the board so that they intersect, like this:

Using Think Aloud, tell students that there are four *right angles* (also known as 90 degree angles) in this drawing, at each of the points where the two lines meet. For advanced students, you can tell them that two lines that intersect in a right angle are called *perpendicular*.



Ask students to identify areas in the classroom where they can find right angles (such as where the wall meets the floor; if you stand a book up on a table; or the English capital letter "L")

Step 3: Use Think Aloud as you explain to students that when an angle is BIGGER than a right angle, it is called OBTUSE. Draw an example on the chart or board, and then ask students to draw more examples.

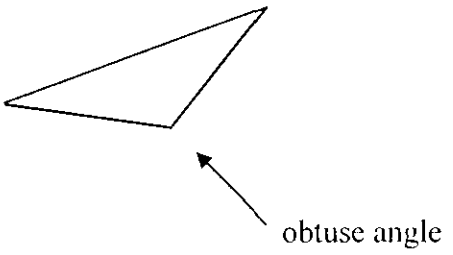
Examples of obtuse angles:

Explain to students that when an angle is SMALLER than a right angle, it is called ACUTE. Draw an example on the chart or board, and then ask students to draw more examples.

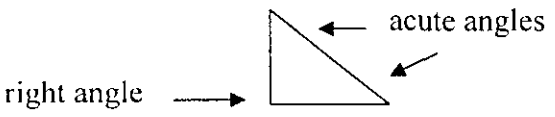
Examples of acute angles

Step 4: Explain that an EQUILATERAL TRIANGLE has THREE EQUAL SIDES and THREE EQUAL ANGLES, WHICH ARE ALL ACUTE. Draw an example:

Explain that an ISOSCELES TRIANGLE has TWO SIDES THAT ARE EQUAL LENGTH, but not three. An ISOSCELES TRIANGLE MAY HAVE ACUTE AND OBTUSE ANGLES. Draw an example:



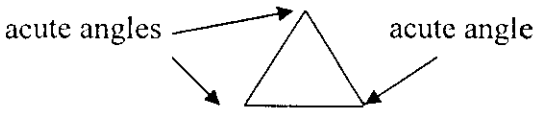
Next, explain that a RIGHT TRIANGLE is a special type of isosceles triangle with ONE RIGHT ANGLE AND TWO ACUTE ANGLES in it. Draw an example:



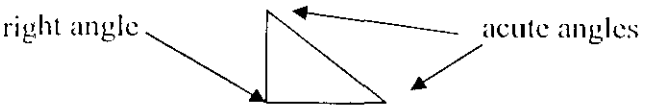
Step 5: Finally, point out to the students that the examples of triangles on the chart or the board have acute, obtuse, and right angles in them. Ask students to point out the acute, obtuse, and right angles. Correct students as necessary so that at the end of the exercise you have examples with the angles correctly marked.

For example:

Equilateral triangle



Right triangle



Phase 3: Evaluate and Apply

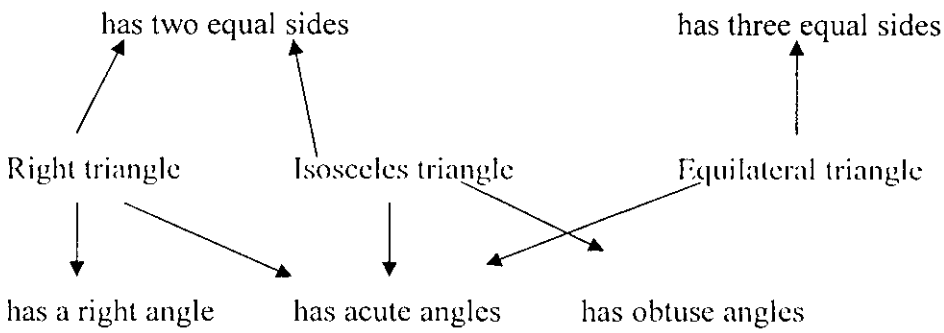
Step 6: Place students in groups. Give each group pictures on which you've drawn several examples of isosceles, equilateral, and right triangles.

Each group should have a ruler to measure the sides of the triangles on their paper (If no rulers are available, then hold a piece of paper to each side of each triangle, and use pencil marks to indicate how long each side is. This way, students can determine which sides are of equal length).

Each group should identify their triangles as isosceles, equilateral, or right triangles.

Step 7: Using what they now know, each group can create a Concept Web about triangles. Their Concept Webs should have the word "Triangles" at the top, either circled or underlined, and they should include the terms: sides, angles, right angle, acute angle, obtuse angle, equilateral triangle, right triangle, isosceles triangle. Once webs are complete, invite a discussion about the similarities and differences between the different types of triangles. The Concept Webs will differ from each other, but might look like this:

TRIANGLES



Notes to Facilitator:
To assess participants' level of understanding of this workshop:

d. Ask participants to develop a similar demonstration lesson using Concept Web and Think Aloud strategies using a mathematics topic.
e. Share the lesson with a colleague and discuss similarities and differences in their plans.
f. Teach the same lesson during the field work and self assess his/her own teaching.

At the end of the session the participants will complete the Debriefing Sheet for the lesson.

Allow time to discuss the participants' questions and comments from the debriefing sheet using the "Think, Pair, Share" method.

d. Each participant completes the Debriefing Sheet independently.
e. Each participant discusses his or her Debriefing Sheet with a partner.
f. Partners share their responses to the Debriefing Sheet if they choose. The facilitator should help participants to feel comfortable and should tell them to share only what they want to share, help each other answer questions, and respond to comments from each other and the facilitator.

Debriefing Sheet for Demonstration Lesson #2

1. Please list three things you learned from this lesson:

_____

_____

_____

_____

_____

2. Please list two questions you have after finishing this lesson:

_____

_____

_____

_____

_____

3. How might you adapt this lesson to fit your classroom context?

_____

_____

_____

_____

Demonstration Lesson # 3

Developing an Understanding of Highest Common Factors Using Venn Diagram Strategy

Objectives

Through this demonstration lesson the participants should be able to:

- Understand constructivist strategies including Venn Diagrams; and
- Acquire necessary skills for teaching the concept of highest common factors.

Out comes

Learning through the model of constructivism student(s) should be able to:

- Understand the concept of highest common factors;
- Recognize these factors from given numbers; and
- Use Venn Diagram technique to solve mathematical problems.

Vocabulary:

factor, common, highest

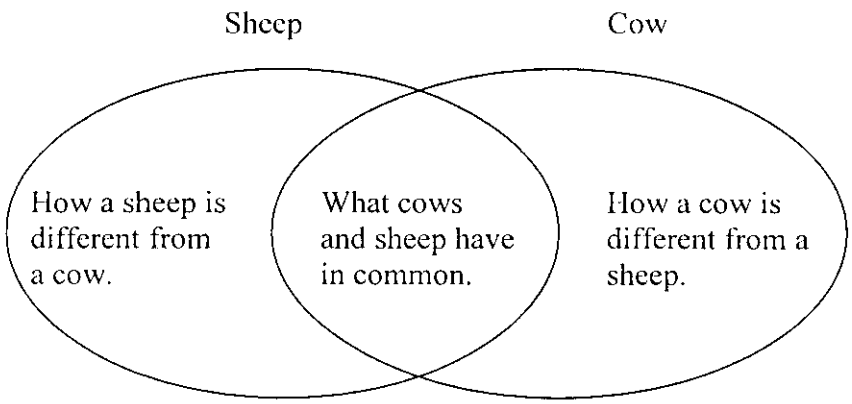
Introduction

This lesson will use the topic of highest common factors to present a constructivist strategy called Venn Diagram.

A Venn Diagram is an effective strategy to help students compare and contrast information. It can be used as a prediction technique in the Access Background Knowledge phase (for example, "How are a sheep and a cow alike and different?") or as a

graphic organizer during the Constructing Meaning phase, for students to organize information, or it can be used in the Evaluate and Apply phase as a means for students to show what they have learned.

A basic Venn Diagram has two overlapping circles. Each outside section tells how the two things being compared are different; the similarities are written in the overlapping center of the two circles.



Phase 1: Activating Background Knowledge

Step 1: Students should already know the terms and concepts "highest," "factor," and "common." Hold a short activity to remind students of these terms. For example, make marks on a chart or a blackboard and point out which is high, higher, and highest. Then, talk about "common" as things that are similar, or the opposite of concepts like "different" or "uncommon." Finally, have students recall the definition of "factor": One of two or more numbers that can be divided into a given number without a remainder, in the formula "a and b are factors of ab." For

example, 2 and 4 are factors of 8; 3 and 5 are factors of 15; 6 and 9 are factors of 54.

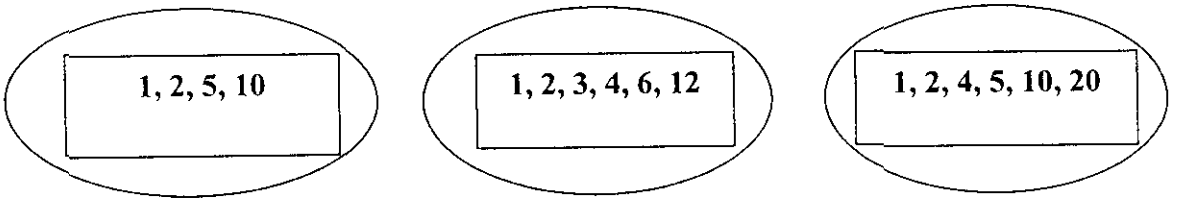
Step 2: Once you are sure that all students understand "highest," "common," and "factor," it is time to make a list of numbers. Call on students to contribute any numbers they can think of up to the number 20. Write the numbers in a box on the blackboard or chart (if available).

For example:

6, 8, 3, 10, 19, 15, 20, 5, 12, 16,
(Numbers)
9, 11, 18, 2, 4, 17, 14, 6, 13, 7,

Step 3: Next, write three circles on the board or chart (if available), and label them "FACTORS OF 10," "FACTORS OF 15," AND "FACTORS OF 20." Also have students make the circles on their own paper (if available).

Ask students to help you organize the numbers into categories by placing each number in the appropriate circle. For example:

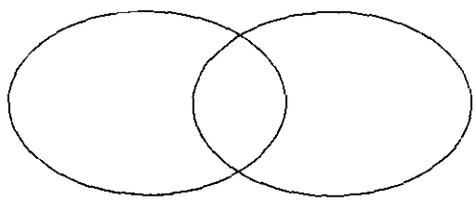


FACTORS OF 10 **FACTORS OF 12** **FACTORS OF 20**

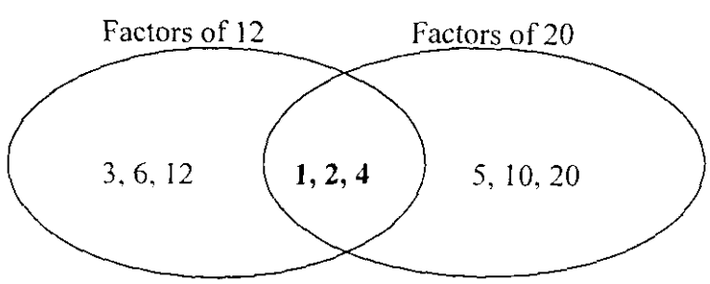
Make sure that the students fill in the circles on their papers as you fill in the circles on the chart or blackboard.

Phase 2: Constructing Meaning

Step 4. Next, draw a Venn diagram on the blackboard or chart (if available), with two intersecting circles:



Label one circle "Factors of 12" and the other "Factors of 20." Fill in each circle using the numbers in the circles. The factors that each number have *in common* should go in the middle; the factors that are different go in the outside portions of each circle:



Explain to students that the numbers 12 and 20 have three factors in common: 1, 2, and 4. The other factors of 12 and of 20, in the outsides of the circles, are different. Among the *common* factors, 4 is the *highest*. Underline the 4. Tell students, "For the numbers 12 and 20, 4 is the highest common factor."

Notes to Facilitator:
To assess participants' level of understanding of this workshop:

g. Ask participants to develop a similar demonstration lesson using Venn Diagrams.
h. Share the lesson with a colleague and discuss similarities and differences in their plans.
i. Teach the same lesson during the field work and self assess his/her own teaching.

At the end of the session the participants will complete the Debriefing Sheet for the lesson.

Allow time to discuss the participants' questions and comments from the debriefing sheet using the "Think, Pair, Share" method.

g. Each participant completes the Debriefing Sheet independently.
h. Each participant discusses his or her Debriefing Sheet with a partner.
i. Partners share their responses to the Debriefing Sheet if they choose. The facilitator should help participants to feel comfortable and should tell them to share only what they want to share, help each other answer questions, and respond to comments from each other and the facilitator.

Debriefing Sheet for Demonstration Lesson #3

1. Please list three things you learned from this lesson:

_____

_____

_____

_____

_____

2. Please list two questions you have after finishing this lesson:

_____

_____

_____

_____

_____

3. How might you adapt this lesson to fit your classroom context?

_____

_____

_____

_____

Part II
Techniques for Instruction and Assessment in Science

PURPOSE OF THE MODULE -- SCIENCE

Introduction

The module is designed to improve teachers' knowledge, skills, and attitudes of teaching science effectively and inculcating the spirit of scientific inquiry and interest among the primary students. This module contains teaching techniques and strategies that will support lessons in current textbooks at government schools, and will draw upon principles of reflective practice and constructivist models of teaching. These techniques and strategies are designed to encourage students to become more active and independent learners.

Teachers have many topics to cover in teaching science in the primary grades. It is not possible to cover all science topics in this module. It is the purpose of this module to introduce teachers to a *way* of teaching science that they can use with many topics. This way of teaching, called **constructivism**, will be shown with the demonstration lessons in this module. The demonstration lessons will include the following topics: good health; living and nonliving things; day and night; and weather, climates, and seasons.

Framework of Learning

This module is based on constructivist ideas about how students learn. When we lecture to children from a textbook, they are passive learners. For some lessons and topics this is appropriate, but for most lessons and topics, teachers can use constructivist strategies to

activate students' curiosity, ask students to share what they think, and engage students so that they become active learners.

Constructivist ideas suggest that students learn best when teachers first help them **activate background knowledge** about a topic, then support them **construct meaning** from new knowledge or a new skill, and finally teach them to **evaluate and apply** what they have learned in the lesson. The lessons in this module are based on these three phases of a teaching session or unit.

PHASE I: Activate Background Knowledge	**PHASE II: Construct Meaning**	**PHASE III: Evaluate and Apply**
During this phase of the lesson, the teacher helps students recall knowledge that they may relate to the new topic.	During this phase of the lesson, the teacher presents activities that introduce new knowledge or skills and help students discover what the knowledge or skills mean to them.	During this phase of the lesson, the teacher helps students think deeply about what they have learned and how to apply what they have just learned to new situations or to further learning.

PHASE I : Activate Background Knowledge

In this phase, techniques are used to remind the students of the knowledge they already have on the topic and to encourage students to develop a real purpose for learning new information. It is also possible to show the students how science is connected to their own lives and the knowledge they use every day. For example, students can be asked to notice all of the living and non-living things around them, and to understand the differences between living and non-living things. Students can easily become interested in their environments, in ways that their bodies use food as energy, and the different

qualities of sounds they hear every day. This phase is an opportunity to motivate the students to be actively involved in learning new information.

PHASE II: Construct Meaning

In this phase, the teacher engages the students in constructing meaning from new knowledge or skills presented in this lesson. Teachers encourage and support students as they find answers to questions in textbooks, questions from the teacher, and finally, as they learn to answer their own questions.

PHASE III: Evaluate and Apply

This phase includes techniques that help the teacher and the student work together to evaluate the learning that has taken place. The strategies help the students to remember and reorganize important information, ideas, and their relationships that they have learned from the lesson. This phase is enhanced if the teacher can help students connect what they have learned to their daily lives and reflect on their learning. In this phase, the teacher should also help students monitor their own learning and give students feedback on their learning.

Why is this topic generally important?

Science and technology are developing rapidly. Because children in schools today will be responsible for the advancement of science in the future, science education is important for all students. It not only affects their future but also the future of their country.

Science is the study of the physical world. Science is also a method, a means of experimental examination that allows us to answer questions about the physical world. According to Jennings, T., (1993) "the word science comes from the Latin term 'scire,' to know. It is concerned about our knowledge of the universe and all that is in it."

Teaching science involves great responsibility. If children are provided with an environment in which they can study and observe the physical world, then they may develop correct and clear concepts about the world. However, if science is poorly taught and badly learnt, it is little more than burdening the mind with bad information and can cause rumors and superstition. Many, many years ago, people believed that the earth was flat and that the sun moved around the earth. Through science, we know that the earth is round and that the earth moves around the sun.

Therefore, teaching science requires careful consideration, especially when it is taught to primary learners because children in primary schools are just forming ideas about the physical world. Children need opportunities to interact, explore, and test ideas in science.

Harlen, W. (1989) also supports this idea and says teaching science in primary schools is not about abstract theories and principles. It involves students discovering their surroundings through their own thinking and investigations and requires that students be allowed to work in a scientific way, completing experiments and answering questions they may have about the world. In this way, students can develop good attitudes toward science.

Constructivism is a good way to teach science. Children are naturally curious about the world around them and they can learn that they already do experiments every day in their routine lives. For example, a child may taste a new fruit to see if he likes it, or a mother may add a new spice to a recipe to see if the family likes it better. We may take a new route to school or work to see if it is faster. When we organize these experiments like scientists do, then we are using the scientific method.

Constructivism works well with the scientific method, because like the scientific method, it encourages inquiry and the process of finding answers to questions rather than passively listening to lectures and copying notes. The scientific method involves posing a **question**, suggesting a **hypothesis**, conducting an **experiment**; analyzing the **results**; and determining an **answer to the question** (or answers; sometimes there are more than one!).

Many of these demonstration lessons can also be taught using the scientific method. For example, students can extend the Lesson on Day and Night to think about the movement of the earth through the calendar year. They may ask the **question**, "Does the earth move in its orbit through the year?" They may pose various **hypotheses**. Then they may conduct an **experiment**: every day at the same time of day, they can go outside and stand on the same spot and mark their shadows. Over time, they will notice that their shadows move. They can **analyze** these results to **answer the question** of whether or not the earth moves in its axis through the year.

Constructivism supports the National Curriculum of Pakistan in teaching science, which aims to:

- Develop a broad and genuine understanding of scientific approach;
- Nurture the spirit of inquiry and curiosity;
- Enhance the ability to observe carefully and report facts accurately;
- Cultivate scientific attitudes and awareness about the basic concepts of various disciplines in science;
- Provide opportunities to the children to determine their interest and aptitudes; and
- Promote scientific literacy and provide scientific and technological manpower in the country.

Objectives of the Module

Participants should complete the module with the following outcomes:

- Demonstrate understanding of techniques and strategies thorough planning and teaching mathematics lessons;
- Demonstrate understanding of techniques and strategies thorough planning and teaching science lessons; and
- Show a responsible attitude towards his/her learning and his/her students' learning.
- Critically reflect on their classroom beliefs and practices on teaching and learning science during this module.

Demonstration Lessons

Demonstration Lesson # 1

Learning about Good Health

Using the Value-Line and Anticipation Guide Strategies

Objectives

Through this demonstration lesson the participants should be able to:

- Understand constructivist strategies including Value-Line and Anticipation Guides; and
- Acquire skills of teaching concepts related to good health using the Value-Line and Anticipation Guide strategies.

Outcomes

Learning through the model of constructivism, student(s) should be able to:

- Understand and recognize concepts related to good health, such as exercise, eating well, and being clean; and
- Display good habits that will help them stay healthy.

Introduction

This lesson will use the topic of good health to present constructivist strategies called Value-Line and Anticipation Guides.

The Value-Line strategy helps students develop critical thinking skills. It provides a way for them to think about and express their opinions about a subject. In using a Value Line, place a line on a chart or blackboard (if available) with opposite responses to a new idea

or issue (such as "Agree" and "Disagree" or "Yes" and "No") on either end of the line. For example:

AGREE ———————————————————————— DISAGREE

Then, present an idea to the students in the form of a question which can be answered with the responses from the Value Line. The students think about the idea and come up to the chart or board to place a mark on the line to indicate their opinions; for example, on an "Agree" or "Disagree" line, a student may make a mark on one end or the other, indicating a strong opinion; in the middle, indicating a neutral opinion; or somewhere along the line, indicating a mild opinion. The most important part of the Value Line exercise is holding a discussion afterward in which each student supports his or her opinion.

Anticipation Guides are useful in activating background knowledge. Anticipation Guides help students prepare their minds for new ideas and concepts. There are different kinds of Anticipation Guides. The one used here involves the teacher making four statements on the chart or blackboard (if available) that relate to the concept to be studied in the coming lesson. The students respond to the statements and the class holds a discussion. This is one way to activate students' background knowledge and engage their interest.

In this lesson, we will use a combination of the Value Line and the Anticipation Guide strategies.

Phase I: Activate Background Knowledge

Step 1: Select a short piece of text about good health practices, such as eating good food, being clean, or exercising. Appendix One offers an example of a text that you can use. If you have access to the internet, you can get more ideas from (http://www.coolfoodplanet.org/gb/kidz.)

Using the information in the text, write four statements on the chart or blackboard (if available). The statements should be opinion statements, so that the students can agree or disagree with them. Underneath each statement, write a value line.

For example:

- People should wash their hands before they handle food.

AGREE ———————————————————— DISAGREE

- Children should not exercise.

AGREE ———————————————————— DISAGREE

- Candy is a healthier food than fruit.

AGREE ———————————————————— DISAGREE

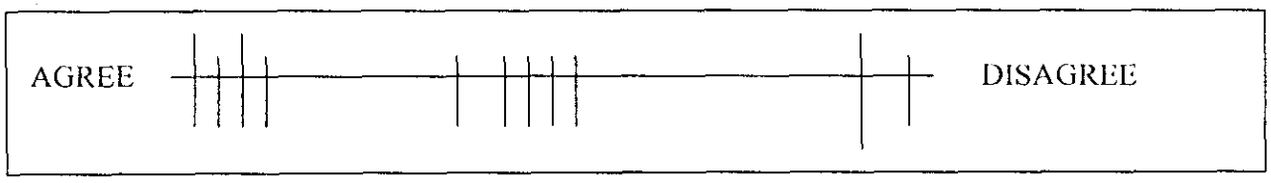
• Taking baths or showers helps us stay healthy.

AGREE ———————————————————— DISAGREE

Step 2: Ask students to think about each statement, and to decide if they agree or disagree. Have each student come up to the chart or blackboard (if available) and make a mark indicating how much they agree or disagree with each statement.

If four of your students strongly agree, two of your students strongly disagree, and five of your students are neutral, then your value line might look like this:

• Taking baths or showers helps us stay healthy.



Hold a class discussion of the value line. Ask students to offer reasons why they agreed or disagreed with the statement.

Phase 2: Constructing Meaning

Step 3. Next, say, "Now we will read a piece of text called 'Healthy Habits. While we read, try to determine whether the author of this text agrees or disagrees with each of the statements."

If possible, each student should have a copy of the text or should be able to see it on an overhead projector. Otherwise, students can share or can listen while you read. Depending on the materials available and the students' reading ability, you can read the text out loud to the students or you can have them take turns reading out loud.

Read the piece of text.

Step 4: Discuss the author's opinion. According to the piece of text, the author would AGREE with the first and the last statements, but would DISAGREE with the second and third statements.

Phase 3: Evaluate and Apply

Step 5: Correct the statements on the board so that they are all true:

- People should wash their hands before they handle food.
- Children should exercise.
- Fruit is a healthier food than candy.
- Taking baths or showers helps us stay healthy.

Step 6: Ask questions to make sure that students understand why each of these four statements is true.

Ask students to compose short original sentences, either in writing or orally, about ways to stay healthy.

Notes to Facilitator:
To assess participants' level of understanding of this workshop:

j. Ask participants to develop a similar demonstration lesson using Value-Line and Anticipation Guide strategies using a science topic.
k. Share the lesson with a colleague and discuss similarities and differences in their plans.
l. Teach the same lesson during the field work and self assess his/her own teaching.

At the end of the session the participants will complete the Debriefing Sheet for the lesson.

Allow time to discuss the participants' questions and comments from the Debriefing Sheet using the "Think, Pair, Share" method.

j. Each participant completes the Debriefing Sheet independently.
k. Each participant discusses his or her Debriefing Sheet with a partner.
l. Partners share their responses to the Debriefing Sheet if they choose. The facilitator should help participants to feel comfortable and should tell them to share only what they want to share, help each other answer questions, and respond to comments from each other and the facilitator.

Debriefing Sheet for Demonstration Lesson #1

1. Please list three things you learned from this lesson:

_____

_____

_____

_____

_____

2. Please list two questions you have after finishing this lesson:

_____

_____

_____

_____

_____

3. How might you adapt this lesson to fit your classroom context?

_____

_____

_____

_____

Demonstration Lesson # 2

Learning About Living and Non-Living Things

Using the Scientific Classification Strategy

Objectives

Through this demonstration lesson the participants should be able to:

- Understand constructivist strategies including Classification; and
- Acquire skills of teaching the properties of living things using the Classification strategy.

Outcomes

Learning through the model of constructivism, student(s) should be able to:

- Understand and classify objects into living and nonliving; and
- Understand the five qualifications for living things.

Introduction

This lesson will use the topic of living and non-living things to present the constructivist strategy called Classification.

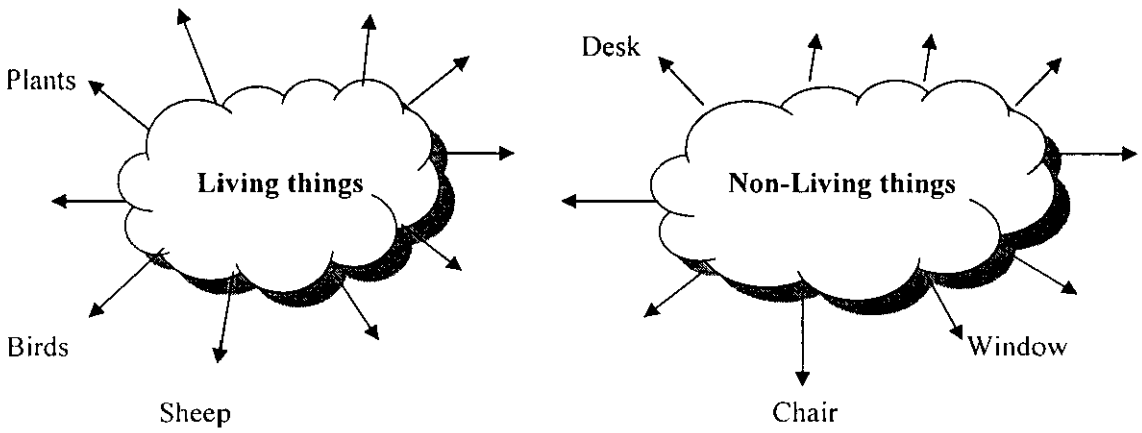
Classification is one way that scientists identify unknown objects. Working from a set of qualities, they can decide what an unknown object is by determining which qualities it does or does not have. For example, suppose a scientist discovers a creature sitting by a pond. He has never seen such a creature. The creature moves its head to look at him, flaps its feathered wings, and flies away. The man knows that birds have feathers and wings, so

he concludes that it is an animal, a type of bird. On a more sophisticated level, a scientist may discover a new rock. She knows that igneous rocks are formed from molten magma and are very hard, like granite, while sedimentary rocks are formed from sediment and are often soft, like chalk. When the rock crumbles in her hand, she decides that it is a sedimentary rock.

Classification is a useful tool to teach to students. It helps them think like scientists do, and to feel confident as they approach more sophisticated problems. It also helps them organize new information and concepts as they learn them.

Phase I: Activate Background Knowledge

Step 1: Encourage students to think about living and non-living things. Ask students to tell of living and non-living things they know about, and write their responses on the blackboard or a chart (if available):



Step 2: Ask students what they know about the differences between living things and nonliving things. Encourage them to share their ideas with a partner, and then with the whole class.

Phase I: Activate Background Knowledge

Step 3: After students have shared ideas, tell them that there are five things that all living things do. All living things start small and grow up. All living things reproduce – make more living things. All living things can move on their own; they can fly, walk, swim, or extend roots and branches. All living things need nutrients, or some form of food, to keep living. All living things are sensitive to their environments; living animals can see, hear, smell, taste, or feel while living things like plants can sense heat and cold and other aspects of their environment. Explain the five things and write on a chart or blackboard (if available):

LIVING THINGS GROW, REPRODUCE, MOVE, NEED NUTRIENTS, and ARE SENSITIVE TO THEIR ENVIRONMENTS.

Make a chart on the board and give some examples. For example, a mango tree is a living thing. It grows from a seed; it reproduces by bearing fruit: it moves when it extends its roots into the ground; it gets nutrients from sunlight and the soil; it is sensitive to its environment and will die if it gets too cold or is chopped down. Explain that a nonliving thing, like a chair or a bicycle, doesn't do these things. Ask the students to help you complete some more examples. Some ideas are fish and parrot:

	GROW	REPRODUCE	MOVE	NEED NUTRIENTS	SENSITIVE TO THE ENVIRONMENT
MANGO TREE	Grows from a seed	Makes fruit	Roots and branches	Sunlight and soil	Will die if it gets too cold or is chopped down
FISH	Baby fish grow into adult fish.	Baby fish are hatched from fish eggs or born from adult fish.	Fish swim.	Fish eat food from the water around them.	Fish must live in the water to stay alive.
PARROT	Baby parrots grow into adult birds.	Parrots lay eggs.	Parrots fly.	Parrots eat seeds and other nutrients.	Parrots

Phase 3: Evaluate and Apply

Step 4: Have students work in pairs to fill out their own charts with more examples of living things. After students have worked in pairs, hold a discussion with the whole class to share ideas.

Explain to students that they have now learned to **classify**. You can extend this lesson by creating other charts. For example, you can classify kinds of plants by whether they grow fruits or vegetables, have a trunk, or by what kinds of leaves they have. You can classify an animal as a mammal if it has hair or fur, breathes air, gives birth to live babies and nurses its babies with milk. Although it breathes air, bird is not a mammal because it has feathers and lays eggs rather than giving birth.

Notes to Facilitator:
To assess participants' level of understanding of this workshop:

m. Ask participants to develop a similar demonstration lesson using the Classification strategy using a science topic.
n. Share the lesson with a colleague and discuss similarities and differences in their plans.
o. Teach the same lesson during the field work and self assess his/her own teaching.

At the end of the session the participants will complete the Debriefing Sheet for the lesson.

Allow time to discuss the participants' questions and comments from the Debriefing Sheet using the "Think, Pair, Share" method.

m. Each participant completes the Debriefing Sheet independently.
n. Each participant discusses his or her Debriefing Sheet with a partner.
o. Partners share their responses to the Debriefing Sheet if they choose. The facilitator should help participants to feel comfortable and should tell them to share only what they want to share, help each other answer questions, and respond to comments from each other and the facilitator.

Debriefing Sheet for Demonstration Lesson #2

1. Please list three things you learned from this lesson:

_____

_____

_____

_____

_____

2. Please list two questions you have after finishing this lesson:

_____

_____

_____

_____

_____

3. How might you adapt this lesson to fit your classroom context?

_____

_____

_____

_____

Demonstration Lesson # 3

Learning About Day and Night

Using Projects

Objectives

Through this demonstration lesson the participants should be able to:

- Understand constructivist strategies including projects; and
- Acquire skills of teaching about concepts relating to day and night using projects.

Outcomes

Learning through the model of constructivism, student(s) should be able to:

- Understand the concepts of how day and night are determined by the spin of the earth;
- Understand how that although the sun appears to move, it is the earth that moves; and
- Understand why we say that the sun "rises" in the east and "sets" in the west

Introduction

This lesson will use the topics of day and night to present the constructivist strategy of learning through completing a project.

When students complete projects, abstract concepts become concrete and easier to understand and to recall. Particularly with topics that may be difficult to understand, such as the fact that the earth spins when it appears to us on earth that it is the sun which is moving, manipulating objects with our hands can help us understand.

In this activity, the teacher should have an object to represent the earth and a source of light such as a torch (flashlight) or small lamp to represent the sun.

Phase 1: Activate Background Knowledge

Step 1: Ask students to share what they know about the earth and the sun. Review with them the difference between a "sun" and a "planet." Make sure that they are aware that the earth moves in two ways: it spins on its axis, and it moves around the sun. As it spins, we experience morning, noon, evening, and night. The earth moves around the sun once in every year. If possible, use different objects representing the earth and the sun to demonstrate this for students.

Step 2: If possible, take students outside in a place where the sun will cast a shadow. Try to do this first thing in the morning. With chalk, write each student's name on the ground where he or she is standing, and make an X where each student's shadow ends. (If no chalk is available, place objects where each student stands and where each shadow ends). If possible, return to the same spot near noon, and have each student stand in the same place and mark where his or her shadow falls now. Then, return at the end of the school day and mark where each student's shadow now falls. Hold a class discussion about how students' shadows moved during the day. If students say that the sun moved, correct this and remind them that the sun stays still but the earth is rotating so it appears that the sun moves.

Phase 2: Constructing Meaning

Step 3: Have students make the following drawing on their papers:

EAST								WEST
4 AM	6 AM	8 AM	10 AM	NOON	2 PM	4 PM	6 PM	8 PM

In pairs, have students draw the path of the sun through the day. Then, hold a whole-class discussion. Ask students where the sun is in the morning (to the east), where it is at noon (straight up), where it is in the evening (to the west), and where it is at night (you cannot see the sun).

The students' diagrams should show the sun rising through the morning, at its highest at noon, then lowering through the afternoon until, but 8 PM, it is dark and you cannot see the sun any longer.

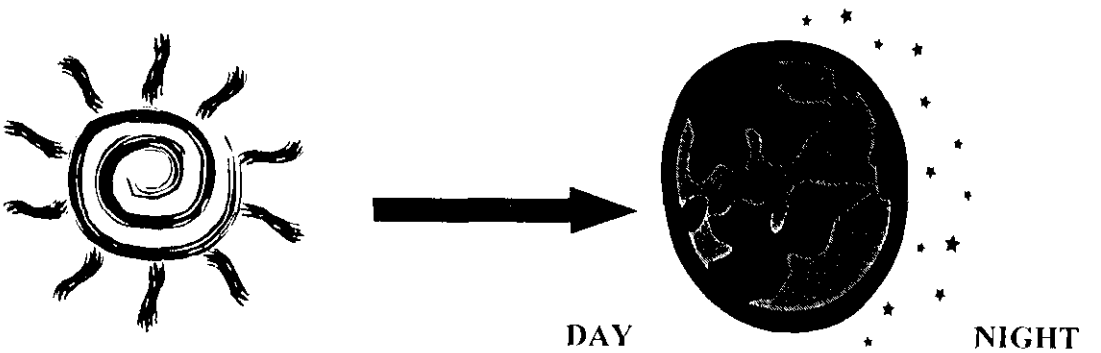
Phase 3: Evaluate and Apply

Step 4: Discuss with students why we say the "sun is rising" and "the sun is setting" when in fact the sun does not move. Assure that they understand this concept.

Have students take turns holding the object you have selected to represent the earth and rotating it in front of the light source so that some portion of the object is lit at all times and some portion of the object is in shadow. As they do this,

students should do a "Think Aloud," thinking out loud as they explain where on the object it is day and where on the object it is night.

Finally, you could have students draw a representation that illustrates the concept of day and night. For example:



Notes to Facilitator:
To assess participants' level of understanding of this workshop:

p. Ask participants to develop a similar demonstration lesson using projects to teach a science topic.
q. Share the lesson with a colleague and discuss similarities and differences in their plans.
r. Teach the same lesson during the field work and self assess his/her own teaching.

At the end of the session the participants will complete the Debriefing Sheet for the lesson.

Allow time to discuss the participants' questions and comments from the Debriefing Sheet using the "Think, Pair, Share" method.

p. Each participant completes the Debriefing Sheet independently.
q. Each participant discusses his or her Debriefing Sheet with a partner.
r. Partners share their responses to the Debriefing Sheet if they choose. The facilitator should help participants to feel comfortable and should tell them to share only what they want to share, help each other answer questions, and respond to comments from each other and the facilitator.

Debriefing Sheet for Demonstration Lesson #3

1. Please list three things you learned from this lesson:

_____

_____

_____

_____

_____

2. Please list two questions you have after finishing this lesson:

_____

_____

_____

_____

_____

3. How might you adapt this lesson to fit your classroom context?

_____

_____

_____

_____

Demonstration Lesson # 4

Learning About Weather, Climates, and Seasons

Using the Inquiry and Jigsaw Strategies

Objectives

Through this demonstration lesson the participants should be able to:

- Understand constructivist strategies including Inquiry and Jigsaw; and
- Acquire skills of teaching concepts related to weather, climates, and seasons using Inquiry and Jigsaw strategies.

Outcomes

Learning through the model of constructivism, student(s) should be able to:

- Understand and recognize concepts related to the weather;
- Understand and recognize concepts related to climates; and
- Understand and recognize concepts related to the four seasons.

Introduction

This lesson will use the topics of weather, climates, and seasons to present the constructivist strategies called Jigsaw and Inquiry.

Inquiry is a strategy in which students conduct independent research about a topic. They may use a variety of sources: the Internet (if available), encyclopedias, books or magazines, or even short pieces of text written by the teacher. What is important about Inquiry activities is that the teacher helps students set it up, but then the students do their

own investigations while the teacher monitors their progress. Before the students begin their Inquiry, the teacher helps them determine two to four questions that they will answer with their research. For example, for an Inquiry project on Animal Habitats: How Do Different Animals Live?, a class might decide on these questions:

1. What does my animal eat?
2. Where does my animal sleep?
3. What other animals can be found in the same place as my animal?

A Jigsaw activity is performed with students formed into groups of three (3) to five (5) children. In a Jigsaw, questions or topics are posed and each group sets about answering one or more of the questions or gathering information about one or more of the topic(s). In this way, each group becomes the "Expert Group" for one set of question(s) or topic(s). Once each group has gathered information or answered its question(s), they can share their answers with the rest of the group. Depending on the classroom context and the teacher's preference, each Expert Group can share its knowledge in a variety of ways. They may make a presentation to the whole group; they may create a picture, a project, or other artifact to show; or students may re-form groups so that each new group now has an expert. An example of how this would work would look like this:

Jigsaw Activity on Animal Habitats: How Do Different Animals Live?

Expert Group on Rabbits: R R R R (Four students who will study how rabbits live)	Expert Group on Sheep: S S S S Expert Group on Goats: G G G G Expert Group on Pigeons: P P P P

After each group has conducted its inquiry about its animal and how it lives (rabbit, sheep, goat, and pigeon), the groups break apart and form new groups with one expert from each expert group. Now the same 16 students belong to groups look which look like this:
Group 1: R S G P Group 2: R S G P Group 3: R S G P Group 4: R S G P

In each group, each "expert" teaches the other three students about his or her particular animal. For example, in Group 1, the "R" expert student will teach the other three students about how rabbits live. Next, the "S" expert student will teach the other three students about how sheep live. Then the "G" expert student will teach the other three students about how goats live, and finally, the "P" expert student will teach the other three students how pigeons live.

In this way, all students are responsible for learning their topic, because they will soon be teaching the topic to other students. Teachers should carefully monitor groups and offer assistance as needed.

At the end of the activity, all students could take a test or complete an activity about all four animals. This will ensure that all students will have learned from each other and all students will now be "experts" on how rabbits, sheep, goats, and pigeons live.

Phase I: Activate Background Knowledge

Step 1: Ask students what the weather is like outside today. If possible, take the class outside and check the temperature; look at the clouds; determine if it is rainy or dry; and if the wind is blowing. Have students discuss if they like the kind of weather they are experiencing at the moment, or if they prefer a different kind of weather.

Talk about the different weather in Pakistan. Most of Pakistan has a dry, warm climate, with much desert, but there are also areas that have mountains and rain. If any students in the class have moved to your area from a different area, ask them to describe the different kinds of weather in the two places. If any of your students have traveled to places with different weather, ask them to share also.

Step 2: Ask students what words they know that refer to the weather. Write them on the blackboard or chart (if available). Examples might include: rain, sunshine, windy, cloudy, cold, dry, warm, snowy, or blustery.

Phase 2: Constructing Meaning

Step 3: Tell the students that they are going to do an Inquiry into weather, climates, and the seasons. Place students into groups, and tell them that they need to find the answers to three questions:

1. What is the difference between weather and climate?
2. What weather is usually associated with each of the four seasons?
3. What are the summer solstice and the winter solstice?

Students may use any resources available: the Internet (if available), encyclopedias, dictionaries, or other reference texts; or they can interview each other or an expert. The teacher should supervise and assist as much as possible

Step 4: Students should share their answers to the Inquiry with the whole class. Write the correct answers on the blackboard or chart (if available) and make sure that students have the correct information at the end of the discussion.

Use the following to check answers:

Weather is the conditions right here, right now. Look out of the window and you will see what the weather is like today. It might be sunny, hot, windy or cloudy, raining or snowing.

Climate is the average weather expected for a certain place. Climate is based on the average weather experienced over 30 years or more. Climate refers to what is expected to happen, so it is possible for the weather today to be different from what is expected. For example, you may live in a dry climate with little rainfall, but one day you may have a big rainstorm.

The four **seasons** are **spring, summer, autumn,** and **winter**.

During **spring**, the weather is usually mild and plants grow new leaves and flowers. In some places, spring is rainy or windy.

During **summer**, the weather is usually the warmest of the year. Some places have big thunderstorms and a lot of wind in summer. Other places, like deserts, have little or no rain in summer.

Autumn usually has windy weather and nights that gradually grow cooler. In some places, the leaves of trees turn bright colors and fall off the trees during autumn.

Winter is the coldest season of the year. During winter, some places have snow or rain. Other places are dry and pleasant in winter.

The **summer solstice** is the day that the North Pole is closest to the sun. It is the longest day of the year and is around 21 June.

The **winter solstice** is the day when the North Pole is furthest from the sun. It is the shortest day of the year and is around 22 December.

Phase 3: Evaluate and Apply

Step 5: Conduct a Jigsaw activity. Place your students into Expert Groups, and have each Expert Group be responsible for conducting an Inquiry about a topic related to the

weather, climate, or the seasons. Remember to give each Expert Group two to four questions or topics to guide their Inquiry.

For example, you might have the Expert Groups study the climate for different regions in Pakistan or the world. You might have Expert Groups study topics related to weather (such as, "What causes rain?" "What causes rain?" and "What causes snow?") or seasons (such as, "Why is summer hotter than winter?" "Why do leaves fall from trees in autumn?" Why do trees and plants grow new flowers and leaves in spring?"). What is most important is to assure that your students have access to the information to answer their inquiries.

Notes to Facilitator:
To assess participants' level of understanding of this workshop:

s. Ask participants to develop a similar demonstration lesson using projects to teach a science topic.
t. Share the lesson with a colleague and discuss similarities and differences in their plans.
u. Teach the same lesson during the field work and self assess his/her own teaching.

At the end of the session the participants will complete the Debriefing Sheet for the lesson.

Allow time to discuss the participants' questions and comments from the Debriefing Sheet using the "Think, Pair, Share" method.

s. Each participant completes the Debriefing Sheet independently.
t. Each participant discusses his or her Debriefing Sheet with a partner.
u. Partners share their responses to the Debriefing Sheet if they choose. The facilitator should help participants to feel comfortable and should tell them to share only what they want to share, help each other answer questions, and respond to comments from each other and the facilitator.

Debriefing Sheet for Demonstration Lesson #4

1. Please list three things you learned from this lesson:

_____

_____

_____

_____

_____

2. Please list two questions you have after finishing this lesson:

_____

_____

_____

_____

_____

3. How might you adapt this lesson to fit your classroom context?

_____

_____

_____

_____

Appendix One

Healthy Habits

There are many things we can do to stay healthy. We should all work hard to develop healthy habits. Some healthy habits include eating good foods and drinking plenty of good fluids, being active, and staying clean.

Did you know that our bodies are made of more than 60% water, and that our bodies use food to make energy? The better the food we eat, the more energy we will have. Fruits and vegetables are better for our bodies than are sugary snacks like candy. Can you name other foods that are good for us? We must also drink a lot of healthy fluids, especially clean water. It is especially important to drink a lot of healthy fluids when it is hot outside. Can you guess why that is? Can you name some other healthy drinks?

It is also important to be active. Exercise helps us feel better and develop stronger bones and muscles. There are many ways to exercise in our daily lives. We can walk instead of taking the bus. We can join sports teams. Even doing chores helps us stay fit. Can you think of other ways to stay active?

Finally, keeping our bodies clean is very important. We should wash our hands with soap often. If we have a cut on our skin, we should cover it. We must clean our teeth, take baths or showers, and keep our clothes clean. We should never cough or sneeze around food and should always wash our hands before we handle food.

These are some simple things we can do every day to develop healthy habits. If we develop healthy habits now, we can help our bodies grow strong and to feel well. What healthy habits did you follow today?

Adapted from http://www.coolfoodplanet.org/gb/kidz