

INVESTIGATING EARTH SYSTEMS

TEACHER WORKSHOP MANUAL



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Investigating Earth Systems Introduction

Introduction

Investigating Earth Systems (IES) is a middle school earth science curriculum project developed by the American Geological Institute, in association with It's About Time Publishing. The nine IES modules were developed from the National Science Education Standards. In addition, they correlate to the American Association for the Advancement of Science's *Benchmarks for Science Literacy*. The modules promote inquiry-based approaches to science learning in which students actively investigate the natural world around them.

Goals of IES

The purpose of IES is to provide inquiry-based modules that will help teachers enhance their students' understanding of key earth science concepts and inquiry. IES can serve as the basis of a middle school earth science curriculum. Alternatively, it can be used in integrated science curricula, in conjunction with life science and physical science modules. The major objectives of the IES program are to help students:

- Learn the principles and practices of Earth science.
- Question, hypothesize, experiment, reflect, and analyze.
- Develop an understanding of how the Earth works as a set of systems.
- Appreciate the relevance of earth science to their lives and the environment.
- Work collaboratively with other students to solve problems.

Philosophy of Training

The principles underlying the IES program also underlie an IES workshop. In other words, an IES workshop should be:

- Learner centered. The specific needs and interests of the learner should have a significant effect on instruction,
- Reliant on earth systems science for the explanations of earth science phenomena. It should be designed to make prominent the interactions among earth systems: the biosphere, the geosphere, the hydrosphere, and the atmosphere.
- Geared toward community relevance. Concepts, practices, and/or issues should relate to the specific site from which the participants come.

- Active and inquiry-based. Participants should be directly engaged in doing activities and taking part in inquiry as part of the learning process.

For the workshop to be learner centered, workshop facilitators should learn about the specific needs and interests of the participants and consider how the content of the workshop relates to the settings in which the participants teach. Workshop facilitators will need to learn about where the participants come from, and try to acquire maps, agency addresses, and other information that will make it possible to begin making ties between the curriculum and those sites.

The overarching strategy for doing activities in workshops is not to lecture about the program, but to discuss important features of the program (using overheads) after participants complete a portion of an activity.

Workshop Planning

As a general rule for planning, consider completing the pre-assessment and one activity in a one-hour workshop, and completing the pre-assessment and 3-4 activities in a one-day workshop.

This training manual uses *Investigating Soil* to illustrate how to conduct IES presentations and workshops. In a one-hour presentation on *Investigating Soil*, you should be able to complete the pre-assessment and Investigation 1. In a one-day workshop, you should be able to complete the pre-assessment, Investigations 1 through 4, and part 4 of Investigation 5. You should briefly describe portions of any investigations that you are not having teachers do.

The old saying that “the devil is in the details” is generally true for any workshop. Below are some of the issues that you should be sure to check into:

- What materials are needed for activities? How will they get to the workshop site?
- If materials are being shipped, is it better to have the materials go to the workshop facilitator so they can be checked before the workshop? (Such as to the facilitators’ hotel.)
- Do some participants have specific dietary, mobility, or other needs? How can these be accommodated?
- Where will participants find parking? Are permits needed?
- Where are some suggested spots to eat evening meals that can be provided to participants from out of town?

- How should out of town participants get breakfast in time to be at the workshop on time?
- What form of transportation can be used from lodging to workshop site?
- What materials can workshop participants keep? What must be returned?
- What AV media will be needed for the workshop? Do presenters know how to use it? Where are extra bulbs and other backups?
- What kinds of activities will be done and what kinds of physical resources (sinks, windows, doors to outside) will be needed for those activities?
- Is the physical space large enough?
- Are there special tours and/or other events that are available for participants to take advantage of during their off hours?
- How can participants keep in touch with their homes and workplaces? Where can they find telephones? Where can they access e-mail?
- If participants would like to use computer resources, where are they available?

General Advice

- Go in prepared. Demonstrate respect for the group by planning ahead, and working your plan.
- Be open-minded about your approach or activity—if something isn’t working, acknowledge that and shift the plan.
- If you make mistakes, don’t gloss over them, but don’t dwell on them either—mistakes are part of any human system, and participants will generally understand.
- Avoid trying to entertain the group—spontaneous humor is genuinely appreciated, but forced humor can be seen as inappropriate, especially if it offends.
- Stay on time, especially at the end of the day. Stick to the schedule as much as possible, and tell (or, better, ask) the group if an alteration is needed so it does not seem careless.
- Get to know participants and their specific needs as much as possible. Acknowledge differences in background as a strength of the group and encourage participants to help each other.
- Don’t make the workshop “about” you—anecdotes are often more fun for the teller than the listener, and as much as possible attention should

be turned to the participants, their actions, and their attempts to do things.

- Remember that everything you do should be geared toward conveying specific messages—know your goals for the day and don't distract the participants through digressions.
- Pay attention to “off hours” when participants are traveling to the workshop site and are new to the area—consider how those individuals might want to spend time. Collect information about local sites and help participants make connections with others with similar interests so that off hours are enjoyable.
- Be enthusiastic!

One-hour Presentation Using *Investigating Soil*

Materials needed

For the instructor:

- Overhead transparency sheets and overhead projector
- Soil sample in zip-lock bag

For each group of participants:

- Soil samples in zip lock bags (Investigations 1 and 2)
- Drinking straws, knives or tongue depressors (for probing soil)
- Water source
- Plastic cups, clear (2 or more)
- Hand lenses (2 or more)
- Newspaper or paper towels to cover the work area

Procedure

**Have the IES logo transparency on the overhead projector as participants arrive.
See Presentation Notes page 1.**

1. Pre-assessment

- Show a soil sample and ask participants to share their thoughts

Questions you might ask include, "What does soil feel like," "What is soil made of," "Is soil the same all over the Earth? Explain."

- Instruct participants to write answers to the pre-assessment questions

Pre-assessment questions are included in the Resources section of this manual. These same questions appear on the "Reflecting" page at the end of the student book, under the subheading "Back to the Beginning". Tell participants that the purpose of the Pre-assessment is to provide a baseline assessment of student knowledge. This can be compared with later answers, as a measure of student progress.

- Hold a review session, recording participant responses

Build two lists, one for "ideas we have about soil," and one for "questions we have about soil". List participants' ideas as they give them, without alteration. Record these ideas on an overhead transparency, flip chart, chalkboard, or dry-erase board.

- Distribute handouts (from the back of this manual):

- Student Ratings and Self-Evaluation
- Earth System Connection Sheet

- Checkpoint Form

Introduce Investigating Earth Systems. See Presentation Notes pages 2-5.

2. Investigation 1

- Introduce the Key Question, "What can you investigate about soil?"

Solicit participant responses, recording them on an overhead transparency. Solicit new questions that participants have about soil. Tell participants that, although this repeats some of the pre-assessment, in a classroom this activity would serve as both a review of the pre-assessment and an introduction to the upcoming investigation.

- Distribute soil samples

Participants will record observations using all their senses. Ask participants how they intend to record their results. As you circulate, inquire as to what kinds of data they are collecting (visual, tactile, etc.) and how they are recording it. Of course, the intent here is to model teacher behavior, not interrogate the participants! Suggest methods of recording observations, such as a table with columns for each of the senses.

- Re-visit soil questions and select one for further investigation

Instruct groups to discuss their observations and revisit their earlier questions. Instruct them to choose a question for further investigation. Remind them that it must be a question they can answer given the constraints of time, space and materials.

- Conduct the investigation

Circulate, observe, and interact with the participants. Ask questions about their inquiry processes, i.e. What is their question? What do they predict? How will they test their prediction?

- Discuss findings

Ask participants to share the question they investigated, their results, and any new question they want to investigate.

- Briefly discuss Investigations 2-7

Discuss the flow of a typical IES module. Additionally, you will want to discuss assessment in IES and the scope of the project (the different modules). See Presentation Notes pages 5-13.

One-day Workshop Using *Investigating Soil*

Materials Needed

For the instructor:

- Overhead transparency sheets and overhead projector
- Soil sample in zip lock bag

For each group of participants:

- Soil samples in zip lock bags (Investigations 1 and 2)
- Additional soil samples (Investigation 3)
- Access to location for taking core samples of soil (Investigation 4)
- Map of sampling area where core samples will be taken
- Water source
- Plastic cups, clear (2 or more)
- Hand lenses (2 or more)
- Newspaper or paper towels to cover the work area
- Plastic strainer (spaghetti colanders work well)
- Kitchen sieve
- Spoon
- Hand lens
- 3 large mixing bowls
- 4 squares of white poster board
- Access to a sink or water supply
- Wooden block
- Hammer
- 1" Heavy Duty PVC pipe (the piece should be about 10" in length)
- Wooden dowel piece that is longer than the PVC, but that fits inside it
- Drinking straws, knives, or tongue depressors (for probing soil)
- pH soil test kit

For each participant:

- Copy or photocopy of module (Note: these cannot be given to participants to take home without written permission of It's About Time Publishing)

Procedure

Project IES logo as participants arrive. See Presentation Notes page 1.

1. Pre-assessment

- Show a soil sample and ask participants to share their thoughts

Questions you might ask include, "What does soil feel like," "What is soil made of," "Is soil the same all over the Earth? Explain."

- Instruct participants to write answers to the pre-assessment questions

The questions are included in the Resources section of this manual. These same questions appear on the "Reflecting" page at the end of the student book, under the subheading "Back to the Beginning". Tell participants that the purpose of the Pre-assessment is to provide a baseline assessment of student knowledge. This can be compared with later answers, as a measure of student progress.

- Hold a review session, recording participant responses

Build two lists, one for "ideas we have about soil," and one for "questions we have about soil". List participants' ideas as they give them, without alteration. Record these ideas on an overhead transparency, flip chart, chalkboard, or dry-erase board.

- Distribute the following handouts (from the back of this manual):

- Student Ratings and Self-Evaluation
- Earth System Connection Sheet
- How to Make Maps
- Checkpoint Form

Additionally, you will need to distribute a copy of Investigating Soil. (Note: these cannot be given to participants to take home without written permission of It's About Time Publishing)

Introduce Investigating Earth Systems. See Presentation Notes pages 2-5.

2. Investigation 1

You will need to collect soil samples in advance of the workshop. Keep them in sealed plastic bags to retain soil moisture (water is part of soil!). Remember to focus on inquiry processes, especially question-forming and observing. As an introduction to the module, participants will examine soil using their senses.

- Introduce the Key Question, "What can you investigate about soil?"

Solicit participant responses, recording them on an overhead transparency. Solicit new questions. Tell participants that, although this repeats some of the Pre-assessment, in a classroom this activity would serve as both a review of the pre-assessment and an introduction to the upcoming investigation.

- Distribute soil samples

Participants will record observations using all their senses. Ask participants how they intend to record their results. As you circulate, inquire as to what kinds of data they are collecting (visual, tactile, etc.) and how they are recording it. Of course, the intent here is to model teacher behavior, not interrogate the participants! Suggest methods of recording observations, such as a table with columns for each of the senses.

- Re-visit soil questions and select one for further investigation

Instruct groups to discuss their observations and revisit their earlier questions. Instruct them to choose a question for further investigation. Remind them that it must be a question they can answer given the constraints of time, space and materials.

- Conduct the investigation

Circulate, observe, and interact with the participants. Ask questions about their inquiry processes, i.e. What is their question? What do they predict? How will they test their prediction?

- Discuss findings

Ask participants to share the question they investigated, their results, and any new question they want to investigate.

Discuss the structure of an IES Investigation, the Student Journal, and the Key Question. See Presentation Notes pages 6-8.

3. Investigation 2

Soil samples used in the first investigation can be used here – just make sure that the samples are “reassembled”. You may have to bring a large container of water if you are not holding the workshop in a science classroom. The goals of the activity include not only separating soil by passing it through air and water, but also predicting and using evidence.

- Introduce the Key Question, "How can soil be separated?"

This time, encourage active participation by choosing a member of the group to lead the discussion of the Key Question. Instruct the volunteer to copy participants' responses without altering them. Circulate among the participants, encouraging participation from less vocal members of the group.

- Introduce steps 1-2

Discuss the steps by reading through them with the participants. Ask for questions. If there are no questions, ask the group to tell you:

- *What to do if there are lumps in the soil*
- *What they should observe*
- *What they should record*

This mirrors what teachers might do in the classroom to check for their students' understanding. Explain why you check for understanding before moving to the investigation (i.e. it allows you to identify misconceptions, avoiding confusion and frustration).

- Circulate and observe as participants separate soil by passing it through air
- Discuss participants' predictions about how soil will move through water
Record participants' ideas on an overhead transparency.
- Circulate and observe as participants investigate
- Discuss predicted and observed outcomes of the experiment

Explain the next phase of the experiment, which will not be done. Students would be asked to predict the outcome if soil and water mixtures were allowed to sit out overnight. Students would then label their soil samples and place them in a secure location for later observation.

- Instruct participants to complete the handout "Student Ratings and Self-Evaluation"

Select numbers to represent the highest and lowest rating. These numbers go in the "Key" at the top of the page. Collect handouts. Inform participants

that this is one of many assessment tools in the teacher's edition of each IES module.

4. Investigation 3

For this investigation, each group will need the following materials:

- Newspaper or paper towels to cover the work area
- Plastic strainer (spaghetti colanders work well)
- Kitchen sieve
- Spoon
- Hand lens
- 3 large mixing bowls
- 4 squares of white posterboard
- Access to a sink or water supply
- Soil sample

- Begin with the Key Question, "How can soil be separated?"

Invite a volunteer to summarize participants' responses on an overhead transparency.

- Discuss the procedure for investigation 3

Invite 2 participant volunteers to come to the front for a demonstration. Have prepared the supplies needed for one group to perform the experiment. Place them on a table at the front. Stand at the back of the room. Instruct one of the seated participants to read the instructions for step 1. Volunteers then perform the step. Choose participants to read steps 2-6. The volunteers perform the steps, in abbreviated fashion.

- Discuss problems that participants might have with the procedure
- Instruct participants to begin the investigation
- Circulate and observe participants
- Read the Digging Deeper article for this investigation "Materials Found in Soil"

Read it aloud or distribute copies and read as a group. Explain that there is a reading at the end of each investigation. Explain the reason for this (i.e., the focus is on the investigation, which gives context and deeper meaning to the content in the readings). Explain also that there are background readings for teachers in the teacher's edition. These readings go into much more depth than student readings.

- Instruct participants to complete the Checkpoint forms during the break.

Break for Lunch**5. Investigation 4**

For this investigation, each group will need the following materials:

- 1" Heavy Duty PVC pipe (about 10" long)
- Wooden dowel (longer than the PVC pipe, but thin enough to fit snugly inside it)
- Access to a site where core soil samples can be taken
- Map of sampling area (see the appendix for instructions on how to make a map of any site in the U.S.)

Note: If you think it will be difficult or too time-consuming to collect samples during the workshop, collect the soil cores ahead of time, bag each core sample, and transport them to the workshop. Bring one section of PVC pipe and the wooden dowel to show how you collected and extruded the samples. Bring the map to show where you collected the samples.

Discuss inquiry in IES. See Presentation Notes pages 9-10.

- Discuss responses to Checkpoint forms. Ask for additional feedback from the participants.
- Collect soil core samples, or distribute pre-collected samples
- Distribute maps of the local sampling area (for instructions on how to make a map of the local area, see the Resources section at the back of this manual).

Record sampling areas on the map.

- Analyze soil core samples

Emphasize observing and collecting data as you circulate among the participants.

- Discuss each group's results

Record their data in the form of a chart. Project these data on the overhead projector.

- Instruct participants to make soil maps of the local area, using the class's data.
- When the maps have been completed, discuss what additional data could be included in the map.
- Discuss Investigation 5, parts 1-3

6. Investigation 5, part 4

For this investigation, each group will need the following materials:

Soil sample

Soil Testing Kit (pH only)

- Distribute soil test kits

Discuss directions for measuring pH.

- Instruct participants to complete steps 2-3
- Instruct participants to add this information to their soil maps.
- Explain that, in a classroom setting, students would test for nitrogen, phosphorous and potassium as well.
- Discuss Investigations 6 and 7.

Discuss the Earth System Connections Sheet (they should have received a copy of this already). Also, discuss using the final investigation as assessment. See Presentation Notes pages 11-13.

Questions?

Resources

Pre-assessment questions

What is soil, and what is it made of?

How is soil formed and how does it wear away?

Why is soil important, and why is it important to know about soil?

What questions do you have about soil?

IES web site

- AGI's IES web site <www.agiweb.org/ies/> is a good source for additional readings to accompany each Investigation.

How to make maps

- The IES Soils web site (www.agiweb.org/ies/) lists additional topographic map resources: www.agiweb.org/ies/soil.html#topo.
- The quickest and easiest way to make a map for your area is to visit <maps.yahoo.com/>. Just type in the street address, city and state. Click "Get Map". Click the button next to "Zoom in". Your map will look like the example below (Long Beach Polytechnic High School is marked with a star).



Aerial maps and topographic maps can be made at Microsoft's Terraserver page. Type in the name of the city you wish to locate where it says "Find a specific place". Topographic maps, aerial photos and even satellite photos can be found for virtually any city in the United States. Zoom in on topographic maps by clicking on the "+" symbol above the map. Scroll right, left, up, or down by clicking on the arrows.

Student Ratings and Self-Evaluation

Name: _____ Date: _____ Module: _____

Key:

Highest rating _____

Lowest rating _____

1. In the chart, rate each person in your group, including yourself.

Names of Group Members					
Quality of Work					
Quantity of Work					
Cooperativeness					
Other Comments					

2. What went well in your investigation?

3. If you could repeat the investigation, how would you change it?

Checkpoint Form

Time and date _____

Please write your comments regarding each of these areas in general and with respect to the past several hours in particular.

I. What is going well?

II. What could have gone better?

III. Where should we go from here?

IV. Other comments.

Please feel free to continue on the back.