Workshop 3: Conceptual Thinking

This workshop will focus on concept maps as tools for helping students learn. Joseph Novak will explain how students learn by assimilating new concepts into their already existing frameworks, and will take a teacher step-by-step through the design and process of concept mapping. You will see concept maps being used in a variety of different ways in mathematics and science lessons, and will even have an opportunity to make some concept maps of your own.

JOSEPH D. NOVAK

Professor of Biological Science and Science Education recently retired from Cornell University, Joseph Novak is one of the seminal investigators in the research in children's ideas in science. He is the author of *Learning How to Learn* and a developer of the concept mapping formalism. His latest book, *Learning, Creating, and Using Knowledge,* was published in 1998. *Teaching Science for Understanding,* co-authored with Mintzes and Wandersee, was also published in 1998.

Workshop 3 timeline

GETTING READY

30 minutes

20 minutes— Moon Discussion

Examine the Moon Chart that you made in Workshop 1. In your observations of the Moon thus far, have you gathered any data that supports or challenges the information on the Moon Ideas list? Share and discuss your information, and update the chart.

Have you or your colleagues developed any new questions that you can add to the Moon Questions list? Consider where these questions came from. What, specifically, inspired the questions?

Now that you have thought about your own questions, think about your students. Where do you think they get their questions?

10 minutes— Concept Map Discussion

Have you ever used concept mapping in your classroom? How have you used concept maps (i.e., for what purpose)? What kinds of things have your students mapped?

Remember to update the Moon and Learning Charts.

WATCH THE WORKSHOP VIDEO

60 minutes

GOING FURTHER

30 minutes

30 minutes—Making Concept Maps

In pairs, have one person construct a concept map about **teaching** while the other person makes one about **learning**. After you have made the two concept maps, compare them. What are the similarities? The differences? Did the word "teach" appear in the **learning** concept map? Did "learn" appear in the **teaching** map? How do you believe teaching and learning should be connected?

Save your concept map—you will need it again in Workshop 8.

Note: You can assess your students' prior knowledge of a particular topic by having them make concept maps before you prepare and introduce the lesson on that topic. You might have them make concept maps again at the end of the lesson, and compare the before and after maps to see what they've learned.

For next time

HOMEWORK ASSIGNMENT

Using the materials of your choice, make two pendulums (e.g., hand-held, taped to a table edge, free-standing) with the following specifications:

Pendulum 1: a period of 15 swings in 10 seconds
Pendulum 2: a period of 30 swings in 30 seconds

! Please bring your pendulums with you to Workshop 4.

READING ASSIGNMENT

In preparation for Workshop 4, please read "Assessing 'Imperfect' Conceptions" by Hubert Dyasi. (All readings are included in the Appendix.)

MOON JOURNAL

Here are more suggestions for your Moon Journal:

Does the Moon's position change over time?

If you want to record the Moon's exact position in the sky in your journal, what information do you need?

Where do you predict the Moon will be positioned in the sky tomorrow night during your regular observing time? One week from now?

Suggested activity

Measuring the Elevation of the Moon

One piece of information helpful in describing the Moon's position is its height in angles (angular height) above the horizon. The horizon is the line along which the sky and land—or sea—appear to meet. You can determine the Moon's height above the horizon if you know the angle between the line from your eyes to the Moon and the line from your eyes to a point on the horizon directly below the Moon.

MEASURING WITH FISTS

You can estimate the Moon's angular height by simply using your hands. Stretch one arm out straight and make a fist with the hand on your outstretched arm. From the horizon to the highest point in the sky is one quarter of a circle or 90 degrees. If you measure with fists, putting one fist on top of the other, nine fists will about equal this angle—one (adult) fist is roughly the same as 10 degrees.

To measure the angular height of the Moon at any given time, stretch one arm out straight and make a fist with the hand on your outstretched arm. Close one eye and adjust your sight so the outstretched fist is aligned with the horizon. Make a fist with your other hand and stack it on top of the first. Continue stacking your fists, one on top of the other, until the Moon appears to be covered by one of the fists. The number of fists you stacked indicates the angular height of the Moon. For example, if you counted six fists, the angular height of the Moon above the horizon would be approximately 60 degrees.

MEASURING WITH A CLINOMETER

A clinometer is a tool that can help you to measure the angular height of the Moon more accurately than with your fists.

MATERIALS:

Protractor template (p. 29)
Cardstock
Paste or glue
Drinking straw
Clear tape
Scissors
30 cm fishing line or kite string
Metal washer or weight with hole
Tack or pin

BUILDING A CLINOMETER

1. Adhere the protractor template to a piece of cardstock and cut along the dotted lines.
2. Center the straw lengthwise along the edge of the template directly above the straight side of the protractor. Secure it in this position with tape.
3. At the point where the protractor's center line (0 degrees) meets with the line that runs parallel to the straw, use a tack or pin to make a hole.
4. Thread one end of the fishing line or kite string through the hole so that approximately 2 cm extends out the back side of the protractor. Secure this portion of string to the back side of the protractor.
5. Tie the metal washer to the opposite end of the fishing line or kite string. The string and washer should swing freely along the front side of the protractor.

USING A CLINOMETER

1. Position the Clinometer straw-side up so the straw is parallel to the ground and the string hangs parallel to the 0 degree marking on the protractor.
2. Look through the straw and adjust the position of the Clinometer until you sight the horizon directly below the Moon (while keeping the straw parallel to the ground).
3. While looking through the straw, tip the entire Clinometer upward until you can sight the Moon through the straw.
4. As you move the Clinometer, the string moves along the protractor. By noting the position of the string along the protractor, you can determine how many degrees you are tipping the Clinometer to sight the Moon. This measurement is the angular height of the Moon.

EXTENSIONS

To measure the height of an object that makes a right angle with the land, such as a tree or a building, sight the top of the object through your clinometer and walk towards the object until the clinometer measures 45 degrees. By mentally tracking from your observation point to the base of the object to the top of the object and back to your observation point, you will make an isosceles triangle. Given that two sides of an isosceles triangle are equal, you can determine that the distance from the observation point to the object itself will be equal to the height of the object.

Adapted from:

Coyle, H.P., Gregory, B., Luzader, W.M., Sadler, P.M., & Shapiro, I.I. (1993). *Project STAR: The universe in your hands.* Kendall/Hunt Publishing Co.: Dubuque, Iowa.

Education Development Center, Inc. (1968). *Where is the moon?* Webster Division, McGraw-Hill Book Co.: New York.

PROTRACTOR TEMPLATE