SCIENCE NORTH SCIENCE NORD
SUDBURY, ONTARIO, CANADA

Mission Carbon Emissions	Grade 7 & 8

Lesson Plan

Coding Tool	Scratch
Time Required	2 periods

Math Curriculum Connections

Algebra: Coding

C3. Solve problems and create computational representations of mathematical situations using coding concepts and skills

Specific Expectations

C3.1 solve problems and create computational representations of mathematical situations by writing and executing code

C3.2 read and alter existing code, including code that involves events influenced by a defined count and/or sub-program and other control structures, and describe how changes to the code affect the outcomes and the efficiency of the code

Science Curriculum Connections

Heat in the Environment

Heat has both positive and negative effects on the environment.

Overall Expectations

1. Assess the costs and benefits of technologies that reduce heat loss or heat-related impacts on the environment.

Specific Expectations

1.2 Assess the environmental and economic impacts of using conventional and alternative forms of energy

3.8 Identify common sources of greenhouse gases and describe ways of reducing emissions of these gases

Description

Students will investigate the environmental impacts of choices that increase or reduce emissions of greenhouse gases using both hands-on classroom activities and on-screen coding activities. They will apply their learning to build and iterate code that applies conditional statements, variables, integers, and loops. The result will be a playable game that describes the relationships between gas emissions and environmental impacts.

Success Criteria

- Students will be able to identify sources of carbon dioxide as a greenhouse gas and describe how individual and systemic decisions have impacts on the environment.
- Students will be able to apply computational thinking to describe programs using flowcharts
- Students will be able to apply computational thinking and control structure fundamentals to build and modify a playable game using Scratch.

Materials and Media

- Mission Carbon Emissions Cards Printouts
- Scissors
- Mission Carbon Emissions Game Instructions
- Mission Carbon Emissions Flowchart
- iPads or Computers with access to Scratch
- Marbles, beans, etc. to serve as counters
- Containers to hold the marbles
- Paper
- Pencils
- Rulers

Computational Thinking Skills

The unplugged activity will introduce the practice of flowcharting. Making a flowchart is a great way to practice computational thinking and logic flow. The process of computational thinking involves **decomposition** (breaking down tasks into smaller parts, including inputs, outputs, and decisions), **pattern recognition** (noticing and clearly indicating instructions that repeat), **abstraction** (focussing on only the relevant information to create clear and concise instructions), and building **algorithms** (step by step instructions, as in the steps of a program).

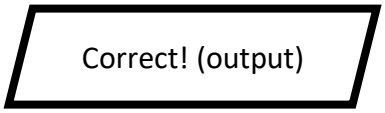
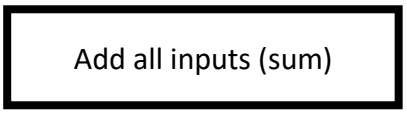
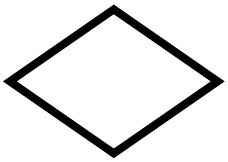
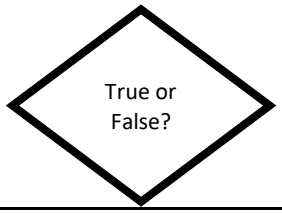
The online coding program will reinforce coding fundamentals, including control factors, such as conditional statements, loops, and wait blocks, and the use of variables to store inputs that will influence program outputs.

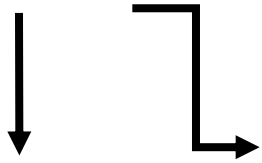
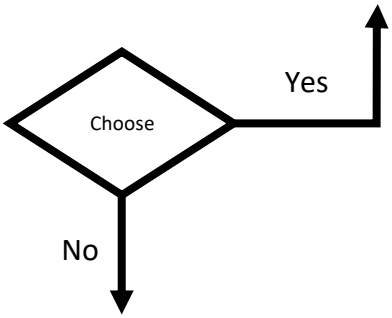
Introduction

Introduction to Flowcharting

In this lesson, we will be practicing computational thinking using flowcharts.

Flowcharts use standard shapes to represent information. For example:

	**Ovals/rounded rectangles** are used to indicate the beginning and end of a program.	**Example:** 
	**Parallelograms** represent data as inputs (information being entered into or received by the program) or outputs (information being delivered by the program).	**Example:** 
	**Rectangles** represent a process, action step, or an operation, like calculations, modifications, or manipulations of data.	**Example:** 
	**Diamonds** represent decisions or conditions. They can have two or more lines flowing from them, one for each possible outcome.	

	**Arrows** represent how to move from one step to the next in the program. The direction of the arrow points to the next step in the program. Some arrows are labelled to help clarify logic flow (e.g., if the arrows are attached to a decision diamond)	

These shapes and arrows can be linked together to describe algorithms, or the steps of a program.

Introduction to Greenhouse Gas Emissions:

Greenhouse Gases, like carbon dioxide and methane, are atmospheric gases that allow for solar radiation to pass through the atmosphere, but absorbs the radiation that the earth emits back toward space. This trapped radiation makes the earth's surface warmer, and is a contributing factor to climate change.

Human activities are one of the main causes of greenhouse gas emissions. Activities that emit the most greenhouse gases usually involve burning fossil fuels. Fossil fuels are carbon-based fuels that were formed hundreds of years ago from the remains of plants and animals (fossils). Coal, oil, natural gas, and propane gas are fossil fuels that people use in their everyday lives.

You can think of this in terms of moving carbon that is stored in the ground as fossil fuels into the atmosphere as gas emissions.

A **carbon footprint** is the total greenhouse gases emissions caused by personal choices like what products we buy (e.g., is it in a plastic container? Does it contain components created by burning fossil fuels), what food we eat (e.g., are we buying food grown locally or food that has to be transported from far away? How is the food that we eat made?), and how we travel (e.g., are we traveling in ways that use more fossil fuels (gas) like traveling by plane or car?) and industrial processes and services that burn fossil fuels, like manufacturing, food production, transportation, construction, and more.

In this lesson we are going to look at how to the choices we make (at a personal and global level) can affect the outcome of how much carbon we are releasing into the atmosphere.

Action

Flowcharting Practice:

let's create a simple program to describe waking up to an alarm clock.

The steps that we're going to describe:

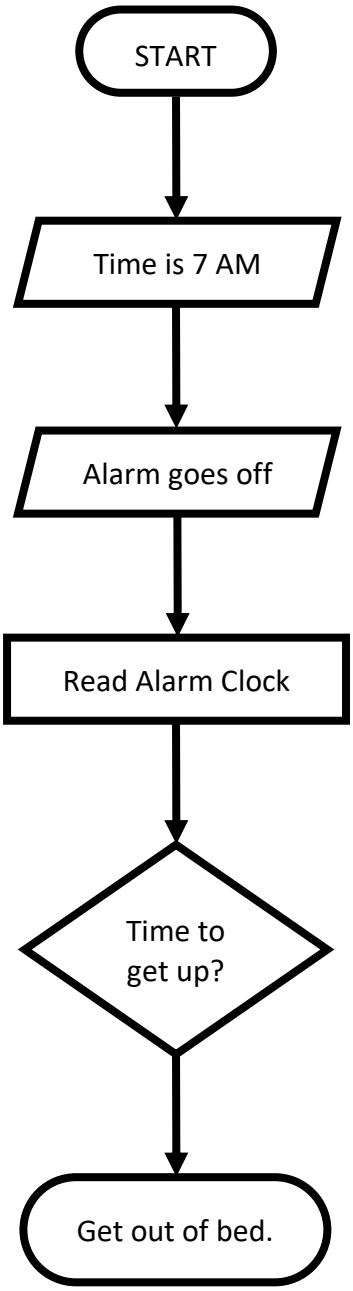
1. Start.
2. Time reaches 7 AM
3. Alarm clock rings.
4. Read Alarm Clock
5. Are you ready to get up?
6. Get out of bed*

* This isn't the only possible outcome! We'll visit the second outcome later in this lesson.

First, let's take a closer look at the steps we've chosen. What kind of steps are they?

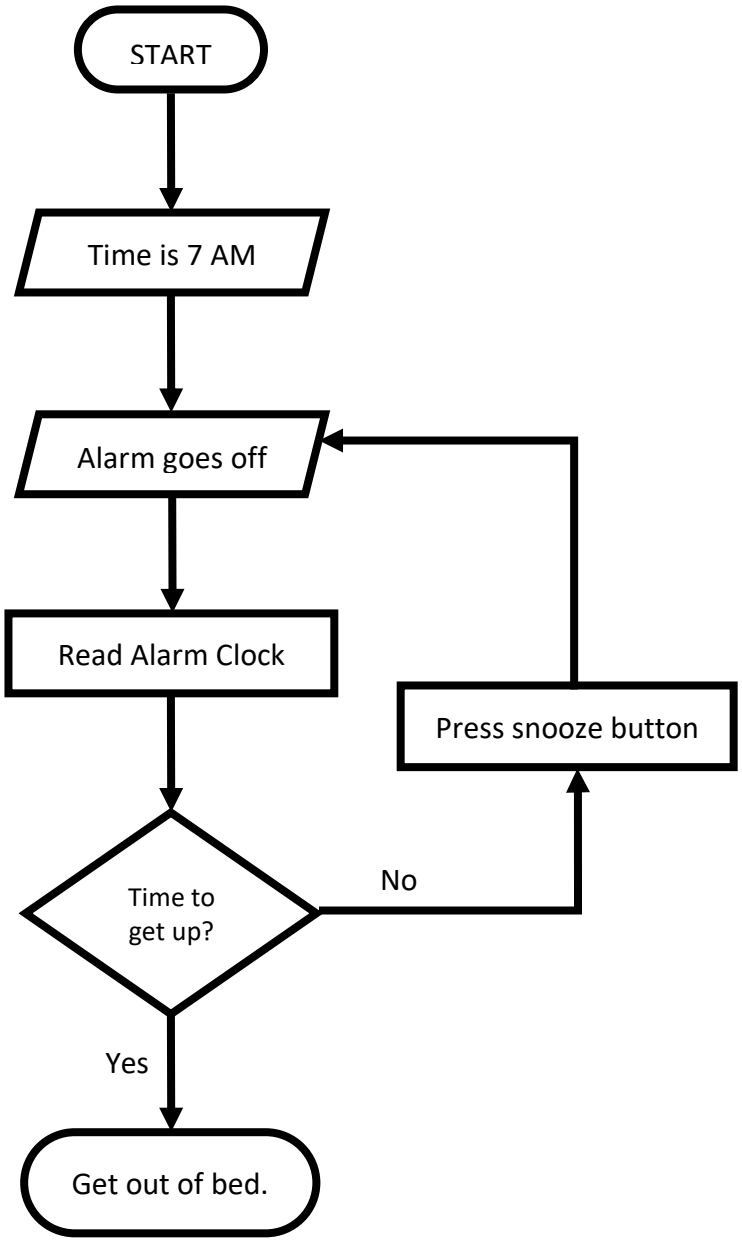
1. Start	Program Start
2. Time reaches 7 AM	Input
3. Alarm clock rings.	Output
4. Read alarm clock	Process
5. Are you ready to get up?	Decision
6. Get out of bed	Action/Program End

Now, let's describe these steps using flowchart shapes:



This flowchart only shows one possible outcome to this program — getting out of bed. But we know that there are two possible outcomes to the decision block: Yes and No. If the answer to step 5 (Are you ready to get up?) is No, then the next step is to press the snooze button, which brings us back to step 3 (Alarm clock rings), creating a loop.

We can represent the decision and the loop like this:



Now we can follow the flow chart along different paths (although eventually we will want to exit the loop and get out of bed).

The **Mission Carbon Emissions Flowcharting Handout** provides more exercises to practice flowcharting.

Carbon Emissions Card Game:

This classroom activity will reinforce the concepts of activities that cause stored carbon (fossil fuels) to become greenhouse gas emissions that store carbon in the atmosphere. As well, it will open discussion about what types of actions are carbon neutral, and which actions may have a positive impact on reducing carbon emissions.

The **Mission Carbon Emissions Card Game Instructions** include a step-by-step guide for how to prepare and play the game. The **Mission Carbon Emissions Card Template** document includes printable cards to use for gameplay.

Note: the card game is optional for this lesson plan. It is useful for reinforcing concepts for the grade 7 Heat in the Environment unit but if, for example, you are teaching flowcharting to grade 8 students, you can supplement this activity with another activity that involves instructions that can be decomposed and flowcharted in the next section (suggestions are included under the **More Flowcharting Practice** section below).

Ask students for their observations after 10 rounds have been played. A possible observation would be that it is much easier to released stored carbon into the atmosphere as carbon emissions with our actions, than it is to find ways to "undo" the effects of moving so much carbon into the atmosphere.

More Flowcharting Practice:

Now that we are familiar with the Carbon Emissions Card Game, we can take a closer look at the steps that followed to play the game.

Can we translate the gameplay instructions into a logic flowchart? Like we did with the alarm clock example, decompose the instructions into tasks, consider which information is relevant, disregard irrelevant information assign the relevant tasks to flowchart symbols, and map the steps out.

Possible extension/alternative activity: Provide students with a list of foods from different cultures and ask them to select one, research a recipe for that food, and create a flowchart based on the recipe.

Coding Activity

To apply these concepts in a computer programming context, students are going to code a Clicker Game in Scratch. Clicker games are a form of video game where the gameplay consists of a simple repeated action (such as clicking a button) to gain points or currency that can be exchanged for "upgrades" or factors that alter the rate at which the currency increases.

A Clicker Game model is a great fit for creating a game that demonstrates how non-green industries have exponential and cumulative effects on carbon in the atmosphere. Here is what the game does:

- The amount of carbon starts at 10,000
- The carbon increases by 1 every second
- Clicking the tree will decrease the carbon level down by 1.
- Clicking the tree will increase the amount of gold by 1
- Buying a factory adds an automatic increase in gold. Every purchase increases the rate of gold by one per second.
- Buying a factory also increases the carbon rate by one per second.
- Buying a green action reduces the carbon level by 100 and reduces the rate of carbon by one per second.

The goal of the game is in time to reduce the amount of carbon to zero, but as students will see, that is no easy task. Extensions for expanding this game are included below.

Looking at the components of this game, the code involves events influenced by defined counts.

The goals of this activity:

1. Create clickable sprites that trigger an output when clicked.
2. Build a counter that accumulates one point for every time a sprite is clicked.
3. Build a counter that decreases the amount of carbon every time the sprite is clicked
4. Add "purchasable" items that autonomously increase or decrease the score on the counter (without clicks)
5. Decrease the score on the counter based on the "cost" value of purchases.

The program will reinforce coding fundamentals, including control factors, such as conditional statements, loops, and wait blocks, the use of variables to store inputs that will influence program outputs, and events that call on or trigger other programs.

Closure and Assessment

- By the end of this lesson, students will have practiced computational thinking using flowcharts and Scratch Coding Software. They will also have applied these skills to evaluate scenarios involving the impacts of different actions on greenhouse gas emissions.
- For assessment, collect the Flowcharting handouts and evaluate based on the answer key.
- Students Scratch programs can be assessed by having them save their projects as public and sending you the share link (if your classroom is using public accounts).

Adaptations

- Flowcharts can be hand-drawn or built using a computer.
- Card game colours can be modified to have better contrast for colour-blind students (text labels provide context to the cards so colour change is not required)
- Card game can be reproduced digitally using online tools (see link in Additional Resources)

Extensions

- Students who finish their clicker game early can add complexity, multipliers and visual design to their game (suggestions included in the **Mission Carbon Emissions Coding Guide**)
- Ask students to create a flowchart that represents the logic flow of the clicker game. What information from the code is relevant to include in the flowchart?

Additional Resources

- This is a great online tool for drawing flowcharts and diagrams. https://app.diagrams.net/
- Additional information about flowchart shapes and their meaning: https://creately.com/diagram-type/objects/flowchart

- Linked below are examples of popular clicker games built in Scratch — students can "look inside" to see the coding strategies that other programmers have used.
    - Cookie Clicker: https://scratch.mit.edu/projects/12684770/
    - Pokémon Clicker: https://scratch.mit.edu/projects/116421566

- Potential tool for reproducing the Mission Carbon Emissions Card Game digitally: https://playingcards.io/docs/