Extreme Environments

Grade 6 Science and Applied Design, Skills, and Technologies

BRITISH COLUMBIA
Ministry of Education

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This resource is a comprehensive module designed to address the learning standards and core competencies outlined in the new BC Curriculum for Grade 6 Science and Applied Design, Skills, and Technologies. It was developed by Open School BC, in partnership with the Ministry of Education's Curriculum and Assessment team.

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Contents

Module Framework

This Grade 6 Science and Applied Design, Skills, and Technologies module on extreme environments is inquiry-based and cross-curricular.

In the Science section of this module, students research one of the five types of extreme environments in depth, and make a presentation to the class. For the ADST section, students design and build a technology that scientists could use to study the extreme environment that they researched.

Extreme environments highlighted in this module include:

- volcanoes
- deserts
- polar regions
- oceans
- space

There are a variety of other ways this module could be taught.

  - » Rather than covering all five extreme environments, the teacher chooses one or more to teach.
  - » Extreme environment stations could be set up in the classroom for small groups of students to rotate through, to study all the extreme environments.
  - » Small groups could research extreme environments on Earth, and Space is studied as a class.

Curriculum Connections

SCIENCE 6

Big Ideas

- Multicellular organisms rely on internal systems to survive, reproduce, and interact with their environment.
- The solar system is part of the Milky Way, which is one of billions of galaxies.

Essential Question

- What do humans need to survive?

Learning Standards

Content

- the position, motion, and components of our solar system in our galaxy

Elaboration:

Extreme environments including contributions of Canadians to exploration technologies

Curricular Competencies

Questioning and Predicting

- Demonstrate a sustained curiosity about a scientific topic or problem of personal interest
- Identify questions to answer or problems to solve through scientific inquiry

Planning and Conducting

- Demonstrate a sustained curiosity about a scientific topic or problem of personal interest
- Identify questions to answer or problems to solve through scientific inquiry

Planning and Conducting

- With support, plan appropriate investigations to answer their questions or solve problems they have identified
- Choose appropriate data to collect to answer their questions

Processing and Analyzing Data and Information

- Construct and use a variety of methods, including tables, graphs, and digital technologies, as appropriate, to represent patterns or relationships in data
- Identify First Peoples' perspectives and knowledge as sources of information

Evaluating

- Demonstrate an understanding and appreciation of evidence
- Identify some of the social, ethical, and environmental implications of the findings from their own and others' investigations

Applying and Innovating

- Contribute to care for self, others, and community through personal or collaborative approaches
- Co-operatively design projects

Communicating

- Communicate ideas, explanations, and processes in a variety of ways
- Express and reflect on personal, shared, or others' experiences of place

Curriculum Connections

ADST 6

Big Ideas

- Design can be responsive to identified needs.
- Complex tasks may require multiple tools and technologies.

Learning Standards

Curricular Competencies

Understanding context

- Empathize with potential users to find issues and uncover needs and potential design opportunities

Defining

- Choose a design opportunity
- Identify key features or potential users and their requirements
- Identify criteria for success and any constraints

Ideating

- Generate potential ideas and add to others' ideas
- Screen ideas against criteria and constraints
- Evaluate personal, social, and environmental impacts and ethical considerations
- Choose an idea to pursue

Prototyping

- Identify and use sources of information
- Develop a plan that identifies key stages and resources

- Explore and test a variety of materials for effective use
- Construct a first version of the product or a prototype, as appropriate, making changes to tools, materials, and procedures as needed
- Record iterations of prototyping

Testing

- Test the first version of the product or the prototype
- Gather peer and/or user and/or expert feedback and inspiration
- Make changes, troubleshoot, and test again

Making

- Identify and use appropriate tools, technologies, and materials for production
- Make a plan for production that includes key stages, and carry it out, making changes as needed
- Use materials in ways that minimize waste

Sharing

- Demonstrate their product and describe their process, using appropriate terminology and providing reasons for their selected solution and modifications
- Evaluate their product against their criteria and explain how it contributes to the individual, family, community, and/or environment
- Reflect on their design thinking and processes, and evaluate their ability to work effectively both as individuals and collaboratively in a group, including their ability to share and maintain an efficient co-operative work space
- Identify new design issues

Core Competencies

Communication

- Connect and engage with others
- Acquire, interpret, and present information

Creative Thinking

- Generating Ideas
- Developing Ideas

Critical Thinking

- Analyze and critique
- Question and investigate

First Peoples Principles of Learning

- Learning takes patience and time.
- Learning is holistic, reflexive, reflective, experiential, and relational.

Part One: Science 6

Learning Plan 1: Introduction to Extreme Environments

Students learn that an extreme environment is any place that is missing one or more of the basic conditions humans need to survive. Students research one extreme environment and present their research to the class.

Overview

Activities	Possible Assessments
Mind mapping	Students' questions and observations made during the mind mapping process.
Identify conditions that make an extreme environment.	Assess answers to: ▪ What conditions does your body need to survive? ▪ What is an extreme environment?

Materials

- Computer / Projector
- Whiteboard or Flipchart paper for mind mapping
- **What do humans need to survive?** Slide show
- Optional: **Staying Alive** matching exercise

Introduction

- Essential inquiry questions for this module are:
  - What is an extreme environment?
  - What extreme environments exist on Earth and in our galaxy?
  - What technologies are used to explore extreme environments?
  - What technologies have Canadians contributed?
- Explain to students that in Part One of this module they will research one extreme environment.
- In Part Two, students will design and build a prototype of a new piece of equipment, clothing, a device or technology to help scientists explore the extreme environment they researched.

Accessing Prior Knowledge: What conditions does your body need to survive?

Core Competency	Critical Thinking

- Question and investigate

- On a board or a flipchart, write the following essential question in the middle:

What does your body need to survive?

- Using a mind map, brainstorm all the conditions necessary for human survival and write them on the board. The list should include: air, fresh drinking water, food, moderate temperature, proper air pressure, and a source of natural light.

Note: For this exercise, you may have to differentiate "needs" versus "wants."

- Continue adding spokes on the mind map as you ask students why the conditions identified are vital for human survival.

  Your list may include the following:

Air

- Oxygen from air is absorbed into the bloodstream and carried to cells.
- Carbon dioxide is breathed out, expelled from our lungs.
- Humans depend on this exchange of gases in the cycle of breathing to stay alive.

Potable water

- Our bodies are made up of 50-70% water.
- Water helps control body temperature.
- Water allows nutrients to travel through our bodies.
- Water transports oxygen to our cells.

Food

- Food fuels our bodies.
- Food provides nutrients to help our bodies function properly.
- Food keeps our blood circulating.
- Food provides energy.

Moderate temperature

- Too hot, our bodies cannot cool.
- Too cold, can lead to frostbite - freezing of the body's tissues.

Proper air pressure

- The combined weight of tiny air molecules causes a pressure pressing down on people's bodies.
- Air exerts this pressure in all directions¬—down, out and up—which balances out the force on our bodies so that we don't collapse.
- Air exerts massive pressure, but the pressure inside our bodies balances it.
- Proper air pressure allows us to inhale and exhale.
- Proper air pressure lets certain gases dissolve in our bloodstream.

Source of natural light

- Without a sufficient amount of natural light, our sleep, appetite, moods, and other functions in our bodies can be affected.
- Too much exposure to Sun's radiation can cause skin cancer and eye diseases, and affect the body's ability to fight infection.

Activity 1: Identify Extreme Environments

- Remind students that an extreme environment is any place that is missing one or more of the basic conditions humans need to survive.

- While projecting the slide show**, What do humans need to survive?** (in the Teacher section of the extreme environment web page), ask students to identify which survival conditions are missing in that environment.

  - volcano
  - desert
  - polar region
  - ocean
  - space

- Optional: Individually or in small groups, have students complete the **Staying Alive** matching exercise.

Learning Plan 2: Students Research and Present Extreme Environments

Individually or in small groups, students research one extreme environment and make a presentation to the class.

Overview

Activities	Possible Assessments
Research extreme environments	Observe students' abilities to gather and evaluate relevant resources. ▪ Are they able to collect pertinent information? ▪ Are their sources reputable? ▪ Are they making inferences from the information they gathered? ▪ Are they making connections to prior knowledge? ▪ Are they considering any local knowledge of extreme environments?
Group presentations	Class co-constructed presentation rubric Peer assessment Descriptive feedback

Materials

- computers or devices
- internet access
- *Extreme Environment* webpage resources
- library books on extreme environments

Introduction:

- Individually or in small group, students research one of the following extreme environments:
  - volcanoes
  - deserts
  - polar regions
  - oceans
  - space

- Tell students to imagine that Science and Innovation Canada has asked them, as scientists, to design and build a prototype of equipment, clothing, or technology to explore extreme environments. Before they build their prototype, they need to research the extreme environment, and present their findings to your colleagues.

Activity 1: Research

Core Competency	Critical Thinking

- Analyze and critique
- Question and investigate

- As a class, brainstorm inquiry questions students would need answered in order to design and build a prototype for their extreme environment. What might they need/want to know? Examples include:
  - What makes the environment extreme?
  - What are the challenges and obstacles to explore the environment?
  - What harmful conditions do humans need to be protected from?
  - Where on Earth is the extreme environment located?
  - Why does exploration of this environment matter to us? What do we need to learn?
  - What existing technologies have been created to explore the environment?
  - Are there technologies First Peoples use to explore the extreme environment?
  - What knowledge and technologies has Canada contributed to the exploration of this environment?
- Review the Students' section of the webpage to show students where to find research resources.
- Individually or in pairs, students begin researching their extreme environments.

Activity 2: Presentation

Core Competency	Communication

- Connect and engage with others
- Acquire, interpret, and present information

- With students, co-construct criteria for evaluating a presentation, and write it down where the class can see. (regular eye contact, audience engagement, appropriate speaking volume and body language, pertinent information is covered, presentation is concise, etc.)
- Students present their extreme environments research to the class.

Part Two: ADST 6

Learning Plan 3: Design and Build a Prototype

Using the stages of design and the scientific method, students draft and build a prototype (form of technology, mode of transportation, equipment, robot, clothing, machine, device, etc.) for scientists to explore the extreme environment the students researched.

Overview

Activities	Possible Assessments
Prototype a new product	▪ Student Self-assessment Rubrics • Concept Generation and Designing • Testing and Manufacturing • Sharing ▪ Teacher Evaluation Rubric

Materials

Blackline master - Prototype Recording Sheet
Rubrics

Note: The resources will largely be determined by the prototype ideas students come up with. Or, you may require groups to work with the materials available. Here are a few examples below:

- drawing and drafting materials
- electronic hardware and software
- fabrics / textiles (sewing needles, thread, sewing machine)
- metal
- wood
- hand tools (drills, hammers, saws, screwdrivers, nails, clamps, vise grips, soldering gun)
- cardboard (glue, X-Acto knife, scissors)
- recycled plastics
- 3D printer (if school has access to one)

Activity 1: Identifying a Problem

- Extreme environment groups work together for this ADST Learning Plan. Tell students their task will be to design, prototype, test, and make a new piece of equipment or technology for scientists to use when exploring a particular extreme environment.

  Identify the problem:
  What special equipment, technology, machine or device do scientists need to explore the extreme environment?

- Have students fill out the "Identify the Problem" section of their "Prototype Recording Sheet."
- Have students identify the key features and their requirements.
- Have students fill out the "Constraints" section of their "Prototype Recording Sheet." (*What can and cannot this equipment or technology do?*)

Activity 2: Concept Generation and Designing

Core Competency	Creative Thinking

- Generating Ideas
- Developing Ideas

- Have students work in their extreme environment groups to brainstorm different prototypes that will solve the problem.
- Guide students how to actively listen to each other's ideas and ask probing questions: Why did you choose_____? Why is that important? Have you thought about _____?
- After 10–15 minutes of discussion, bring the students back together and have groups report out on their ideas. Model the thoughtful questioning process and refining of ideas for the class by asking the same probing questions above. List on the board the potential options that the students may not have thought of.
- Have students select two ideas to prototype and test and fill in the "Materials / Resources" section of the "Prototype Recording Sheet."
- Have students complete the "Concept Generation and Designing Self-assessment Rubric."

Activity 3: Prototyping

- Have students prototype their own designs using available materials.

Activity 4: Testing

- Have the students walk around the class and compare their designs with other groups. Encourage students to ask questions of other groups.
- Have students discuss which prototype worked the best according to their understanding of the clients' needs.
- How does their prototype solve the problem?

- How could they refine and improve on their design (Prototype 1.0)? Are there more constraints they could take into consideration? Can they refine their design for efficiency, ease of making, and expense of materials?
- If no, can they go back to the brainstorming design stage to choose a new design to prototype (2.0 or 3.0) to build and test?

Activity 5: Making

- Have students discuss what is the best material for the job. What material is cheapest? Easiest to use? Can recycled material be used?
- Have students self-assess or complete a reflection activity on their ability to work effectively both as individuals and collaboratively in a group, including their ability to share and maintain an efficient co-operative workspace.
- Have students complete the "Testing and Manufacturing Self-assessment Rubric."

Activity 6: Sharing Prototypes

- Have students present:
    - which prototype worked better and why
    - which one may need refinements
    - which is ready to be put into production
- Students share which prototype they felt was the best for scientists to explore their extreme environment and explain their rationale.
- Have students complete the "Sharing Self-assessment Rubric."
- Have students fill in the "After you test your prototype" sections on the "What I know and learned about designing" blackline master.

Extension Activity

- Students develop a marketing plan including branding, budget, and pricing the product.
- Students explore how their product could be adapted to respond to more than one extreme environment.