



Introduction

The Arctic region has long been portrayed as the final frontier of exploration — a faraway place of otherworldly landscapes. Although the sheer beauty of the Arctic is undeniable, the reality of life in the North is very different from anywhere else on the planet. People have called the Arctic home for thousands of years, learning to live off the land by embracing its cold and harsh climate. Despite how people may perceive the Arctic, one thing that is agreed upon is that its climate, landscape, and wildlife are unique.

This Arctic Circumpolar Map is unlike any other giant floor map created by Canadian Geographic Education. Projecting the Earth from the Arctic circumpolar region gives students the opportunity to stand at the top of the world and view Canada and the world from a new perspective. This outlook encourages them to think critically about the importance of global relationships, climate change, and natural processes, such as ocean currents and animal migration.

The following 10 learning activities were designed in partnership with Polar Knowledge Canada (POLAR). These activities help to inform Canadian students about POLAR's commitment to advancing Canada's knowledge of the Arctic, strengthening Canadian leadership in polar science and technology, and promoting the development and distribution of knowledge in both circumpolar regions, Arctic and Antarctic. This teaching resource will provide students with the opportunity to learn about animal migration, communication and new technologies, climate change and much more.



Canada and Antarctica

Polar Knowledge Canada (POLAR) is Canada's lead federal agency aimed at strengthening Canadian leadership in polar science and technology. POLAR is currently working to develop a Canadian Antarctic Research Program to better coordinate and expand Canadian Antarctic research to provide a more comprehensive understanding of the Antarctic region, its place in global systems, and the links between polar regions.

Although this giant floor map highlights the Arctic circumpolar region, the kit provides a smaller paper copy of the map with Antarctica on the back. There are many ways to apply this resource to the Antarctic region. While students are exploring the Arctic, encourage them to learn about the Antarctic circumpolar region as well. Here are a few ideas on how you can integrate Antarctica into your lessons.

- ▷ **Landscape:** Once your students have explored the Arctic landscape on the giant floor map in Activity 1, have them compare it to Antarctica landscape. Ask them to consider how the polar regions are similar and how they are different.
- ▷ **Animals:** Activity 3 explores animal migration in the Arctic. Once students have learned about the animals that live in the Arctic, have them research which animals can be found in Antarctica. Are there animals that can be found in both polar regions?
- ▷ **Antarctic Treaty:** Activity 4 teaches students about the Arctic Council and the roles and responsibilities of the different groups represented on the council. After this lesson, introduce students to the Antarctic Treaty and explain how different countries have made land claims in the Antarctic circumpolar region.
- ▷ **Climate:** Activity 7 teaches students to examine and analyze climate graphs. After this lesson, have students research what the climate is like in Antarctica and ask them to create a climate graph for specific locations and stations in Antarctica.
- ▷ **Science and Research:** All the people who work in Antarctica are scientists or support staff; there is no Indigenous or native population in Antarctica. After students have learned about the research projects in the Arctic, have them research what projects are under development in the Antarctic region.
- ▷ **Key Questions:**
 - What kind of climate and landscape exist in Antarctica?
 - How has Antarctica been used for scientific research?
 - How does it differ from research in the Arctic circumpolar region?
 - How has Antarctica been used for commercial profit?
 - Which countries have signed the Antarctic Treaty?



Additional Resources

.....

Polar Knowledge Canada (www.canada.ca/en/polar-knowledge/maps)

Teachers and students can download free Arctic and Antarctic circumpolar maps.

Arctic Council (arctic-council.org)

The Arctic Council is the leading intergovernmental forum promoting cooperation, coordination and interaction among the Arctic states, Indigenous peoples, and other Arctic inhabitants on common Arctic issues.

Arctic Spatial Data Infrastructure (arctic-sdi.org)

The aim of the Arctic SDI is to provide politicians, governments, policy makers, scientists, private enterprises and citizens in the Arctic with access to geographically related Arctic data, digital maps, and tools to facilitate monitoring and decision-making.

Arctic Report Card (arctic.noaa.gov/report-card)

Issued annually since 2006, the Arctic Report Card is a timely and peer-reviewed resource for clear, reliable and concise environmental information.

British Antarctic Survey (BAS) (bas.ac.uk)

BAS is an institute of the Natural Environment Research Council, delivering and enabling world-leading interdisciplinary research in the polar regions.

Canadian Network of Northern Research Operators (CNNRO) (cnnro.ca)

CNNRO is a network of research support facilities providing specialized technical services to academic, government, private, and international scientific research sectors.

Inuit Tapiriit Kanatami (itk.ca)

This national organization works to represent, protect, and advance the rights and interests of Inuit in Canada.

Inuit Siku Atlas (sikuatlas.ca)

This online atlas will help students learn about Inuit knowledge of sea ice (siku) around Baffin Island, Nunavut.

International Network for Terrestrial Research and Monitoring in the Arctic (INTERACT)

(eu-interact.org) This project's main objective is to build capacity for identifying, understanding, predicting and responding to diverse environmental changes in the Arctic.

Landsat Image Mosaic of Antarctica (LIMA) (lima.nasa.gov/Antarctica)

Explore satellite images, graphs, and maps of Antarctica and download fact sheets for your students.

National Oceanic and Atmospheric Administration (NOAA) (noaa.gov)

NOAA is an agency that uses science to understand and predict changes in climate, weather, oceans, and coastlines.

SmartICE (smartice.org)

SmartICE is developing a sea-ice monitoring and information-sharing system that works almost in real-time, blending together Inuit traditional knowledge with state-of-the-art technology.



About This Resource

.....

1. All About the Arctic

Students will learn how to navigate the Arctic Circumpolar Map and the various ways in which people define the term “Arctic”.

2. Arctic Research

Students will explore Arctic issues and learn about Canada’s role as a leader in science and technology research in the Arctic circumpolar region. They will also learn about the different types of research projects currently ongoing in Canada’s Arctic circumpolar region.

3. Animal Migration

Students will learn about the animals that live in the Arctic and how and why they migrate. They will also familiarize themselves with the types of technology used to monitor animal migration routes and patterns.

4. Arctic Council

Students will learn about the Arctic Council and the roles and responsibilities of the different groups represented on the council, including the eight Arctic member states and six permanent participants.

5. Sea Ice in the Arctic

Students will learn about the different forms of Arctic sea ice and the role of leads and polynyas. They will examine images of ice, and learn how to navigate through frozen seaways using ice charts. They will also learn about how the Arctic will change in the future.

6. Arctic Monitoring

Students will learn how the Arctic circumpolar region is being monitored and will investigate specific examples, which will help illustrate why monitoring of the region is important.

7. Climate Change: Indicators and Signs

Students will learn about climate change and explore indicators that can be used to assess climate change in the Arctic.

8. Arctic Renewable Energy

Students will learn about the growing use of renewable energy and how solar, wind, hydro and biomass are being used to reduce dependency on diesel fuel in the North.

9. Northern Housing Challenges

Students will learn about the housing challenges that Indigenous and non-Indigenous communities in the Arctic circumpolar region face because of the changing climate and the remoteness of the area.

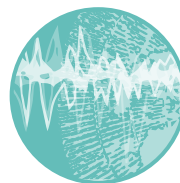
10. Communication in Arctic Communities

Students will explore specific examples of how Arctic communities in Canada are using information and communication technology.

Table of Contents



Activity 1:
All About the Arctic



Activity 6:
Arctic Monitoring



Activity 2:
Arctic Research



Activity 7:
Climate Change: Indicators
and Signs



Activity 3:
Animal Migration



Activity 8:
Arctic Renewable Energy



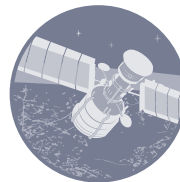
Activity 4:
Arctic Council



Activity 9:
Northern Housing Challenges



Activity 5:
Sea Ice in the Arctic



Activity 10:
Communication in Arctic
Communities



Contributors

.....

The Royal Canadian Geographical Society

Gavin Fitch
President

Connie Wyatt Anderson
Chair, Canadian Geographic Education

Sara Black
Manager, Education Programs

Tanya Kirnishni
Special Projects Editor

John G. Geiger
Chief Executive Officer

Ellen Curtis
Director of Education

Andrea Buchholz
Education Program Coordinator

Nadira Ramharry
French Proofreader

Canadian Geographic Enterprises

Gilles Gagnier
Chief Operating Officer and Publisher

Mike Elston
Director of Production

Kathryn Barqueiro
Designer

Stephanie Small
Copy Editor

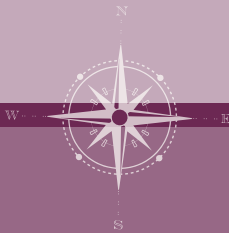
Roisin O'Reilly
Project Manager

Nicole Casteran
Translator



Polar Knowledge
Canada

Savoir polaire
Canada



1 All About the Arctic

Learning objectives

- ▷ Students will learn how to navigate the circumpolar map.
- ▷ Students will investigate how people across the globe define “Arctic.”
- ▷ Students will use photo cards to explore what the landscape looks like across the Arctic circumpolar region.

Grades

- ▷ K-12

Materials

- ▷ Photo cards (41)
- ▷ Arctic map cards (5)
- ▷ Inflatable globe (1)
- ▷ Arctic quiz card (1)
- ▷ Chains (16)
- ▷ Pylons (20)

Set-up

Review the photo cards, Arctic map cards and Arctic quiz card to help familiarize yourself with the map.

Introduction

Allow time for students to explore the map. Ask students to locate areas on the map that they are familiar with or have visited. Ask students to describe how this map differs from other maps they have seen.

Explain to students that this map displays the Arctic circumpolar region of the world. Using the inflatable globe, show students where Canada is. Then show them North America and the rest of the continents. Next, turn the globe so students see the North Pole. Explain that the Earth has two polar regions, one in the south (Antarctic) and one in the north (Arctic), which is what this map displays. Have a student volunteer place a pylon on the centre of the map, on the geographic North Pole. Next, have students locate the other North Pole labelled on the map, and its location in previous years. As a class, have students define and explain the difference between the magnetic North Pole (the pole where the north arrow points to on a compass, which changes because of shifts in the Earth’s inner core) and the geographical North Pole (where the lines of longitude intersect).

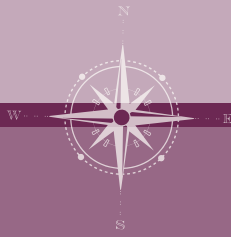
Ask students to identify the different countries on the map. Once each country has been identified, show students where these countries are on the inflatable globe. Ask: Why can you not see all of Canada? How would this map look different if we tried to make it square? Ask students to locate their hometown on the map using a coloured pylon. If their hometown is not on this map, have a class discussion about why it is not on this map and what story this map tells.

Development

Divide students into five groups and distribute a different Arctic map card to each group. Allow time for each group to examine their card, read the information on it and use the coloured chains provided to highlight the Arctic’s borders as outlined on their card.

Have each group present their border to the rest of the class once all of them have been mapped. After each presentation, ask students to consider who would likely support the defined border presented (scientists, Canadians, northern residents, government, etc.). As a class, discuss how students define the Arctic and/or which map card they associate most with the definition of the Arctic and why. Create a working definition of the Arctic as a class. For older grades, discuss which definition would be used for various applications (laws and regulations, science research, international agreements, etc.).





1 All About the Arctic

Conclusion

Point out and label different landforms on the map using the map's legend, the Arctic map cards, and students' previous knowledge. Make sure to highlight key features such as the treeline, ice caps (large masses of ice that rest on land), glaciers and mountain ranges. Define terms like permafrost (the layer of soil that is permanently frozen all year round) and tundra (a treeless biome found at high latitudes).

Distribute an Arctic photo card to each student or pair of students. Have students examine their picture and place name on the card, find it on the map, and then place their card on that spot. For younger students, this can be done as a class. Once all cards have been placed around the map, ask students what surprised them about the pictures. Which pictures stand out and why? Are there any common themes in the pictures? Which pictures/landscapes are similar to those surrounding your community?

Extend your geographical thinking

Using the Arctic quiz card, read questions one by one to the rest of the class. After reading each question, allow time for students to share their answers and demonstrate how they came to their conclusions.

To finish the activity, use the Fun Facts portion of the quiz to highlight even more interesting things about the Arctic.

Links to the Canadian National Standards for Geography

Essential Element 1: The World in Spatial Terms

- ▷ Relative location
- ▷ Map projections
- ▷ Map, globe and atlas use

Essential Element 2: Places and Regions

- ▷ Similarities and differences of local places and regions and other places and regions
- ▷ Regions defined by multiple criteria
- ▷ Perceptions of places and regions



2 Arctic Research

Learning objectives

- ▷ Students will explore Arctic issues and Canada's strength in science and technology in the Arctic circumpolar region.
- ▷ Students will learn about different types of research occurring in Canada's Arctic circumpolar region.

Grades

- ▷ 7-12

Materials

- ▷ Arctic research cards (8)
- ▷ Pylons (20)
- ▷ Brainstorm template (8 copies)
- ▷ Whiteboard markers
- ▷ Research station cards (14)

Set-up

Review the text on the cards.

Introduction

Once students have had an opportunity to explore the map independently, ask them to stand on a community labelled on the map. Next, ask them about the types of jobs that may exist in each community. If your own community is labelled on the map, place a pylon on this location and ask students to consider the types of jobs found in nearby and other Arctic communities. Ask students how occupations change in communities based on their location. Use your own community as a reference. Explain to students that the Arctic circumpolar region is of interest to many people. Ask students what scientists could study in this region and why it may be important.

Have students explore the map again, and this time ask them to stand on the red squares labelled on the map. Ask students about the patterns and trends they see based on the location of these squares. Explain to students that these squares represent research facilities managed by the Canadian Network of Northern Research Operators (CNNRO). CNNRO facilities range from oceanographic research vessels and long-term research institutes and observatories, to seasonal field stations and un-staffed remote monitoring installations. They are widespread, representing every major ecological region in Canada's North.

Hand out the 14 different research station cards, and have students examine the image on their card and locate where their research station is. Have students walk around to compare how the landscape and research stations differ across Canada's Arctic.

Inform students that Polar Knowledge Canada (known as "POLAR") promotes the development and distribution of knowledge of the Arctic and Antarctic circumpolar regions. POLAR also works to improve economic opportunities, environmental stewardship and quality of life for northerners and Canadians. Place a pylon on the research station in Cambridge Bay, Nunavut. This station is called the Canadian High Arctic Research Station campus and is a world-class hub for science and technology research.

Development

Explain to students that they will be learning about specific research activities in Canada's North. Divide them into eight groups and distribute a different Arctic research card to each group, followed by a brainstorm template and whiteboard marker. Have groups locate the area identified on their Arctic research card and sit in that area on the map. Allow time for students to review the information on the card and use the brainstorm template to organize their thoughts. Have them highlight the following: the area of study, specific locations, key individuals and why their research is important.





2 Arctic Research

Conclusion

Once students have reviewed their research, gather all groups around the map's border. Allow time for each group to share their research, where it is occurring and information about the individuals involved. Have each group select one or two people from their group to act as speakers. The remaining students will act as locators throughout the presentation to highlight specific areas where this research took place.

Once all groups have presented, bring attention to what students recorded on their brainstorm template about Indigenous knowledge. Explain that research in Arctic communities should be community-driven and should integrate Indigenous knowledge. Ask students how communities and researchers can ensure this and how it can be done. Next, ask students to think about the changes occurring in the Arctic due to climate change and the types of research and occupations that will be needed in this region in the future.

Extend your geographical thinking

The Arctic research cards provided in this lesson are part of a series of monthly blogs produced jointly by POLAR and *Canadian Geographic* magazine. They feature a wide range of topics that span the broad spectrum of polar knowledge, from Arctic landscapes that help explain features observed on Mars, to the insects and spiders that thrive in the North and how they influence the Arctic landscape. Have students visit canadiangeographic.ca/polarblog or canada.ca/en/polar-knowledge to follow along each month to learn more about the types of research occurring in Canada's North.

Links to the Canadian National Standards for Geography

Essential Element 2: Places and Regions

- ▷ Regions defined by multiple criteria
- ▷ Factors that influence people's perception of places and regions
- ▷ The importance of places and regions to individual and social identity

Essential Element 5: Environment and Society

- ▷ Human modification of the physical environment
- ▷ Human adaptation to the physical environment



3 Animal Migration

Learning objectives

- ▷ Students will learn about the types of animals that live in the Arctic and how and why they migrate.
- ▷ Students will learn about the types of technology used to monitor animal migration routes and patterns.

Grades

- ▷ K-12

Materials

- ▷ Animal cards (13)
- ▷ Animal tracking cards (6)

Set-up

Review the information provided on the back of the animal cards and the animal tracking cards.

Introduction

Once students have had an opportunity to explore the map, ask them to describe the kinds of animals that live in the Arctic circumpolar region. What physical characteristics would these animals need to help them survive the harsh Arctic conditions? Ask students which animals stay in the Arctic all year long by adapting to the environment and which migrate.

Divide students into 13 small groups, and give each group a different animal card. Allow students time to look at the picture of the animal and review the information on the back of their card. When students are ready, have each group place their card somewhere on the map where this animal can be found. For younger students, you can do this together as a class. Next, ask students to raise their hand if they have an animal that migrates. Ask each of these groups, one by one, to show their animal's migration on the map based on the information on the back of the card.

Development

Gather students around the map's border, and collect all the animal cards. Explain to students that when scientists study the Arctic circumpolar region, tracking animal migration routes helps them understand the changes occurring in the region. Ask students about the kind of information and data a scientist would need to collect from an animal's migration in order to understand the changes occurring (diet, breeding grounds, resting periods, etc.).

Introduce the concept of Indigenous knowledge (also referred to as traditional knowledge) and explain that Indigenous communities have been tracking animals for thousands of years. Ask students to consider how Indigenous people can do this. Next, ask students how scientists track animal migration routes. Explain that it is important for Indigenous communities and Arctic scientists to work together to co-develop data and gather research. Ask students why it is important for communities and researchers to work together.

Remind students that it is important that researchers not harm animals or disrupt their natural migration route in any way. Have students share their ideas about how researchers can do this with the class.

Explain that students will be learning about the different kinds of technology used to track animals in the Arctic circumpolar region. Divide students into six groups, and give each group a different animal tracking card. Inform students that each group will read and review the information on their card and share three facts with the rest of the class — without revealing the animal. When students are choosing their





3 Animal Migration

facts, encourage them to share as much information about the technology as possible without sharing the animal it tracks. It will be the responsibility of the rest of the class to guess which animal it monitors.

Conclusion

When all groups are ready to share their technology and facts, gather students around the map's border. Have each group share their technology with the rest of the class, and ask the rest of the class to guess which animal(s) this technology monitors. For younger students, you can do this together as a class. Make sure each group also highlights where this technology is being used and place a coloured pylon on the map.

Once all groups have presented, ask students to consider how animal tracking and animal migration routes may change in the next 10, 20 and 50 years. How might the technology evolve?

Extend your geographical thinking

When students get back to the classroom, have them investigate animals that live and survive in the Antarctic region and the kinds of technology used to track these animals. Have students create their own Antarctic animal information cards.

Links to the Canadian National Standards for Geography

Essential Element 5: Environment and Society

- ▷ Limits and opportunities of the physical environment
- ▷ Effects of human modification of the physical environment
- ▷ Use and sustainability of resources

Essential Element 6: The Uses of Geography

- ▷ Role of multiple points of view in contemporary geographic policies and issues
- ▷ Local, regional and world policies and problems with spatial dimensions

4 Arctic Council

Learning objectives

- ▷ Students will learn about the countries in the Arctic circumpolar region and investigate why the Arctic is a valuable geographic location.
- ▷ Students will learn about the Arctic Council and the roles and responsibilities of the different groups represented on the council, including the eight Arctic member states and six permanent participants.
- ▷ Students will host a mock council to discuss and debate important topics related to the Arctic circumpolar region.

Grades

- ▷ 5-12

Materials

- ▷ Country flag cards (8)
- ▷ Arctic Council cards (14)
- ▷ Teacher discussion card (1)
- ▷ Coloured chains (16)

Set-up

Review card content and the Arctic Council background information provided on the teacher discussion card.

Introduction

Allow time for students to explore the giant floor map independently. Have students locate the Arctic Circle and outline it using the chains. Ask students to identify how many countries are located completely or partially above the Arctic Circle. [8: Canada, United States, Russia, Norway, Denmark (Greenland), Sweden, Finland, Iceland (where the Arctic Circle passes through the small offshore island of Grímsey)] Ask students to identify each country by placing its corresponding flag card on it.

Next, place a pylon on the geographic North Pole. Which country is the closest? Does the Arctic region belong to any one country in particular? Who owns the Arctic? Why would a country want to own it? Use these questions to discuss why the Arctic is important and why it is appealing to different countries.

Development

Introduce the Arctic Council to your students. Explain that the Arctic Council is the leading intergovernmental forum that promotes cooperation, coordination and interaction among Arctic states (the 8 countries identified), Arctic Indigenous communities and Arctic inhabitants. Explain to students that the Arctic Council is a forum. This means that it does not and cannot implement or enforce the decisions it makes. However, this council is important because it addresses issues faced by the Arctic states and northerners, including the Indigenous people of the Arctic.

Divide students into 14 groups and distribute a different Arctic Council card to each group. Allow time for each group to review the information on the card and use the map to explore how the Arctic circumpolar region affects their Arctic state or organization. Allow time for each group to share who they are and how they are connected to the Arctic. Based on what students now know about their state or organization, ask students to brainstorm areas of concern that most relate to them (marine, ecozone, culture, etc.). Have students share their ideas with the class.



4 Arctic Council

Conclusion

Explain to students that they will host a mock Arctic Council discussion or debate. Using the teacher discussion card provided, select one of the five Arctic issues listed on the card and introduce the topic to your class. Allow time for groups to discuss among themselves how they would address this topic and how it is connected to their country or organization. Make sure students use the map to highlight areas of concern or areas that are connected to the topic. Afterwards, act as a moderator and allow students to share their thoughts with the class. If time allows, go through the other themes listed on the card.

Conclude the lesson by asking students to reflect on the consensus-based decision-making process in an important organization like the Arctic Council.

Extend your geographical thinking

After their experience with the map, have students visit the Arctic Council website (arctic-council.org) to learn about what the Arctic Council has accomplished in its first 20 years. Have students discuss what challenges it may face in the next 20 years.

Links to the Canadian National Standards for Geography

Essential Element 4: Human Systems

- ▷ Patterns of culture in Canada and the world
- ▷ Regional development in Canada and the world
- ▷ Cooperation and conflict in the division and control of the Earth's surface

Essential Element 6: The Uses of Geography

- ▷ Role of multiple points of view in contemporary geographic policies and issues
- ▷ Influence of geographical features on the evolution of significant historic events and movements
- ▷ Local, regional and world policies and problems with spatial dimensions



5 Sea Ice in the Arctic

Learning objectives

- ▷ Students will learn about the different forms of ice and the role of leads and polynyas.
- ▷ Students will examine images of Arctic sea ice, learn how to navigate through Arctic ice using ice charts, and learn how the Arctic will change in the future.

Grades

- ▷ 7-12

Materials

- ▷ Ice image cards (9)
- ▷ Sea ice location cards (6)
- ▷ Coloured blocks (100)
- ▷ Radar satellite image (6)
- ▷ Teacher information card (1)
- ▷ Regional ice charts (4)

Set-up

Review all the cards and place them in piles near the map for easy access throughout the lesson.

Introduction

Invite students onto the map and ask them to explore the Arctic Ocean. Bring their attention to the white line in the Arctic Ocean. Have students stand along this line or use chains in the kit to outline it. Inform students that this line represents the median sea ice extent for September (1981-2010).

Explain to students that sea ice comes in a variety of types and forms. Sea ice types are defined based on the ice's stage of development. Sea ice forms are defined based on external conditions. Randomly distribute ice image cards to students. Have students examine the image on their card and read the information on the card to the rest of the class. As a class, determine if their ice is a "type" of sea ice or a "form." Use the teacher information card to access the correct answers when needed. Then use the teacher information card to introduce and define "leads" and "polynyas" (paul-in-YAWs) and why they are important. Allow time for students to hypothesize where they think this ice can be found on the map and place their card there. Ask students to consider the type of technology that was used to collect information on these different forms of ice and why something like this may be important. Who would use this data?

Explain to students that many factors play a role in where sea ice can be formed: temperature, wind, ocean currents, bathymetry (depth of ocean) and salinity (amount of salt). Explain to students that they will be given different locations in Canada's Arctic region to learn more about the type of ice found there and the factors that play a role in the formation of this type of ice. Divide students into six groups and give each a different sea ice location card. Have students find their highlighted location on the giant floor map and examine the information on the cards. Using coloured blocks, have students place a block on areas mentioned in the card information or to highlight how ice changes in these regions each season. Encourage students to use different colours to highlight different stages, movements, etc. Allow time for students to share their locations and findings with the rest of the class.

Development

Explain to students that scientists monitor and analyze ice regularly using charts, as well as raw data. Explain that ice and iceberg charts play an important role because they help plan transportation routes and various operations. These charts illustrate ice or iceberg conditions at a particular moment in time. The information is then presented using a standard international code, known as the Egg Code because of the shape of the symbol. The Egg Code shares basic data about the concentration, stages of development (age) and the form of the ice (size, shape, location).

Divide students into four groups, and give each group a regional ice chart. Allow time for students to locate the area highlighted in their chart on the map and examine the information displayed on the chart. Ask students what kind of information they can gather just by examining these charts.





5 Sea Ice in the Arctic

Explain to students that these regional ice charts show the analysis of ice conditions for a given region. The information collected is based on an analysis and integration of data from satellite imagery, weather and oceanographic information and visual observations from ship and aircraft. The charts that the students are examining indicate the stage of development and form of ice. The charts also list the average and normal temperatures of the regions, which give an indication of current ice conditions. Ask students who would find these charts useful (They are useful for the strategic planning of marine operations by shipping companies and other marine interests, as well as for researchers studying ice conditions over time.).

Conclusion

Finally, explain to students that they will take a closer look at how ships navigate through the Arctic waters and how ice can affect their routes, as well as how local communities can be influenced by changes in the ice. Explain that climate change is altering the timing, thickness and movement of ice. In ice-covered waters, ships have to pay careful attention to the location of the ice, the quantity and build-up of it, and what kind of ice is around them. Going the wrong way could waste fuel, slow the ship down or even get it stranded and stuck in the ice.

Satellite images can help. They can inform local communities and also help navigate ships through icy waters. These images can give a large view of an area so that experienced interpreters can determine the safest route through the waters before them. Explain to students that they are going to be ice interpreters. Using the same groups as before, distribute a copy of a radar satellite image to each group (note: each group will receive the same image). Have students examine the image, locate the area where this image was taken and work together to plan a safe route for the ship through the waters. Allow time for students to share how they found the location of the image and their process with the rest of the class.

Conclude the lesson by asking students who should have access to these satellite images. In Canada, who should provide these images and who should pay for them? What if a ship not from Canada is stuck, stranded, or an accident occurs? Who is responsible for search and rescue and/or for cleanup? Finally, ask students how Indigenous communities can add to the information provided by these images and how they can use them. How can these satellite images benefit Indigenous hunting practices and improve Indigenous knowledge on routes?

Extend your geographical thinking

Have students investigate different types of ice occurring in Antarctica. Encourage students to visit the following websites as resources: British Antarctic Survey website (bas.ac.uk), Polar Discovery (polardiscovery.whoi.edu), Discovering Antarctica (discoveringantarctica.org.uk).

Links to the Canadian National Standards for Geography

Essential Element 3: Physical Systems

- ▷ Physical processes shape patterns in the physical environment
- ▷ Global patterns of wind and water
- ▷ World climate regions

Essential Element 5: Environment and Society

- ▷ Effects of human modification of the physical environment
- ▷ Limits and opportunities of the physical environment for human activities
- ▷ World patterns of resource distribution and utilization
- ▷ Use and sustainability of resources

6 Arctic Monitoring

Learning objectives

- ▷ Students will learn how the Arctic circumpolar region is being monitored.
- ▷ Students will investigate specific examples of how the Arctic is being monitored and why it is important.

Grades

- ▷ 5-12

Materials

- ▷ Arctic monitoring cards (7)
- ▷ Coloured blocks (100)
- ▷ Coloured chains (16) (optional)
- ▷ Coloured pylons (20) (optional)

Set-up

Review Arctic monitoring cards and separate coloured blocks by colour so each group has one colour to work with.

Introduction

As students are exploring the map, review with them how many countries have land claims in the Arctic circumpolar region (8), what the white line highlighted on the map means (median sea ice extent for September 1981-2010) and what the red boxes displayed in Canada's territories represent (research facilities). Explain that the Arctic circumpolar region is changing drastically as the climate changes. Climate change affects the Arctic faster and more severely than the rest of the world. The Arctic is warming at a rate of almost twice the global average. Monitoring this region is extremely important for understanding the effects of the changing climate. Ask students to brainstorm what types of monitoring might be occurring in this region, using the map to highlight areas of interest.

Development

Divide students into seven small groups and give each group a different Arctic monitoring card. Explain that each group will investigate further into specific examples of how the Arctic is being monitored. Each group is to examine the information on their card, use the coloured blocks, pylons and chains provided to highlight specific locations on the map and determine why this form of monitoring is important. Encourage students to consider what role their form of monitoring plays for local communities, Indigenous knowledge and Canada as a whole.





6 Arctic Monitoring

Conclusion

Gather students back along the map's border, asking students not to disrupt the blocks placed on the map. Allow time for each group to share their monitoring topic, highlighting the key areas where they placed their blocks on the map and why they feel this type of monitoring is important as the Arctic continues to change. When students are finished presenting, ask the class how each topic is connected and what patterns they see. Have students determine the top three things they feel are the most important to monitor and explain why. Finally, ask students to consider how northern communities will be affected as the environment in the Arctic changes. Discuss how traditional ways of life for Indigenous communities may change.

Extend your geographical thinking

Once students get back to class, have them continue to investigate how the Earth's polar regions are being monitored by focusing their attention on how scientists are monitoring Antarctica. Have students compare and contrast how Antarctica and the Arctic are being monitored and explore the necessity of drawing linkages between both poles.

Links to the Canadian National Standards for Geography

Essential Element 4: Human Systems

- ▷ Patterns of culture in Canada and the world
- ▷ Regional development in Canada and the world
- ▷ Transportation and communications networks in Canada and the world

Essential Element 5: Environment and Society

- ▷ Perceptions of and reactions to extreme natural events
- ▷ Limits and opportunities of the physical environment for human activities
- ▷ Global effects of human modification of the physical environment



7 Climate Change: Indicators and Signs

Learning objectives

- ▷ Students will learn about climate change and explore indicators that can be used to assess climate change in the Arctic.
- ▷ Students will create their own Arctic report card to assess these indicators.
- ▷ Students will consider what the future of the Arctic looks like and how Indigenous communities will need to adapt to its changing climate.

Grades

- ▷ 7-12

Materials

- ▷ Climate graphs (11)
- ▷ Pylons (20)
- ▷ Arctic report card (10 copies)
- ▷ Whiteboard markers (10)

Set-up

Review the indicators on the Arctic report card to determine if these terms need to be reviewed with students prior to or during the lesson.

Introduction

Once students have had an opportunity to explore the map, ask them to stand on a community on the floor map. Next, ask them to consider what the weather is like at this location. If your hometown is highlighted on the map, place a pylon there and discuss weather patterns your students have experienced over the past year.

Ask students what the difference is between weather and climate, and why both are important. Explain that weather means the short-term conditions of the atmosphere. It is what you see outside on any particular day. Climate, on the other hand, is the average of weather over time and space. It measures trends in the atmosphere over a longer period of time.

Ask students what climate change is, and ask them to think about and locate areas on the map that may be at risk as the Earth warms. Have students stand around the white line labelled on the map, which represents the median sea ice extent for September (1981-2010). Next, ask students to locate places where glaciers, ice caps (ice masses that cover a land area less than 50,000 square kilometres), ice sheets (ice masses covering a land area greater than 50,000 square kilometres) and permafrost can be found, and ask students to consider how these landscapes may change. Explain to students that on average, temperatures on the Earth's surface have increased by 0.6°C over the last two centuries, and most of the warming has occurred in the past 50 years. The Arctic is warming twice as fast as the rest of the planet, causing great challenges for communities living there. Ask students how your local community and communities in the Arctic circumpolar region could adapt to this changing climate. How do changes at the poles affect global weather and climate change patterns?

Development

Divide the students into 11 small groups, and give each group a climate graph. Have each group locate their city or town on the map. Notify students that the purpose of a climate graph is to compare precipitation and temperature of a given region. Have a class discussion about Arctic climate. Ask students which places have temperatures below -15°C, which months have the highest precipitation and which communities have similar data. If your community is located on the map, place a pylon on this location and have students compare and contrast the climate graphs from other communities.





7 Climate Change: Indicators and Signs

Explain to students that there are many factors to consider when determining the effects of climate change in the Arctic. Inform students that they are going to create their own Arctic report card. Similar to the school report cards students receive each year, an Arctic report card is important to highlight vital signs, indicators and changes in the Arctic on a yearly basis.

Distribute the blank report card sheets to groups of students. Inform them that their task is to explore the map and come up with three key indicators that should be assessed each year. Go over the list of indicators as a class, and check that they understand all the terms. For each indicator they identify, students have to explain why this is important to monitor and how it should be graded. Finally, students are encouraged to identify a location that they consider to be the best place to gather data. Students may use the research facilities highlighted on the map with red squares, or they may choose their own location.

Conclusion

Allow time for each group to share their report card with the class. Have students sit along the map's border so that those who are presenting can highlight their key indicator and explain how it should be monitored. Conclude the lesson by asking students to consider the types of adaptation issues that may come up in Canada and how local communities should address them. What does the future of the Arctic look like and what can be done to preserve this delicate region? How can Indigenous communities and the entire planet adapt to the changing climate?

Extend your geographical thinking

Have students determine how climate change is influencing Antarctica. Have them discuss which three indicators they feel are the most important for this region.

Links to the Canadian National Standards for Geography

Essential Element 2: Places and Regions

- ▷ Factors that influence people's perception of places and regions
- ▷ Changes in places and regions over time
- ▷ Regional analysis of geographic issues and questions

Essential Element 5: Environment and Society

- ▷ Limits and opportunities of the physical environment for human activities
- ▷ Environmental issues
- ▷ Global effects on the human environment of changes in the physical environment



8 Arctic Renewable Resources

Learning objectives

- ▷ Students will learn about the growing use of renewable energy and how solar, wind, hydro and biomass are being used to reduce the dependency on diesel in the North.
- ▷ Students will learn about the renewable energy resource potential of the eight countries in the Arctic circumpolar region.

Grades

- ▷ 7-12

Materials

- ▷ Country renewable cards (8)
- ▷ Flag cards (8)
- ▷ Nunavut community cards (13)

Set-up

Review the country renewable cards and the Nunavut community cards.

Introduction

Once students have had a chance to explore the map, gather them around the map's border. Inform students that Canada is one of the only countries able to produce energy using 10 different resources. Ask students if they can name these resources (wind, sun, biomass, geothermal, natural gas, crude oil, hydropower, liquid natural gas, tidal, nuclear), what the difference is between a renewable and non-renewable resource (renewable resources are those that can be replenished quickly or are near-infinite, such as the sun; non-renewable resources are finite). Identify which of Canada's 10 resources are non-renewable.

Invite students back onto the map and ask them to explore and consider which resources can be used in the Arctic circumpolar region. Ask students how renewable energy can be used in the Arctic climate and why some Arctic communities may prefer to use renewable resources rather than non-renewable. After students have shared their answers, inform students that renewable energy has potential in the Arctic circumpolar regions but faces different challenges than regions with warmer climates. Ask students what these challenges may be, and have them use the map to explain their answers where possible (expensive to transport, fly-in-only communities, smaller population and smaller markets, 24-hour darkness in winter, challenging climate, frozen ground, etc.).

As a result, many Arctic communities in the circumpolar region depend strongly on diesel fuel. Explain that diesel fuel is the energy source of choice in most Arctic communities because it is reliable in a place where weather can be unpredictable, and already has established supporting infrastructure in Northern communities. Unfortunately, using diesel has high logistical and financial costs (transporting it to remote communities) and negative impacts on the environment (large emissions into the atmosphere). It also hinders the self-sufficiency of northern communities. As the Arctic landscape continues to change due to climate change, and as more and more countries pledge to decrease their dependency on fossil fuels, developing renewable energy projects in the Arctic circumpolar regions is more important than ever before.

Development

Divide students into eight groups, each group representing a different Arctic country. Give each group their flag card and have them locate their country and sit in or around it. Allow time for students to brainstorm which renewable resources they feel their country has potential for. Next, distribute the country renewable cards to each group, ensuring the card matches the appropriate country. Allow time for groups to review the information on their card and locate places in their country that play a role in the development and progression of renewable projects.

Have each group randomly select one community in their country. Ask students to consider the needs of their community and determine





8 Arctic Renewable Resources

which renewable resources would thrive in this location. Remind students to consider geographical factors such as latitude, available sunlight, energy demand and accessibility to energy infrastructure. When students are ready, allow them time to share information about their country, selected community, thoughts about its energy demand and its renewable energy future.

Conclusion

After presentations are complete, bring students back to the map's border and focus their attention on Nunavut. Explain that there are still very few renewable energy projects in the Canadian Arctic, and that in most cases wind turbine or solar-panel installations are not large enough to make a substantial dent in diesel use. However, the World Wildlife Federation (WWF) has been working on an Arctic renewable energy program along with the Waterloo Institute for Sustainable Energy (WISE) to demonstrate that low-impact renewable energy from wind and the sun is possible and can contribute to sustainability in northern Canadian communities and to a cleaner Arctic environment. The study demonstrates how a mix of renewable energy in northern communities can lead to a reduction in carbon dioxide (CO₂) emissions and reduce costs, making renewables cheaper for local community members.

Distribute the 13 Nunavut community cards to pairs or small groups. Ask students to locate their community and examine the numbers on the card. Ask students what these numbers mean (potential for CO₂ emissions reduction, cost savings, and practical and sustainable use of renewable energy in a community). Once students have located their communities, ask them to discuss which communities show the highest potential for integrating a successful renewable energy project. Have students discuss this using the numbers on their cards. Inform students that WWF selected Sanikiluaq, Iqaluit, Rankin Inlet, Arviat and Baker Lake as their communities to explore further. All of these identified communities have the potential to add at least 34 per cent renewable energy use to their energy mix, which would lead to at least a 20 per cent reduction in energy operation and maintenance costs and a 34 per cent reduction in CO₂ emissions. WWF Canada and WISE will perform a detailed feasibility study on the selected five communities. WWF will then work with partners to support community pilot projects in at least two Nunavut communities by 2020.

Extend your geographical thinking

Now that students have explored renewable energy projects in Nunavut, Canada, divide students into pairs or small groups and have them explore renewable energy projects in other parts of the Canadian Arctic and in other Arctic countries. Next, bring attention to Antarctica and have students investigate how research stations are employing renewable energy sources and what issues and challenges they may face. Which ones are similar to the potential projects in the Arctic region, and which ones are different?

Links to the Canadian National Standards for Geography

Essential Element 4: Human Systems

- ▷ Types and patterns of human settlement
- ▷ Types and patterns of economic activity
- ▷ Economic development by world regions, countries and regions within countries

Essential Element 5: Environment and Society

- ▷ Changes in the importance of energy resources
- ▷ Environmental issues
- ▷ Global effects on the human environment of changes in the physical environment
- ▷ Use and sustainability of resources



9 Northern Housing Challenges

Learning objectives

- ▷ Students will learn about the housing challenges that Indigenous and non-Indigenous communities in the Arctic circumpolar regions face because of the changing climate and remoteness of the area.
- ▷ Students will design affordable and sustainable housing for an Arctic community.

Grades

- ▷ 7-12

Materials

- ▷ Climate graphs (from activity 7) (11)
- ▷ Blueprint cards (11)
- ▷ Whiteboard markers (11)

Set-up

Lesson 7 on climate change is a great lesson to do before this activity. Review activity 7 prior to this activity.

Introduction

Once students have had an opportunity to explore the map, gather them around the map's border and distribute the 11 climate graphs to pairs or small groups. Have students locate the community highlighted on their climate graph and stand on this community. If your own school's community is on the map, place a coloured pylon on it. Once students have had time to examine information provided on their climate graphs, ask students what the weather is like in their community. Have students compare the temperature and precipitation patterns with their own community, or if your community is in the Arctic, then another community farther away.

Next, ask students to consider the type of infrastructure and housing that would need to be developed in their community. What characteristics do they think buildings would or wouldn't have? Explain that building and maintaining housing in the Arctic circumpolar region is challenging because of the Arctic environment, changing climate, brief construction season and limited local resources. On average, building costs are 150 per cent higher in the North than the rest of Canada, and actual costs in the more isolated communities are likely even higher. Affordability is a barrier for many people; therefore, reliance on public housing is high. Much of the current public housing stock is old, in need of major repairs and energy-inefficient. Also, the housing designs are often culturally unsuitable for large Indigenous families, for whom it is customary for many generations to live in one home, and do not meet the needs of life in the North. Many families in northern communities require open spaces for family gatherings and a large work space with a sink suitable for cleaning fish and preparing skins. All households require running water as well as heating, ventilation, and insulation that can maintain comfortable and healthy conditions when it is extremely cold outside. Household crowding is a significant issue in the North that has been associated with health problems like respiratory infections, transmission of infectious diseases and mental health issues.

Development

Inform students that they are going to act as Arctic architects and design sustainable and affordable housing for the community that matches their climate graph. Students must consider the harsh climate, geography, availability of building supplies (or how their building supplies would get to them) and the needs of Indigenous people living in the Arctic (food preparation area for animals collected through hunting, cold storage for furs and equipment, etc.). Have students work together, using the blueprint cards and whiteboard markers, to design a sustainable building in their community, focusing on building materials, construction, design, ventilation and access to electricity, keeping in mind how changes to permafrost, technology and availability of resources may play a role in developing an energy-efficient home.





9 Northern Housing Challenges

Conclusion

Ask each group to select one spokesperson to share their housing proposal with the rest of the class. Once all designs have been shared, ask students to reflect on each housing proposal. Hold a discussion on which one is the most feasible and how alternative and renewable energy can be incorporated into the housing design.

Extend your geographical thinking

Encourage students to explore the construction of Polar Knowledge Canada's Canadian High Arctic Research Station (CHARS) campus by going to canada.ca/en/polar-knowledge. Have students explore where the station is located, its design and construction, and how the local community was involved.

Links to the Canadian National Standards for Geography

Essential Element 2: Places and Regions

- ▷ Factors that influence people's perception of places and regions
- ▷ How culture affects places and regions
- ▷ Critical issues and problems of places and regions
- ▷ Regional analysis of geographic issues and questions

Essential Element 4: Human Systems

- ▷ Population density, distribution and growth rates
- ▷ Patterns of culture in Canada and the world
- ▷ Regional development in Canada and the world
- ▷ Transportation and communications networks in Canada and the world



10 Communication in Arctic Communities

Learning objectives

- ▷ Students will learn about the current status of communication technology in northern communities and the importance of connectivity in the North.
- ▷ Students will learn about the history and development of information and communication technology in Canada's circumpolar region.
- ▷ Students will explore specific examples of how Arctic communities in Canada are using information and communication technology.

Grades

- ▷ 7-12

Materials

- ▷ Community cards (5)
- ▷ Timeline cards (3)
- ▷ Coloured pylons (20)

Set-up

Review the information on the community cards.

Introduction

Once students have explored the map, ask them how they stay in touch with and communicate with their family and friends. Next, ask students how they gather information outside school (TV, radio, computer, Internet, books, etc.). Finally, ask students to consider how they use the Internet and other communications technology that helps to improve their daily lives. Ask students to consider how their lives would be different if they did not have easy access to a TV, radio, computer or the Internet.

Bringing students' attention back to the map, ask them to stand on a community that they think relies on satellite communications technology. Highlight any patterns and trends that students observe. If your own school's community is on the map, place a pylon on that location and have a class discussion about the type of communications technology that is available in your community and how this technology may develop in the future.

Explain to students that the term "information and communications technology" (ICT) refers to any communication device or application, including radio, television, cellphones, computer and satellite systems. It also includes services such as videoconferencing and distance learning. The importance of ICT lies in its ability to create greater access to information and communication from places outside your community, this also includes economic and educational opportunities.

Development

With students still standing on their communities, use the three timeline cards provided to go through how communication developed in Canada's Arctic. For older grades, select three students to read each card, pausing after each card to discuss and use the map to highlight particular areas. Begin by explaining that during the early 20th century, Canada's Arctic communities were isolated from one another and from the rest of Canada. Ask students how they would have communicated, highlighting their location and the specific challenges their community may have faced. (Answer: communications took place through personal contact or mail carried on annual supply ships.) Once each card has been read, use the following guiding questions to encourage student discussion.

- **First half of the 20th century:** Ask students about what sorts of issues were addressed when the new technology of high-frequency radio was introduced to northern communities (hard-to-access local and regional information, delayed response, etc.).
- **Mid to late 20th century:** Ask students what effect Inuit-language radio and, later, television might have had.
- **Since the late 1990s:** Ask students why Internet access may have changed the community they are standing on. (Answer: Internet access allows easy two-way communication within northern communities, between communities in Canada and with people worldwide.)





10 Communication in Arctic Communities

Now that students have an understanding of the development and the history of information and communication technology, divide students into five groups and give each group a different community card. Allow time for each group to review the information on their card, locate their community on the map, and learn more about how this particular Arctic community uses communication technology and what could change if the technology were to improve.

Conclusion

When groups are ready, have each group select a spokesperson to share what they learned with the rest of the class. After each group has finished presenting, place a pylon on that location. Once all the groups have shared what they learned, ask students to reflect on any patterns and trends they may see in the different examples. Is there a particular part of the country where enhanced technology should be a priority? What does the future hold for information and communication technology in the Arctic (improved satellite service, fibre optic cables, new inventions, etc.)?

Extend your geographical thinking

As climate change continues to alter the Arctic circumpolar landscape, the use of technology alongside traditional and Indigenous knowledge is becoming more and more important. Have students select one challenge that Arctic communities are facing, and investigate how traditional and Indigenous knowledge can help address this issue.

Links to the Canadian National Standards for Geography

Essential Element 4: Human Systems

- ▷ Transportation and communications networks in Canada and the world
- ▷ Global economic interdependence

Essential Element 6: The Uses of Geography

- ▷ Role of multiple points of view in contemporary geographic policies and issues
- ▷ Influence of geographical features on the evolution of significant historic events and movements
- ▷ Local, regional and world policies and problems with spatial dimensions