Glaciers: Here Today, Gone Tomorrow?

Glacial Theory and Earth's Systems

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Grade Level	7th – 8th Grade	**Time Frame**	230 minutes
Subject	Science	**Duration**	4-5 class periods
Course	Environmental Science		

Essential Question

What is happening to modern-day glaciers?

Summary

In this lesson, students will create models to simulate glacial movement. Students then will compare and contrast real glaciers with their models, learn about glacial theory, and research modern-day glaciers to find out what is happening to them.

Snapshot

Engage

Students watch a clip from *Ice Age* and record their prior knowledge using the Tip of the Iceberg strategy.

Explore

Students use models to simulate glacial movement and determine flow rate. Students also view a time-lapse video of a real glacier flow over a 10-year period. Then, students create T-charts to compare and contrast their simulated glacial movement with a real glacier's movement.

Explain

Students learn new vocabulary when deconstructing what happened with their glacier models and examine how scientists study glaciers.

Extend

Students research a U.S. glacier and use this information in an "About & Obit" project. In the group presentation, students share what they learned about the glacier. In the individually written obituary, students write what they would say about the life and legacy of the glacier, should it meet its end.

Evaluate

Student groups share their presentations with the class. Students then use the Spend a Buck strategy to "donate" fake money to at least one organization listed in an obituary of their choice. Finally, students use their new knowledge to complete the Tip of the Iceberg handout from the beginning of the lesson.

Standards

ACT College and Career Readiness Standards - Science (6-12)

EMI301: Identify implications in a model
EMI404: Identify similarities and differences between models

Next Generation Science Standards (Grades 6, 7, 8)

MS-ESS2-1: Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.
MS-ESS2-2: Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.

Oklahoma Academic Standards (7th Grade)

7.ESS3.1 : Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.
7.ESS3.3.1: Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things.

Attachments

- Gak Recipe—Glaciers Here Today Gone Tomorrow - Spanish.docx
- Gak Recipe—Glaciers Here Today Gone Tomorrow - Spanish.pdf
- Gak Recipe—Glaciers Here Today Gone Tomorrow.docx
- Gak Recipe—Glaciers Here Today Gone Tomorrow.pdf
- Glacier Simulation—Glaciers Here Today Gone Tomorrow - Spanish.docx
- Glacier Simulation—Glaciers Here Today Gone Tomorrow - Spanish.pdf
- Glacier Simulation—Glaciers Here Today Gone Tomorrow.docx
- Glacier Simulation—Glaciers Here Today Gone Tomorrow.pdf
- Lesson Slides—Glaciers Here Today Gone Tomorrow.pptx
- Spend a Buck—Glaciers Here Today Gone Tomorrow.docx
- Spend a Buck—Glaciers Here Today Gone Tomorrow.pdf
- T-chart—Glaciers Here Today Gone Tomorrow - Spanish.docx
- T-chart—Glaciers Here Today Gone Tomorrow - Spanish.pdf
- T-chart—Glaciers Here Today Gone Tomorrow.docx
- T-chart—Glaciers Here Today Gone Tomorrow.pdf
- Tip of the Iceberg—Glaciers Here Today Gone Tomorrow - Spanish.docx
- Tip of the Iceberg—Glaciers Here Today Gone Tomorrow - Spanish.pdf
- Tip of the Iceberg—Glaciers Here Today Gone Tomorrow.docx
- Tip of the Iceberg—Glaciers Here Today Gone Tomorrow.pdf

Materials

- Lesson Slides (attached)
- Tip of the Iceberg handout (attached; one per student)
- Glacier Simulation handout (attached; one per group)
- T-chart handout (attached; one per student)
- Spend a Buck handout (attached; one bill per student)
- Gak Recipe (attached; makes 3 cups; ½–1 cup per group)
- White school glue (8 oz. bottle)
- Borax (sodium borate, a powdered soap found in the grocery store)
- Safety Data Sheet for sodium borate (linked)
- Gloves

- Goggles
- Large mixing bowl
- Plastic cup (8 oz. size works well)
- Spoon
- Measuring cup
- Food coloring (at least two different colors)
- Water
- Paper towel tubes (begin saving these in advance; one per group)
- Rulers (one per group)
- Foil (one sheet per group)
- Small rocks or gravel (aquarium gravel works well; about 10–20 pieces of gravel per group)
- Food coloring
- Black permanent markers (one per group)
- Books (two to five per group)
- Student devices with time-lapse capabilities
- Envelopes (one per student)

Preparation

Timing

Ideally, the Engage and the Explore portions are to be completed on Day 1 of the lesson, finishing with the simulation. Prepare "Channel" materials for students: paper towel tube, foil, markers, ruler. To save on time, we suggest preparing the Gak yourself using the attached **Gak Recipe** handout. However, if you think students would enjoy making their own Gak and/or you have the time for it, use the hidden **slide 8** and optional instructions provided to facilitate this part of the lab in class. Prepare the materials listed in the recipe for students.

Time-saving tip: If one class makes the channels, the channels may then be reused in other classes—just gently remove the Gak from the aluminum foil channels.

Safety

In the following glacier simulation, students must work with a slime-like material that includes Borax (sodium borate). For students' safety, please make sure students wear goggles and gloves when handling both Borax and the final product, Gak, and have students wash their hands afterward. You may reference this Safety Data Sheet (SDS) for more information on how to safely work with sodium borate.

Evaluate

Before class begins, cut out the fake $100 bills from the attached **Spend a Buck** handout. Be sure to print enough copies of the handout to provide one bill per student.

10 minutes

Engage

Introduce the lesson using the attached **Lesson Slides**. Display the title on **slide 2** then move to **slide 3** to show students the essential question: What is happening to modern-day glaciers?

Go to **slide 4** and inform students that it is field trip time! Their destination is the Ice Age about 18,000 years ago. Show students the Scrat Ice Age 1 movie clip, but be sure to stop the video at 2:06, as the end of the video is not relevant to the glacial movement described in this lesson.

Play Scrat Ice Age 1 (stop at 2:06):

Embedded video
https://youtube.com/watch?v=vCTNioSW730

Go to **slide 5** and pass out the attached **Tip of the Iceberg** handout one per student. Have students use a modified version of the Tip of the Iceberg strategy to assess their prior knowledge and think about what they want to know about glaciers.

On the handout, ask students to write what they already know about glaciers above the waterline. They should write anything they want to know about glaciers along the waterline. Let students know they will save the space below the waterline for later in the lesson.

Teacher's Note: Context

For context, read the following to students before they fill out the Tip of the Iceberg handout:

"Only about 1/8 of an iceberg is visible above the water. The rest is below the surface. Like the iceberg, learning has some aspects that are visible and many others that can only be suspected, guessed, or learned as understanding grows; the visible part of a subject is only a small part of a much larger whole."

Go to **slide 6** and review the lesson objectives with students. By the end of the lesson, students should be able to model how glaciers move, describe the role that glaciers played in the formation of the Earth's surface, and predict how glaciers will determine the Earth's surface in the future.

50 minutes

Explore

Teacher's Note: Variables

Student groups could use varying slopes and/or temperatures of Gak to test the effects of these variables. They also may choose to capture a time-lapse video of their "glacier" as it moves.

Create small groups of 2-4 students depending on available materials. Display **slide 7**. Present the following directions to students as they construct their glacier models:

1. Cut the paper towel tube in half, lengthwise so that you have two open channels. These two channels will serve as valleys for the simulated glaciers to travel down.
2. Cover the channels with foil. This will keep the Gak from sticking to the valley.
3. Using a marker, mark the sides of the foil-covered channel in 1 cm increments from top to bottom.

Teacher's Note: Students Creating their own Gak

If time allows, consider having students make their own Gak. Once groups have made their channels, unhide **slide 8** and pass out one **Gak Recipe** handout to each group. Allow students time to create their two different colors of Gak following the steps on the handout.

After groups have made their channels, provide the Gak you prepared ahead of time to each group along with rocks/gravel. Display **slide 9**. Present the following directions to students as they build their simulation:

1. Use books to prop up one end of the channel so that the "valley" has a gentle slope.
2. Retrieve equal amounts of the two different colors of Gak.
3. Put 10–15 small rocks or pieces of aquarium gravel in each color of Gak. (These rocks represent boulders that can be moved hundreds of miles by glacial flows.)
4. To create the "glacier," layer the two Gaks like a stack of coins, alternating colors.

Go to **slide 10** and pass out the attached **Glacier Simulation** handout one per group. Ask students to draw their simulated glacier setup and note the variables—such as the number of books used and the temperature of the Gak.

Next, have students start the investigation and begin timing when they place the layered Gak at the top of the valley. Remind students to jot down the starting time and then record the time (in seconds) each time the Gak moves a centimeter.

Go to **slide 11** and ask students who had the fastest glacier. Solicit a few responses from groups who believe theirs was the "fastest." Then, inform students that *speed equals distance divided by time*. Walk students through the calculations for flow rate to determine which group had the fastest glacier. Use the following example found on the Glacier Simulation handout to demonstrate this:

Distance = 30 cm

Time = 45 min 25 sec (2,725 seconds)

Flow rate (speed) = 30 cm/2,725 sec

Flow rate (speed) = 0.011 cm/sec or 0.011 centimeters per second

On the last page of the handout, students in each group should determine how far their glacier moved in centimeters. They also should calculate how many seconds it took for the glacier to move that distance. They should then calculate the flow rate of their glacier using the *speed = distance/time* formula.

Teacher's Note: Variables

If groups varied the steepness of their slope (i.e. the number of books propping up the channel) and/or the temperature of the Gak, this would be the time to talk about those differences and how they affect the speed of glacier movement.

Go to **slide 12** and inform students they will watch a real glacier's movement. Then, show them the time-lapse video of Sólheimajökull Glacier (Iceland). After the video, ask students the following questions:

- Why did you have to take so many time readings while your glacier moved?
- Would you have noticed more of a difference in your glacier's movement if you had observed it two times, about 10 seconds apart or if you had observed it only at the beginning and at the end?

Solicit a few answers and have students explain their reasoning.

Go to **slide 13** and pass out the attached **T-chart** handout, one per student. Have students use the T-chart graphic organizing strategy to compare their simulated glaciers with the real glacier they just viewed in the time-lapsed video. If students don't make a connection right away, replay the video and ask them to note the date stamps (April 2007 to June 2016) of the time-lapsed photography. You may also prompt them to look at the debris in the video. When they're ready, discuss as a class what students wrote on their charts.

Sample Student Responses

Both took a "long time" to move, but in reality, the real glacier took a lot longer to move than the simulated glacier (years versus minutes). Both moved rocks and gravel.

After discussing their T-charts, move to **slide 14** and ask students what they think the benefits are of using simulations and models in science. Then, ask them what they think the drawbacks are.

Sample Student Responses

Models and simulations can help us see something up close and on a small scale when we are unable to study the real thing in nature due to size, proximity, time, etc. Models and simulations also help us save money and allow scientists to manipulate variables before actually trying something new out in the field.

The drawbacks are that models and simulations might not be accurate because it's hard to replicate exact environmental conditions. We can't account for unknown variables (e.g., human impact, increased climate change).

60 minutes

Explain

Display **slide 15**. Have students explain the knowledge they've accumulated so far by posing the following questions:

1. When a glacier moves, along with the rocks it carries, what does it do to the valley underneath?
2. What happens over a long period of time if the glacier continues to scratch the ground?
3. What shape is the valley that forms when a glacier moves through?

Sample Student Responses and Teacher Input

1. It scratches the ground and rocks underneath it. These scratches are called *abrasions*.

2. It carves the ground into an even deeper valley.

3. The valley is U-shaped. This is called a *trough*. It's the same shape as a water trough for horses and cows.

Go to **slide 16** to continue with the questions:

4. What causes glaciers to move and keep moving?
5. In your glacier simulation, what did the different colors of Gak represent?
6. Did you have any rocks or gravel deposited along the way as your glacier moved?

Sample Student Responses and Teacher Input

4. Gravity is pulling them down the valley slope.

5. The different Gak layers represented different layers of ice.

6. *Moraine* is the term used for all the debris (soil, rocks, boulders) that is carried and deposited by glaciers.

Teacher's Note: Academic Vocabulary

New vocabulary words are italicized in the sample student responses above. As students explain their understanding, you can reinforce their learning by revealing these academic terms to them. You may choose to have students write the words in their notes, or you could create a word wall in the classroom.

Display **slide 17**. Explain to students that, historically, scientists have used two prominent theories to explain how the Earth's surface was shaped: the diluvial theory and the glacial theory. Highlight the major components of each theory. Emphasize that the diluvial theory is no longer accepted and is not supported by evidence. It was an early competing theory that has since been debunked and replaced by the glacial theory.

Go to **slide 18**. Ask students, “How do we continue to learn about glaciers?” Students may bring up the time-lapsed video they watched earlier in the lesson. Inform students that scientists called *glaciologists* study glaciers in a similar way—they use time-lapse photography, which includes still photos, videos, and satellite images.

Go to **slide 19** and show students the video, titled “Dramatic video shows Alaska glacier collapse near kayakers.”

50 minutes

Extend

Place students in groups of 2–3. Then, display **slide 20** and inform students they will create an "About & Obit" presentation on a U.S. glacier of their choice. In groups, have students decide on a glacier in the United States that they are interested in researching.

Display **slide 21** to show students the requirements for the "About" group presentation, and the "Obit" individual writing.

Parameters for the "About" group presentation are as follows:

- All information must be in students' own words.
- Students must include: the glacier's name, its location, its status, one image, and one interesting or unusual fact about the glacier.
- This portion will be presented to the class, so it should be created using an appropriate program such as Google Slides, PowerPoint, or Prezi.

Then, discuss the "Obit" portion of the assignment. Individually, each member of the group must write an obituary for their glacier, should it have met its end. Parameters for this part of the assignment are as follows:

- All information must be in students' own words.
- Students must include the following: the glacier's name, one image, its date of "birth" and date of "death," cause of death, the glacier's "story," list of important life events (at least one), and the name of a fund for individuals to "donate" to in lieu of flowers (can be a real organization like the Union of Concerned Scientists, NOAA, National Resources Defense Council, etc. or students can make up an organization).
- This portion of the assignment will not be presented formally, so it can be created using a program such as Google Docs, Word, or Canva.

Teacher's Note: Obituaries

If students don't know what an obituary is, you may want to share this with them: "An obituary tells the story of a deceased person's life by acknowledging the person's passing, their life accomplishments, etc."

Give students about 15 minutes for glacier research. Students should use the remainder of the period to create their presentations and obituaries.

60 minutes

Evaluate

Before the presentations, display **slide 22** and provide each student with an envelope. Explain that students will use a modified version of the Spend a Buck strategy to evaluate their classmates' presentations, obituaries, and organizations. On the front of the envelope, have each student write the name of the organization they listed in their obituary. This is where other students can place their fake $100 bills if they decide to "donate" to that organization in memory of a glacier.

Teacher's Note: Collecting the Envelopes

You may choose to keep these envelopes at the front of the room or at your desk—this way, you may count the funds yourself after the lesson is over so as not to hurt the feelings of students whose organizations may not have been as well funded as others.

Go to **slide 23**. Have each group share their presentation for the "About" portion of the About & Obit.

Then, ask students to share their individually written obituaries with the class. The obituaries may be printed and displayed around the room, or you may have students upload their obituaries to a site where other students can view them, such as VoiceThread.

After presentations, move to **slide 24**. Using the Spend a Buck strategy, have students evaluate their classmates' presentations, obituaries, and organizations. Give each student a prepared fake $100 bill from the attached **Spend a Buck** handout and inform students they can donate to any organization besides their own. They may "spend" all $100 on the same organization, or they may divide their funds among organizations. Announce to the class the next day whose organization raised the most funds in honor of its fallen glacier.

Go to **slide 25**. Ask students to revisit their Tip of the Iceberg handout and write what they have learned about glaciers below the waterline.

Resources

- Extreme Ice Survey. (2009, August 10). IL-05 Sólheimajökull Glacier (Iceland) Time-lapse [Video]. Vimeo. https://vimeo.com/6039933
- Flinn Scientific. (2014, March 21). Sodium borate [Safety Data Sheet]. Flinn Scientific. https://www.flinnsci.com/sds_712-sodium-borate/sds_712/
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- NBC Nightly News. (2019, August 17). Dramatic video shows Alaska glacier collapse near kayakers [Video]. NBC. https://www.nbcnews.com/nightly-news/video/dramatic-video-shows-alaska-glacier-collapse-near-kayakers-66385477968