How Water Rich is Canada?

Strands:	Suggested time
Algebra Social-Emotional Learning in Mathematics and the Mathematical Processes	5 days
Topic:	**Grade:**
Mathematical Modelling	8

Overall and Specific Expectations:

Algebra

- C4. apply the process of mathematical modelling to represent, analyse, make predictions, and provide insight into real-life situations

Science and Technology

- assess the impact of human activities and technologies on the sustainability of water resources

Geography

- B2.2 gather and organize data and information from a variety of sources and using various technologies to investigate issues related to global development and quality of life from a geographic perspective

Social Emotional Learning Skills in Mathematics and the Mathematical Processes

- A1. Social-Emotional Learning (SEL) Skills and the Mathematical Processes**:** apply, to the best of their ability, a variety of social-emotional learning skills to support their use of the mathematical processes and their learning in connection

with the expectations in the other five strands of the mathematics curriculum

In this lesson, to the best of their ability, students will learn to **maintain positive motivation and perseverance** and to **think critically and creatively** as they apply the mathematical processes **connecting** (make connections among mathematical concepts, procedures, and representations, and relate mathematical ideas to other contexts (e.g., other curriculum areas, daily life, sports) so they can recognize that testing out different approaches to problems and learning from mistakes is an important part of the learning process, and is aided by a sense of optimism and hope.

Learning Goals:	**Success Criteria:**
We are learning the value of a mathematical model to flexibly answer questions about a situation that can change over time. We are learning to create a model that will assess Canada's water richness.	I can apply my mathematical learning to a real life situation. I can determine if Canada is a water rich country.
Prior Learning:	**Resources and Materials:**
Students should have prior knowledge of the following: - Proportional relationships - Adding, subtracting, multiplying and dividing decimals and money amounts - Solving equations involving whole and decimal numbers with unknown values and constants. - Creating graphs	Handout with websites to support research: Websites • Water in Canada Information • Canada's water supply • Water use • Water use - Industrial and Household • Fresh Water Supply and Demand • Canada's Population Increase • Canada's Population over time • Canada's water run off Map • Making Waves Journal Article Process of Mathematical Modelling sheet OntarioMath.Support Webinar 3 - Mathematical Modelling

	 For online/hybrid learning, small groups could be set up ahead of time. This could be facilitated via breakout rooms, depending on the different district conferencing tools used. In the breakout rooms, students could work together to generate questions and make assumptions. They could use a virtual recording tool to support their discussions, such as shared slides, Google Jamboard, Microsoft Whiteboard, Padlet depending on district tools (recording tool). This will also create a record of their work in order to communicate clearly with each other and the teacher.

Learning and Teaching Activities:

Understand the Situation		
Minds-On Activity As a class, students will discuss what does it mean to be a water rich country?	**Teacher Moves**: **Minds - On Activity** Ask the students "What does it mean to be a water-rich country?". Teacher will record student opinions and ideas and sort them into various categories (e.g., financial, population, environmental aspects).  Use a recording tool to share the opinions and ideas.	**Opportunity for Differentiation** As groups meet and discuss the situation they have been posed, the teacher can make observations and make determinations whether intervention or support is necessary.

Understanding the Problem Students are presented with the real life messy problem of identifying when Canada will no longer be a water rich country? Part 1 In small groups, students are encouraged to brainstorm a list of factors that contribute to Canada's water richness.  Use virtual breakout rooms and the recording tool. Part 2 The students will come back together as a class and discuss all the factors the groups determined. Students will add to their own list of factors.	**Understanding the Problem** The goal of this lesson is for the students to determine at what point is Canada no longer a water rich country? Part 1 Teacher Poses modelling question to students: “How long is Canada going to be a water rich country?” Teachers will circulate as groups brainstorm. Questions: ● Are you thinking about all of Canada or just where you live? ● What is water used for in Canada? ● Are we talking about freshwater or saltwater? Part 2 Teacher chooses a method that students share their ideas (e.g. gallery walk, expert jigsaw, inside-outside circle, write in on the board) Possible factors that could affect water richness: ● People use more water than in the past ● Global warming including ice melting ● More pollution will affect the water ● Population	**Opportunity for Differentiation** Students could be provided with a set of assumption sentences that either match the current situation or do not (see “Part 2” sample possible factors for ideas).

	• Increased salinity • Increasing acidity • Rising carbon dioxide concentration in water • Eutrophication (death of lakes) • Exporting water to other countries • Sharing of water between provinces • Accessibility to water (e.g. many lakes in northern Canada are not accessible) • Water from city/town sources vs personal wells • Use of water (agriculture, manufacturing, personal use)	
Analyse the Situation		
Part 1 From the list of factors, students will determine what assumptions they have made. Discuss as a class how these assumptions relate to the factors they created earlier.	**Teacher Moves**: During this stage, the teacher acts as the facilitator. He/she encourages students to identify any and all assumptions that they are making as they dive deeper into the problem. Part 1 The teacher will ask the students what assumptions the students need to make to more fully understand the factors (i.e., what factors might continue to change over time, which factors might stay the same?). The teacher will capture student assumptions and record.	

Part 2 Teachers will let the students know that they need to decide which issues have the most impact on a country's water supply. Students will go back in their groups and rank the issues that are going to affect the amount of water the most and what information they will need to assess the issues. Then discuss it as a whole class.	Some possible assumptions could be: ○ I assume Canada is becoming less water rich ○ I assume the population of Canada will continue to increase ○ I assume that Canada is water rich because it has many lakes ○ I assume we are referring to clean (potable) water ○ I assume we cannot use salt water ○ I assume some water is not accessible ○ I assume pollution will be a factor ○ I assume that industrial water is part of the equation.  Use the recording tool to create and share the list. Part 2 Now that students understand the assumptions they are making through understanding this problem, they can now dive deeper into sorting and prioritizing those factors into ones they can solve with numbers. Circulate as students prioritize their list of factors. After the students have ranked the issues, encourage your students to make a list of all the information that they still need in order to solve this situation.	**Opportunities for Differentiation** The teacher could model for a small group the process by which an issue/factor/assumption can be researched. Teachers could direct students to identify and choose only 2 or 3 factors

 Use virtual breakout rooms and the recording tool. Part 3 Work through one issue as a class if necessary. Part 4 Students then go in groups to research and find numerical data relating to the list of factors that they determined are the most important from the co-created list. Students can be provided with sample links (Websites).  Use virtual breakout rooms and the recording tool. Part 5 Groups will then present the research they collected to the class.  Use the recording tool to share their	Part 3 Pick an issue that is low on most groups' lists. What information is needed to determine how this issue affects Canada's water? This can be done if necessary. Part 4 The teacher will prompt the students to identify any factors that can be solved using mathematics. From this list, student groups can choose which factor they want to find solutions for (e.g., population growth). Questions: • Can mathematics be used to analyse the information we have gathered? • Can mathematics be used to gather information that we need? • How could we get information about the quantities/measurements we don't know? Part 5 Teacher brings the class back together and each group presents the research collected. After all groups have presented, a class discussion can follow	they want to research and use to create their model.

research.	which identifies which factors have yet to be determined, if they are necessary in order to create a model.	
Create a Mathematical Model		
In groups, students are creating a visual representation that would show a possible timeline for how long Canada would remain water rich.  Use virtual breakout rooms and the recording tool.	**Teacher Moves**: Teacher reviews with the students that the goal of the model is to predict when Canada will no longer be a water rich country. Models could include: ● A spreadsheet showing Canada's water use and supply over time ● A graph that compares Canada's use per capita to another county with water issues. ● A graph that shows the depletion of freshwater over time Student models will differ depending on the factors and assumptions that students decide to focus on. The teacher will look for any misconceptions. They will decide if any are common enough to call to the attention of the entire class, or they can be addressed individually or within the group. The teacher will look out for students who really need to revisit "understand the problem" or "analyse the	

	situation" (Are students struggling with creating a plan because there is something about the situation that they do not fully understand? Are they struggling because they need to make an assumption to narrow down the problem? Did they make an unnecessary assumption that is preventing them from making a fulsome model?)	
Analyse and Assess the Model		
Students can present their model to students in a gallery walk/ carousel, or a virtual video.  Breakout rooms could be used to create a virtual carousel. As the students analyse their peers models, they may soon realize that their model may be missing certain components or assumptions. Students can then use those observations to make improvements to their own model. After students have improved their models, the class will come together and students will help the teacher co-create a	**Teacher Moves**: After students have created their model, it is time to analyse their methods. A first step towards analysing the model is asking the students if their model addresses the situation they were presented. Below is a list of questions that the students could ask themselves while analysing and assessing their model. ● Are our assumptions reasonable and defensible? ● Are our assumptions relevant? ● Does our model follow from our assumptions? ● Is our model completely explained by our assumptions, or do we now realize that we need to add more assumptions?	

master list of criteria for analyzing the models. Students will reflect on, be prepared to justify and present their judgement of Canada's waters richness based on the information provided by their model, considering the answers to the following: ● What mathematical tools did you use, and how did they help solve the problem? ● Are there situations where your solution wouldn't work or your model wouldn't apply? Describe these. ● What changes would you need to make to your model so that it could be applied to more situations? ● If you had more time, what else might you do?	● What if our assumptions are wrong? How does that impact our answer? ● What event could happen that would change how your model predicts when Canada will not be water rich anymore. Teachers could create a checklist of items/considerations that the models should include. Students can use that checklist as a self-assessment opportunity.  Use a shared document to cocreate the master list of criteria.	
Consolidation of Learning		
Now that students have made improvements to the reasonableness of their models and created an assessment checklist, students use the created checklist to self-assess their model.	**Teacher Moves** The teacher will facilitate a class discussion and the creation of a sketchnote or consolidation chart whereby the teacher, with the help of the students, will identify the mathematics that was involved in the creation of their models. The teacher will also need to	

Students reflect on the Process of Mathematical Modelling and share, during a class discussion, the process that they took as a group.	facilitate a conversation around the reasonableness of student models. After assessing their own models, students present their models to their peers and ask for feedback for improvement. Students would look to other models to identify any assumptions they did not make, any research they did not consider, etc. Students would then be given time to read the peer feedback and make any adjustments to their model. The teacher will present the students with the Process of Mathematical Modelling sheet and ask them to what degree it represents the process they undertook. The teacher will further students' reflections on the mathematical process by asking questions, such as: ● What is important about this process? ● In what way are assumptions key to an effective model? ● To what extent was our model helpful? ● Why do you think it is important to maintain positive motivation and perseverance when engaging in the mathematical process? ● Why is thinking critically and creatively important when engaging in Mathematical Modelling? ● Do you think the models we created will be accurate? Why? Why not?	

	• Why would it be helpful for us to create models like this? How might a model help us make decisions? • What could happen to change the results of our model that could possibly happen? Allow students to add their own ideas, questions and reminders to the schema.	

Further Consolidation/Next Steps for students and teachers:

Writing
Students could be asked to create a persuasive writing piece to a government agency that discusses the findings of Canada's water richness.

Media Literacy
Students could create an infographic or media text that informs people of the issues of Canada's water resources.

Science:
Students discuss actions that society can take to conserve and sustain Canada's water richness longer.