MAIN MENU

LESSON DIRECTORY

INQUIRY ICEBREAKER: AN ICE EXPERIENCE

PHOTO GALLERY

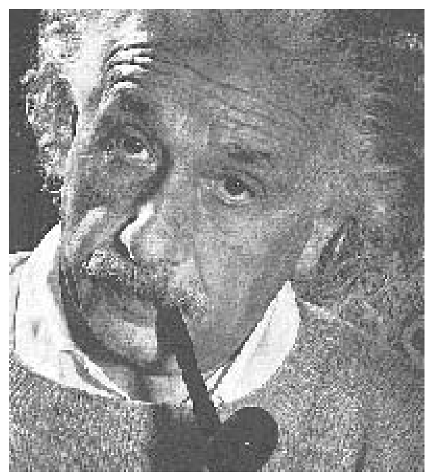
This lesson invites young students to share ice experience stories, to explore the phenomenon of ice, and to activate students' scientific inquiry about ice.

SCIENCE & LITERATURE

"All physical theories, their mathematical expression notwithstanding, ought to lend themselves to so simple a description that even a child could understand."

—Albert Einstein,
Calaprice, Alice, ed. (2000).
The Expanded Quotable Einstein.
Princeton: Princeton University Press, p. 261

Einstein had a gift for expressing complex ideas simply. Young children's minds are rapidly expanding and naturally inquisitive. By listening to and learning from their questions, we can guide them toward precursor understanding, heading them on a life-long learning trajectory toward the world of science. Just as Albert Einstein asked questions as a child and imagined answers that matured as he continued to inquire throughout his life, so this is an inquiry icebreaker designed to evoke children's questions about ice, so that they may begin a journey of thinking like a scientist.



CONCEPT OVERVIEW

This lesson invites young students to share ice experience stories, to explore the phenomenon of ice, and to activate students' scientific inquiry about ice.

Scientists ask questions about the unknown. Children ask questions as well. The questions children ask reflect the same fundamental curiosity that drives scientists' questions. The difference is that scientists activate an inquiry process by applying the tools of scientific inquiry to seek answers. This lesson moves young students toward a precursor understanding of active scientific inquiry, as they explore the phenomenon of ice.

Concepts:

- Phenomenon.
- Nature of Science.
- Scientific Inquiry.

This Lesson Provides a Concrete Experience of:

- Sharing prior knowledge about a natural phenomenon: ice.
- Examining ice, asking questions and making observations about ice.
- Activating scientific inquiry about ice.

PRE K–GRADE 2 CONCEPTS

- Science begins in the encounter with a phenomenon in the world.
- Science questions arise from our own natural curiosity.
- Scientific descriptions of phenomena arise from our powers of observation.

GRADE 3–5 CONCEPTS

- Science begins in the encounter with a phenomenon in the world.
- Activating scientific inquiry occurs by asking questions and searching for answers.
- Thinking like a scientist includes proposing explanations and designing ways to test them out.

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LESSON SUMMARY & OBJECTIVES

This lesson is an inquiry icebreaker! The purpose of this lesson is to evoke the asking of science questions about the phenomenon of ice. This lesson guides young students to notice how their own curiosity and powers of observation are the precursors to: understanding what science is (The Nature of Science), thinking like a scientist (Scientific Inquiry) and doing science (The Scientific Enterprise).

Students Learn To:

- Act as colleagues in a community of science learners in the sharing of knowledge about a natural phenomenon
- Recognize science questions that emerge from their own experiences
- Notice that even though everyone examines the same phenomenon, each person asks different questions, observes different details, makes different speculations, and draws different conclusions—and that we use tools of scientific inquiry as a way to work through these differences

Objective 1: Notice that everyone has an ice experience to share.
Share a true-to-life ice experience of your own. Invite students to share true stories about personally relevant ice experiences in their own life. Then draw out science questions from these vividly shared memories about ice.

Objective 2: Notice that an encounter with a phenomenon creates experience.
Exploratory Zones set up the conditions for students to encounter the natural phenomenon of ice, which also creates a vivid ice experience: have students examine the look and feel of chunks of ice of various shapes and sizes, especially big chunks of ice.

Objective 3: Notice that generating questions activates scientific inquiry.
Thinking like a scientist begins with asking questions based on prior and present experiences. Questions help frame our thinking around how we might use scientific methods in the search for answers.

This lesson initiates the inquiry process about the phenomenon of ice. Students are encouraged to draw upon their prior knowledge and their present experience of ice to ask questions. This icebreaker connects to the other lessons in the collection, which are designed to anticipate the likely range of student-generated questions and to activate scientific inquiry to further explore the science relevant questions that emerge.

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STANDARDS

PROJECT 2061 BENCHMARKS

1B—The Nature of Science: Scientific Inquiry

GRADES K–2, PAGE 10

- People can often learn about things around them by just observing those things carefully, but sometimes they can learn more by doing something to the things and noting what happens.

GRADE 3–5 PAGE 11

- Scientific investigations may take many different forms, including observing what things are like or what is happening somewhere, collecting specimens for analysis, and doing experiments. Investigations can focus on physical, biological, and social questions.

NSES:

Content Standard A Science as Inquiry: Abilities Necessary to do Scientific Inquiry

GRADES K–4, PAGE 122

- Ask a question about objects, organisms, and events in the environment. This aspect of the standard emphasizes students asking questions that they can answer with scientific knowledge, combined with their own observations. Students should answer their questions by seeking information from reliable sources of scientific information and from their own observations and investigations.
- Plan and conduct a simple investigation. In the earliest years, investigations are largely based on systematic observations. As students develop, they may design and conduct simple experiments to answer questions. The idea of a fair test is possible for many students to consider by fourth grade.

Content Standard A Scientific Inquiry: Understanding About Scientific Inquiry

GRADES K–4, PAGE 123

- Scientists use different kinds of investigations depending on the questions they are trying to answer. Types of investigations include describing objects, events, and organisms, classifying them and doing a fair test (experimenting).

Content Standard A Science as Inquiry: Abilities Necessary to do Scientific Inquiry

GRADES 5–8, PAGE 145

- Design and conduct a scientific investigation. Students should develop general abilities, such as systematic observation, making accurate measurements, and identifying and controlling variables. They should also develop the ability to clarify their ideas that are influencing and guiding the inquiry, and to understand how those ideas compare with current scientific knowledge. Students can learn to formulate questions, design investigations, execute investigations, interpret data, use evidence to generate explanations, propose alternative explanations, and critique explanations and procedures.

Content Standard A Scientific Inquiry: Understanding About Scientific Inquiry

GRADES K–4, PAGE 148

- Different kinds of questions suggest different kinds of scientific investigations. Some investigations involve observing and describing objects, organisms, or events, some involve collecting specimens; some involve experiments; some involve seeking more information, some involve discovery of new objects and phenomena; and some involve making models.

Initial Set-Up of Dynamic Science Journals

Science journals are a means of keeping a record of thoughts and ideas on an inquiry journey. A journal can be created out of any convenient kind of notebook or loose-leaf collection of paper.

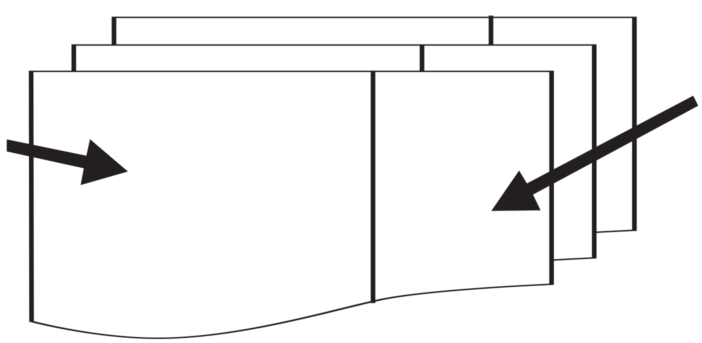
You can make a special event of it by preparing journals ahead of time by leaving the first 3–5 pages blank for a future table of contents, and then preparing the first few pages according to any note-taking system you think would be best for your students. There are many note-taking systems, such as Cornell Notes. The set-up suggested here places a main entry area on the inner 2/3 of each page, and an area for reflection on the outer 1/3 of the page.

Introduce Science Journals:

- Pass new science journals out to students. Let them know that they will be using their science journals often, and that from time to time, they will learn more about how to set-up and use them, starting now.
- Ask students to leave the first 3–5 pages blank, in order to leave space for a future table of contents and other introductory thoughts to be added later.
- Ask students to notice that the next several pages have already been set up in advance:

  Pages numbered using both sides of the pages; let students know that this pattern of numbering pages should be continued as they use their science journal;

  Also notice that a line drawn from top to bottom divides each page into two parts: an inner main entry area, 2/3 of the page for main notes, drawings, charts, and observation data; and an outer margin area, 1/3 page for reflections and thoughts related to the main entries.
- Let students know that the science journal is where they should get into the habit of keeping track of their own thoughts, ideas, observations, questions, drawings, charts, and notes — everything related to science, and that their success will be enhanced by well-kept journals. Let students know that they should keep their science journals handy, whenever and wherever they might be on a science journey.



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ESSENTIAL QUESTION

How Can Our Own Questions Guide Us Toward Scientific Inquiry?

How does our curiosity get us wondering? How do our questions affect our observations? Which came first, the question or the observation? How do we use words and pictures to describe our observations and search for answers to our questions? How do we test out our ideas?

ACTIVITY QUESTION

How do We Learn to Think Like a Scientist from an Encounter with the Natural Phenomenon of Ice?

What can we understand about ice by considering our own prior and present ice experiences, sharing stories, making fresh observations, and asking questions? What science questions can we draw out of our own ice experiences? What can we say, draw, or write about an ice experience in our own life? What can we say, draw, write about ice that we look at, touch and examine in class?

BACKGROUND

Science begins with asking questions for which we do not have an answer about phenomena we encounter in the world. What do we do when we don't have a scientific word for something? We invent a new scientific word! Invite students to have fun with the word "phenomenon."

- The word **phenomenon** or plural, **phenomena**, comes from the ancient Greek word for something that appears to the senses, used by scientists to mean **an observable event**.

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ACT OUT THE SCIENCE

Whole Group Participatory Activity using Movement Integration Mediating Experience, the MIME Approach:
For a more in-depth discussion of the mime approach click here.

As you tell the story, invite students to participate as characters playing out the parts. In this story, the "characters" may be different words or different actions for which words need to be invented.

Note: Words like "whatchamacallit," "thingamabob," or "happenstance," might serve as prompts, if needed. As students invent their own words, write them on the board or flip chart—later on, refer to the student-invented words as alternatives to the word "phenomenon." Later on in the lesson, wherever the words phenomenon or phenomena come up, have fun with them and freely use the student-invented words in context—the idea is to demystify and to encourage the use of science terminology.

The Story of the Phenomenabob

Narrative	Movement	Concept
Many of the words in the English language originated in ancient Greece: words like telephone, telescope, astronomy, microscope, and biology. Ancient Greeks were very interested in science, just like we are.	Refer to a map or the globe to indicate where Greece is; invite students to invent gestures for each word: talk on a cell phone; look through a telescope; motion toward the stars; look through a microscope; show actions of all sorts of living things…	The history of language and the influence of Greek in the English language, particularly in the arena of science.
Have you ever had an experience that you don't have a word for? Have you ever seen something that you don't have a word to call it? Well, a long time ago, among the ancient Greeks, they wanted a new scientific word for "something you experience but don't have a word for" or for "something that happens and appears to you, but that you don't have a word for."		As new phenomena are encountered, new words are often invented.
When they saw something new or saw something happen that made them wonder—they didn't have a word for it, so they had to invent a new word. Have you ever invented a new word?		Words like "whatchamacallit," "thingamabob," or "happenstance," might serve as prompts, if needed.
Before I tell you the word they invented, and that scientists still use today, I wonder…what word would YOU invent to call a "something" or a "something that happens" that you don't have a word for?	As students invent their own words, write them on the board or flip chart	Create a context of meaning: later on, refer to the student—invented words as alternatives to the word "phenomenon."

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Scientists think creatively and make up words all the time, just like you. Are you ready for the word that the ancient Greeks came up with that scientists still use today?		Draw a comparison between scientists and students.
When something's happening that's new or unknown and there's no word for it—because it's unknown, scientists call it a **phenomenon** or if there's more than one, **phenomena**. An easy way to remember it is to put your finger up touching your lips as you say **phenomenomenon** or **phenomenomenomena**.	Have students place their forefingers over their lips, and let them burble the words **phenomenomenon** and **phenomenomenomena**.	
Now we have a scientific word we can use to ask about things that we see happen and want to know more about. So today we are going to explore some **phenomenomenomena** of ice experiences.		Wherever the words phenomenon or phenomena come up, have fun with them and freely use the student—invented words in context—the idea is to demystify and to encourage the use of science terminology.

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Optional Small Group Activity: Movement Integration Mediating Experience
Invite students to form small groups (about three to five students), to create their own mime and narrated story about a phenomenon that needs an invented word. Encourage students to act out a sequence that connects the event to the science concept. As one student tells the story, the other students act it out.

MATERIALS

In this activity, students examine larger chunks of ice than they usually get a chance to experience, whether home-frozen ice in a variety of containers or block ice from the local ice company.

For All Lessons, to Record Reflections, Observations, Calculations, etc.

- Science Notebooks: writing and drawing utensils.

Main Activity

- One or more 10, 20, or 25-pound blocks of ice or homemade chunks of ice.
- A matching amount of ice cubes.
- Plastic trays large enough to display ice and hold meltwater.
- Enough clear plastic cups for each child to observe ice cubes melting.
- Work gloves, to handle the ice safely.

Science Instruments

- Magnifying lenses.
- Light sources.
- Thermometers or digital temperature sensors.

DEMONSTRATION

Tell a brief ice experience story from your own life and/or select a story to read that has a vivid ice experience as part of the story. Consider telling the story in such a way that invites students to act it out along the way.

PRE K–2

Your ice experience story might include personal encounter with ice, such as,

I put an ice cube in my soda pop and I heard the ice crack…

I once licked a frozen metal pole and my tongue got stuck…

I saw an ice storm when I was growing up in Chicago…

I visited a glacier with scientists in Antarctica…

Every winter we would go ice-skating on the frozen lake…

Refer to the story as “an ice experience” and “an experience of the phenomenon of ice.” Model the asking of science questions that emerge from the story, such as: *Why does the ice cube make a cracking sound? Why did my tongue get stuck on that frozen pole? How does ice stick onto the trees in an ice storm? How does a glacier form? How hard is ice?* Encourage the students to ask questions about the ice phenomena related in the story. This leads into the warm-up activity of having the students record and share their own ice experiences.

3–5

Create an opportunity for open-ended discussion about ice in the world. Pose the question, “Where in the world do we find ice phenomena?” List responses on the board or a flip chart. How can we categorize the responses? Countries? Climates? Seasons? Elevations? Ecosystems? Temperature Zones? “Why do we find ice phenomena in those places and times?” List the reasons proposed.

With all that recently in mind, but without closure, introduce the notion of an ice experience—a moment in one's life in which ice phenomena played a meaningful part. Share an ice experience story of your own. Encourage the students to draw science questions from the shared experience. This leads into the warm-up activity of having students record and share their own ice experiences.

MAIN ACTIVITY

PREPARATION

Getting the Ice

Call around town to locate an ice company that provides 10, 20, or 25 pound blocks of ice for a reasonable cost or gain access to large freezer space to make your own block of ice. The idea is to have on hand several relatively large chunks of ice that evoke the natural fascination that children have for big chunks of ice. You can make your own big chunks of ice by using a variety of flexible containers in a relatively empty freezer. Having a variety of chunks of ice helps students notice that although ice is ice, there are many different details to observe. In a plastic tray, a large chunk of ice can be set in a bed of ice cubes so that it doesn't slide around.

Presenting the Ice

Create a dramatic way of presenting and revealing the presence of the ice as a way to focus attention and generate interest. Even simply covering the ice with a cloth and then revealing it at the "right" moment can work. Consider telling or reading an ice-related story or singing an ice song to start things off. The idea is to create the setting that results in students attaining an ice vivencia, a vividly remembered ice experience, in this case a classroom learning experience that they will remember for life.

Setting up the Exploratory Zones

The purpose of mentioning such a rich range of ways to set up for observing is to provide flexibility. The most important thing is to provide a way for all children to express their own experiences and observations—and to record them for future reference and for assessment purposes. This is also the sort of activity that lends itself to inviting parent participation, to share their ice experiences, to help focus attention, and to help record student stories, questions, and observations.

From among these suggestions, select a practical way in your situation, for all students to be involved in a direct encounter with ice phenomena:

OPTION 1:

A central area is set up for viewing ice samples. Small group teams take turns coming up to generate questions and make fresh observations. Set up a flip chart for students to record questions, observations, and speculations.

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OPTION 2:

Several areas are set up around the room for small groups to travel around to ask questions and make observations. Each zone has a different experience of the phenomenon of ice, such as:

- A large block of ice, with light sources and magnifying lenses to look closely.
- Small chunks of ice, some frozen from mixtures of salt, etc.
- Pictures of a variety of types of ice: sea ice, glacial ice, snow.
- Images of ice in the Solar System: Mars polar regions, Europa, the Rings of Saturn, Pluto/Charon, comets, any of the moons of the outer planets.
- A USB microscope (Proscope) hooked up to a computer showing a live magnified image of the ice.

OPTION 3:

In addition to a central area, have enough ice samples (ice cubes) for each individual, table, or team, so that everyone is observing, and each individual or small group has a chance to observe the largest chunks of ice.

Suggested science instruments:

- A collection of flashlights, laser pens, etc. allow students to illuminate the ice and view features more clearly.
- Magnifying lenses add to the ability to see more details.
- USB Microscopes that connect to computers and can produce magnified images on the computer screen to add another dimension.

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TEACHING TIPS

Note: These Teaching Tips are keyed to the phases of the ED^{3}U Science Teaching for Conceptual Change Model. For further background about this teaching model, click here.

This lesson is intended to be an open-ended experience of observing and asking questions about ice, a preliminary to this collection of lessons. The range of emergent questions should lead to the rest of the lessons.

Explore

Focusing attention on personal ice experiences that can be evoked by memory validates the experience of each student as well as builds fundamental skills involved in doing science, such as generating questions, proposing explanations, gathering and organizing data, and devising ways to test out ideas. Following up with a direct encounter with the phenomenon of ice creates an opportunity to teach toward inquiry.

For children in northern, wintry climates, ice experiences are more common and accessible than for children in southern, warmer climates. Encourage children to include any ice experience that may come to mind as a possible vivencia. The idea here is to bring out a wide range of ice experiences that can become the basis of shared meanings about ice.

Diagnose

Listen to the range of student ice experiences, questions, and observations. These acts of expression reveal the nature of students' personal conceptions about ice. In this exploratory context, you can detect the presence of precursor understandings and potential misconceptions. This entire lesson is designed to provide a great deal of diagnostic information about students' prior knowledge and emerging conceptions that can be used to guide further exploration and inquiry. Student-generated questions can help you decide which lesson to explore next. You can select from your repertoire of instructional strategies.

This lesson is not designed to answer questions, but to generate questions that lead to further investigation. It provides a powerful way to bring out both prior experiences (in the context of the ice vivencias) and emerging conceptions (that arise in the context of the lesson). This becomes a diagnostic tool for the teacher in planning the scope and sequence of lessons to follow. The observations and questions that emerge from this activity lead directly to the other topics within this collection.

Design

Generating questions and framing ways to approach getting answers to those questions is fundamental to the science process. This lesson emphasizes posing questions that lead to further exploration. You are able to make instructional decisions about what to explore next based the activated curiosity expressed by the students.

Discuss

From the realm of personal experience based on memory and the classroom experience of a direct encounter with ice, we enter the discourse of science, and establish for young children a personal context of meaning related to the world of science. Explore with students how a science question is distinguished from other kinds of questions.

Use

Whether through the concrete expression of drawing, writing, storyboarding, or acting it out, the act of evoking an ice experience, and sharing it with the group-prepares students for the next step: drawing science questions out of life experience and the encounters with phenomena in the world around them. Science is in their midst, everyday, everywhere.

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WARM-UP AND PRE-ASSESSMENT

Vivencia: Evoking a Memory of Ice

STEP 1:

Invite the students to share an ice experience from their own life.

Instructions for students: Consider an ice experience from your life. Vivencia is a wonderful Spanish word used by poets to describe a vividly remembered experience in which the details are as fresh and as tangible as the living moments from which the memories arose. Can you recall an ice vivencia? Perhaps the sheer beauty of ice or the utter strangeness or the refreshing coldness or the blocky hardness or the sudden slipperiness or…the icy iciness has frozen a memory of a moment in your life when you encountered the phenomenon of ice.

STEP 2:

Invite students to write and/or draw their vivencia. Provide assistance to record ideas where necessary.

Instructions for students: Take a moment with pen or pencil and your science notebook right now. Write and illustrate an ice experience, a vivencia from your life. Take the time to bring it so clearly into your mind that it is as if you were really there again! By taking the time to observe and record your own ice experience, you have taken the first step to enter a community of science learners. …Ready! …Set! …QuickWrite and/or QuickDraw your Vivencia!

STEP 3:

Invite students to share their ice stories with each other. Introduce the notion of literary science circle. Circulate among the students, listening in.

Find a group of colleagues (other students) nearby.

- The science community is composed of people interested in asking questions and framing ways to explore for understanding, searching for answers. An important part of the process is to consider fellow scientists as "colleagues"—people gathered together in league around a common goal, in this case to ask questions and to construct new knowledge. The notion of being colleagues includes having mutual respect, even as we may differ in our opinions and approaches to inquiry.

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This table is intended to provide a context of meaning for each of the tasks:

Task	Guiding Questions
1. Evoke memories of an ice experience, an event in one's own life in which ice played a major part.	■ Where you were? ■ How old you were? ■ Who else was with you? ■ What happened? ■ How can you describe the ice experience in your own words?
2. Create a vivencia, the notion of expressing or re-enacting an event or experience in vivid detail.	■ How do you picture the surroundings? ■ How can you make tangible the objects? ■ How can you express the action so that it unfolds like a movie? ■ How can you describe the details of the ice and the surroundings?
QuickDraw means to sketch the vivencia in a single picture or in a storyboard (a sequence of events), without worrying about it being a perfect picture; sketch quickly to get the ideas down on paper.	■ What was around you? ■ What changes took place? ■ Where are you in the picture? ■ Where is the ice in the picture? ■ What shapes will help show the action?
QuickWrite means to write a description of the ice experience in a way that it comes to life when you read it aloud, but without worrying about it being perfect; write quickly to get the ideas down on paper; or tell it to a colleague and have them write your words down.	■ How can you write it like you might tell it out loud? ■ What words can you use to describe the ice and the surroundings? ■ How can you use picturesque words to make the action come to life?
3. Share ice experience stories, this can help everyone learn about ice; each person's vivencia can add to everyone's knowledge about ice.	■ Tell or read aloud an ice experience to one of your colleagues or to a small group. ■ Listen to each other's experiences. ■ Compare and contrast the ice experiences that you hear about. ■ Listen for details. ■ Ask questions that go into more details or explain something more clearly.
4. Select a vivencia and act it out as a dramatic re-enactment.	■ Share the vivencia as if it were a play or a movie. ■ Use MIME to act out the meaning as the story is read.

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Form a literary science circle where each one of you will read, tell, show, or otherwise share your vivencia with your colleagues.

- Scientists must communicate effectively with each other as well as with the larger community. Referring to the circle as a "literary science circle" is to emphasize not only the reasoning patterns required of science, but also the importance of clear expression of ideas.

STEP 4:
Invite students to recommend stories to share with the whole group. Select two or three, or more, as time permits.

Some of you may have heard some ice stories you think everyone should hear about. I heard some really great ice stories, too. Who has a recommendation for a story we should all hear?

Optional Small Group Participatory Activity using: Movement Integration Mediating Experience, the MIME Approach

Invite students to form small groups (about three to five students), to create their own mime and narrated story about their ice experience. Encourage students to act out a sequence that connects the event to the science concept.

PROCEDURES

Ice Encounter: Evoke Questions & Observations

PART 1:

Have students look at, touch, and otherwise examine ice samples.

This table lists a range of typical student observations that emerge from various ways of exploring the phenomenon of ice.

Observations	Measurements
a. Clear areas b. Cloudy areas c. Bubbles d. Cracks e. Smooth f. Rough	Just looking: qualitative, descriptive
a. Features within ice become more clearly visible b. Cracks c. Bubbles	Shining a light source on the ice: qualitative, descriptive
Details of features become more pronounced	Examining ice with magnifiers (magnifying lens, Proscope) qualitative, descriptive
a. Cold b. Hard c. Slippery d. Wet	Examining ice by touching ice qualitative, descriptive

PART 2:

Have students ask questions and make observations based on specific details of their encounters with ice. Devise a practical way to record the questions and observations (A teacher, a parent or an aide can listen to and write down, on a flip chart or the board, voiced questions of students or students could draw and write in their own science notebooks).

This table lists a range of likely questions that may arise in the course of exploring the phenomenon of ice. This list can be used as a guide to anticipate students' questions, to gauge students' personal conceptions, and to encourage students toward active inquiry.

Experience	Question
a. Just looking at ice samples	■ Why are there bubbles? ■ Why is it cloudy in some places and clear in others? ■ How do you make ice? ■ Why does ice melt? ■ What is ice made of? ■ Where does ice come from?
b. Examining ice with light source	■ What are those cracks? ■ What is that stuff in the ice (bubbles? dust? dirt?)
c. Examining ice with magnifiers	■ Why does the same ice look different in different parts?
d. Touching ice	■ How cold is ice? ■ How hard is ice? ■ How does ice get so slippery? ■ Why is it so wet?

PART 3:

Discuss the nature of questions and which kinds of questions can lead to further scientific exploration. Consider organizing students' questions in a way that serves as a graphic organizer and aligns questions to activities coming up. Match emerging questions to the other lessons in this collection.

a. Ask the science questions. Guide students to draw out the emergent science questions from the shared ice experiences.	■ After hearing or watching a shared ice experience, consider the science questions that arise from the stories. ■ Explore more to discover answers to the emerging questions.
b. Map the questions: Look at the range of questions that emerge from all the shared ice experiences; use this information to select which lesson to explore next.	■ Make list of the emerging science questions. ■ Consider what concepts are implied by the questions.

- All of the other lessons in this collection are designed to anticipate the likely range of questions that emerge from this lesson. You can use the student-generated questions to select related lessons. By taking the time to organize the student-generated questions into categories that are similar to the questions addressed in these lessons, you can create a sense of student-led inquiry.

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DISCUSSION & REFLECTION

What is Scientific Inquiry?

Scientists exhibit curiosity about phenomena in the world. Out of their own experiences and observations arise questions and possible explanations. How do scientists move from curiosity to research? The process includes things like:

- Posing questions.
- Observing, both enthusiastically and carefully.
- Recording observations in both writing and drawing.
- Making speculations.
- Proposing explanations.
- Designing ways to test whether an explanation works or not.
- Communicating results, reflections, implications, and findings.

A scientist needs the ability to express ideas at every step of the way. A scientist needs the skills of an artist and a writer to communicate science ideas.

How Do We Move From Hands-On Experience to Minds-On Understanding?

The direct encounter with ice creates a multi-sensory experience for the student, triggering many different questions and observations. Activated curiosity very quickly moves students into arenas that go beyond the immediate capabilities of the classroom: *Apprehension* is our concrete perceptual experience of the phenomenon; as distinguished from *Comprehension*, which is our abstract conceptual understanding of the phenomenon. Hands-on experiences give us the direct multi-sensory data that allows us to apprehend the ice and activates our curiosity to ask questions. The challenge is to draw students from the concrete experience toward the abstract conceptualization, from apprehension toward comprehension.

As our questions arise, we discover that we cannot get to all the answers in a hands-on way. For example, we cannot directly experience the molecular structure of ice (it is too small). We cannot, without a major field trip, directly experience the enormity of a glacier (it is too far away and too big). We can show a film or video, which provides stimulating visualization, yet students are only passively engaged.

We still need to provide a direct and participatory apprehensible connection. Stories and acting the stories out are means of creating such connections. For this reason, each of the lessons includes a lesson adaptation component, Act Out The Science that includes a storyline and a suggested way to invite participation that moves students *from apprehension toward comprehension of the phenomenon*.

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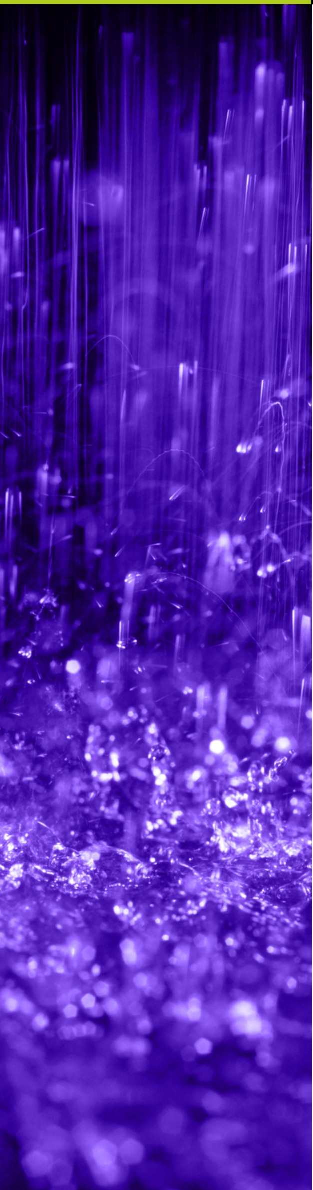
CURRICULUM CONNECTIONS

While our science focus is to draw out the science learning from these experiences and to create new knowledge about ice, watch for ways to build upon the language, visual, or kinesthetic learning potential. The vivencias that are captured in the student writing and drawing easily enters the world of literature, art, and the performing arts.

- Assemble a book of student ice experiences.
- Display a gallery of student ice drawings.
- Organize ice experience scenes into a play.



ASSESSMENT CRITERIA

Exemplary

- Students write and illustrate a personal ice experience and sharing it dynamically with both a small group and the whole group.
- Students identify and extend science questions drawn from ice experience stories.
- Students observe and record a rich range of observations about ice and relate it to prior shared experiences.
- Students ask a rich and extensive range of questions about ice, touching on most of the themes of exploring ice in the Solar System.

Emerging

- Students write and illustrate a personal ice experience and share it with both a small group and the whole group.
- Students ask a rich range of personally relevant questions about ice.
- Students identify basic science questions drawn from ice experience stories.
- Students observe and record a rich range of observations about ice.

Formative

- Students write and/or illustrate a personal ice experience and share it with a small group.
- Students identify basic science questions drawn out of ice experience stories.
- Students observe and record basic observations about ice.
- Students ask basic questions about ice.

RESOURCES

Children's Books About Ice

'Cocoa Ice', Diana Appelbaum,
Orchard Books, New York 1997
ISBN 0-531-30040-4

'Ice Age Mammoth: Will this Ancient Giant Come Back to Life?', Barbara Hehner,
Crown Pub 2001
ISBN: 0375813276

'Ice Storms and Hailstorms (Nature on the Rampage)', Duncan Scheff,
Raintree Steck-Vaughn Publishers 2001
ISBN: 0739847031

'Sea of Ice: The Story of the Endurance',
Monica Kulling,
Random House 1999
ASIN: 0375802134

'Ice Story: Shackelton's Lost Expedition',
Elizabeth Cody Kimmel,
Clarion Books 1999
ISBN 0395915244

'Ice Age Hunter', Giovanni Caselli,
Peter Bedrick Books 1992
ASIN: 0872261034

'Blizzards and Ice Storms', Maria Rosado,
Bt Bound 2000
ISBN 0613212339

'Water as a Solid', Helen Frost,
Pebble Press 2000
ISBN 0736804110

References

Calaprice, Alice, ed. (2000).
The Expanded Quotable Einstein.
Princeton: Princeton University Press, p. 261.

Images

Link to image gallery