Glaciers: an introduction to Earth's icy regions

A lesson plan with activities that combine science and art for a hands-on student experience.

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This lesson plan contains four parts, three of which are dedicated to learning about glaciers and the remaining part outlines art projects that integrate concepts learned here. The yellow highlighted text are concepts or terms that could be incorporated in more detail to extend the duration of the project and enhance understanding of glaciers or explored prior to the implementation of this lesson plan.

Target level: upper elementary or middle school students
Duration: 2 hours (45 minutes of learning – 45 minutes hands-on – 30 minutes for closing)
Format: in-person or virtual, at-school or at-home – wherever learning happens
Cost: low to no cost, depending on number of students and existing availability of supplies

Suggested supplies for activities

Recycled cardboard and plastic
Buttons, random recycled materials
Markers, paint and/or crayons
Pipe cleaners
Glue, hot glue and/or tape
Paper, construction paper, and/or tissue paper
Fabric
Scissors
Cardstock + stamps

NOTE: These supplies can easily be substituted for items already available to make this a no-cost lesson.

Lesson plan

Part I: Frozen parts of our planet: snow and glaciers

Discuss the basics about snow and glaciers
(show glacier_visual.pdf page 1 in background)
Ask the students what they know about snow and glaciers.

1. Let's start with snow, which is a fundamental building block of glaciers. Snow is solid precipitation (the liquid version is rain) with a special and unique crystal structure.
   Ask: Where does snow fall? What season is associated with snow? *Answer: Snow falls in many places during the winter, including high-elevation mountains worldwide, around the north (Arctic) and south (Antarctic) poles, and non-tropical regions (like Virginia).*
   Ask: Where might winter snow not melt during the summer? *Answer: Snow in places that remain cold (at or below the freezing point of water) in the summer, like mountain tops and the poles, might not completely melt . Snow can even fall outside of the winter months where temperatures remain cold, such as Greenland, Antarctica, and mountains like the Himalaya.*
2. Snow builds up over hundreds to thousands of years to form glaciers, so glaciers occur where snow can persist for many years without melting.
3. Glaciers are huge ice bodies that form by squished snow that move across the land, some of which 'drain' like rivers directly into the ocean.
   Show Smithsonian video (without sound): https://www.youtube.com/watch?v=oggvDlPbUr8

Ask: How does the snow get squished and eventually turn into glacier ice? *Answer: The weight of overlying snow compresses the underlying snow and squeezes some of the air, bonding the snow crystals together to form ice.*

Ask: Why do they move? *Answer: Gravity, strain within the ice as ice crystals deform, and ice slipping across land if there is water or loose sediments at the bottom of the ice.*

Part II: Where are the glaciers? Why do they matter?

Discuss where glaciers are found today and their significance in the Earth system.

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1. Glaciers may seem foreign to us in [Virginia], but there are nearly 200,000 glaciers on Earth and they cover 8% of Earth's surface!

   Ask: Has anyone seen a glacier in person, or seen pictures of one?

   Ask: Where are the glaciers? *Answer: Glaciers are found in mountains worldwide, like the Rockies, the Himalaya (termed the 3rd pole), Mt. Kilimanjaro in Tanzania, and New Zealand, and surrounding the Greenland and Antarctic ice sheets (huge continental-scale ice masses made up of many glaciers).*

2. Because the majority of the water in the atmosphere comes from the ocean, when glaciers grow they trap water as ice on land causing sea level to fall. But when glaciers shrink, they cause sea level to rise.

   Ask: Overall, are glaciers (and the gigantic ice sheets) growing today or shrinking? *Answer: most glaciers are shrinking and overall the ice sheets are losing ice to the ocean because of ocean and atmosphere warming. The reason some glaciers and parts of ice sheets are not losing ice is that snowfall has increased in some places (because warmer air can hold more water), but those growths do not outweigh the losses, which is one reason global (mean) sea level is rising today*

3. The sun emits energy that enters our atmosphere. Earth's surface absorbs that energy and causes the atmosphere to warm, but the color of Earth's surface determines how much energy is absorbed (a phenomenon called albedo). Snow and ice are super reflective, so most of the incoming energy is reflected right back to space.

   Ask: In a warming world, we are losing this reflective snow and ice cover, so what will happen to the land surface in those places and how will that impact climate? *Answer: The land surface will darken due to plant cover and soil and rock exposure, causing more heat absorption and increased atmosphere warming.*

Part III: Who studies glaciers and how?

Discuss researchers that study glaciers and how they do it.

1. People who work at governmental organizations like NASA and academic institutions like the [University of Virginia] study glaciers using a variety of methods. We can study glaciers by going to glaciers to collected on-ice measurements, by using 'remote sensing' (not on-ice) methods like measurements taken from airplanes and satellites, and by using sediments and landforms that are influenced by glaciers. These various methods offer different perspectives and scales of glacier change from a single glacier to entire ice sheets.

   Ask: if you were to become a glaciologist, someone who studies glaciers, would you want to take measurements on the ice yourself, fly over them with an airplane, or use data from satellites?

   Ask: what other areas of study, outside of glaciology, are important for studying glaciers and their impacts on our planet? *Answer: engineers, biologists, oceanographers, social scientists, economists, pilots, ship crews, computer scientists, mathematicians, …*

2. One way that we can use geology to explore glaciers and ice sheets is by studying the sediments and landforms influenced or directly molded by glacier ice. Some places that are now below sea level, like offshore of New Jersey, Norway, and New Zealand, were once (thousands of years ago) covered by glaciers and ice sheets. We can now go to those places by boat and collect geological evidence of glacier and ice sheet change to better understand how these icy parts of our planet are changing and will change in the future.

- Optional resources available at https://www.polartrec.com/expeditions/thwaites-offshore-research provided by Sarah Slack, middle school teacher from Brooklyn, who went on a research cruise to Thwaites Glacier, Antarctica.

Part IV: Science-based art projects

Now it is time to take what we have learned and create! You can choose one or all three crafts.

Craft 1: Make glacier-inspired postcards

Using cardstock or other durable paper create two postcards: one postcard to send to a family member with a glacier fact and one with a question to send a glaciologist finishing the phrase ('If I were a glaciologist, I would …'). You can find numerous glaciologists at the below link and do a quick search with their name and institution to find their work address: https://thwaitesglacier.org/people. Feel free to include a glacier-inspired drawing and your contact information if you want to receive a response.

Craft 2: Build a glacier-observing satellite from recycled materials

Using any materials provided, make a satellite that is designed to observe glaciers on our planet.

- For more information about ice-observing satellites, see the below resources:
  IceSat1 and IceSat2: https://icesat.gsfc.nasa.gov/
  IceSat2 photon video: https://www.youtube.com/watch?v=aYRqkdYJRr0

Craft 3: Build a paper glacier using construction paper

Using construction paper, tape or quick drying glue, and scissors, make snowflakes that you will tape to form rows that will eventually be stacked and taped/glued together. You will need at least 10 rows of snowflakes! Once you have the snowflake rows taped together you will corrugate and compress your snowflakes to form a glacier with different annual layers.

Sharing & closing remarks

1. First, let's make sure your postcards have your address (or leave your address and name off to be anonymous), what family member you want to send one to, and what glaciologist you want to send your other postcard to.
2. Discuss your crafts in the context of what you have learned and what to learn.
3. Now that we have learned about glaciers, let's try to answer 3 questions:
   - What are glaciers?
   - Why are they important?
   - How do we study them?