



Date: _____

Maple Syrup and Climate Change

ACKNOWLEDGEMENT

Please read this Acknowledgement before the start of this lesson to respect the knowledge that is being shared and the Land of the People where the knowledge originates.:

This lesson plan was created by faculty, students, and partner school boards of Trent University's School of Education and Professional Learning. We recognize and honour Traditional Knowledge carriers - Anishinaabe Elder Doug Williams, of Curve Lake First Nation, and Potawatomi faculty Barbara Wall, of the Chanie Wenjack School for Indigenous Studies at Trent University.

LEARNING OUTCOMES

Upon successful completion of this lesson plan, students will be able to:

1. Identify and explain the purpose of the biological structures within a tree;
2. Interpret scatter plots to support arguments about sweet water production;
3. Draw conclusions regarding the impact of climate change on maple trees and the production of sweet water.

LIST OF ACTIVITIES

1. Activating Prior Knowledge
2. Exploring the Structure of a Maple Tree and Impacts of Climate Change
3. Maximum/Minimum Scatter Plots and Cross Section
4. Consolidation and Reflection

MATERIALS

- One source for an illustration of a cross-section of a tree: Tree Growth and Structure
- Article by scientist Lin Anh Cat: "Sugar Maple Trees Have Nowhere To Go Under Climate Change"
- Maple Sugar Videos
- Journal Article: Finding the sweet spot: Shifting optimal climate for maple syrup production in North America



Science

Origin

Elders and Traditional Knowledge carriers involved with Trent University and Curve Lake First Nation
Peterborough
Ontario

Learning Level / Grade

8

Also: 7



110 mins

Related Subjects

Math, Biology, History, Social Studies, Indigenous Ways of Knowing & Being

DESCRIPTION

This lesson plan allows students to explore functions of the different structures found within a tree and to use scatter plots to consider the relationship between sweet water harvesting and climate conditions.

HOLISM AND ALL OUR RELATIONS

This lesson plan has been developed with an Indigenous lens that is holistic in nature, a way of being and knowing that acknowledges our relationships with 'all our relations', including plants and animals, other human beings, the water, land, wind, sun, moon, stars, and more - everything seen and unseen. With 'all our relations' in mind, this lesson plan has been developed with a focus on:

- Participatory and experiential learning activities
- Different learning styles; attention given to mind, body, and spirit
- Connections are made with everyday life
- Ethics in the classroom: care, truthfulness and trust, respect, integrity
- Relationship with the land
- Personal reflection time (connecting with thoughts and feelings)
- Language and Culture
- Intergenerational learning with Elders/Knowledge Holders

TEACHERS' GUIDE

Background/Foundational Information

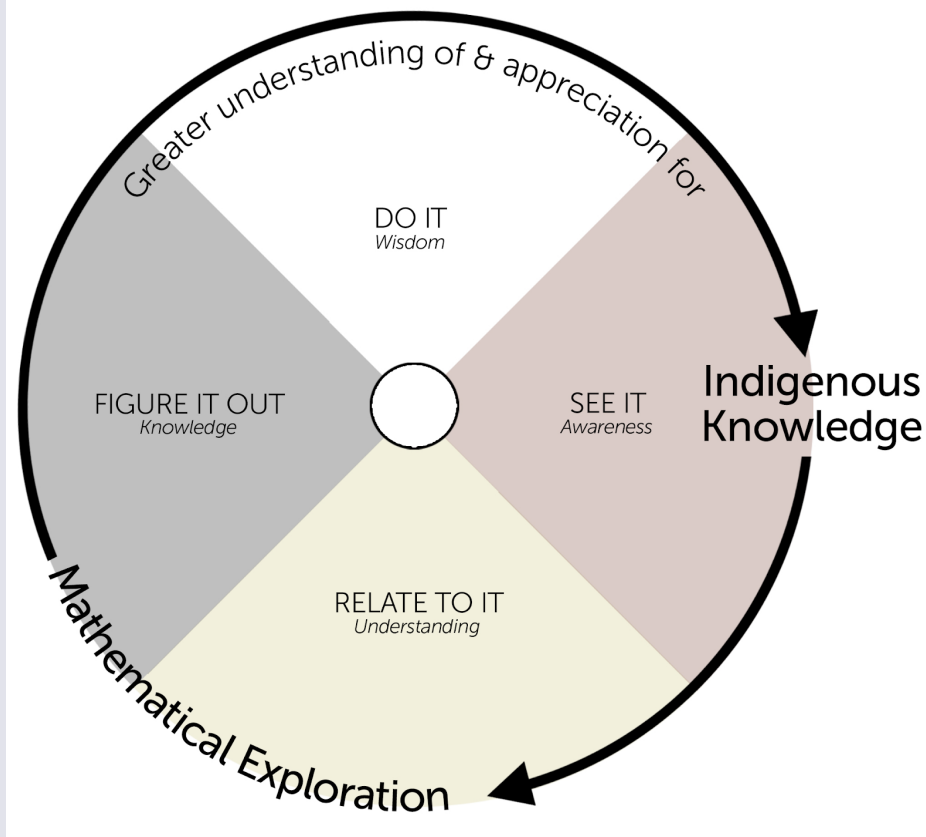
- This lesson plan was designed according to the Medicine Wheel diagram produced by Anishinaabe faculty in Trent University's School of Education and Professional Learning, Dr. Nicole Bell (see figure below). We recommend educators familiarize themselves with the Medicine Wheel and how learning commences through each of the four quadrants (<https://www.edcan.ca/articles/teaching-by-the-medicine-wheel>). Through using the Medicine Wheel as a theoretical framework for inquiry-based learning, each lesson starts and concludes with Indigenous Knowledge by watching a video (<https://vimeopro.com/paradigmpost/maple-videos>; see the 'Materials' section in the Activities for more information about the videos).

The objective of this lesson is for students to form a greater appreciation and deeper understanding of Indigenous Knowledge as transmitted through the act of making maple sugar or maple syrup. In essence, this is land-based education.

Familiarity with the following resources is also recommended: "Nanaboozo and the Maple Tree" in *Keepers of the Earth: Native American Stories and Environmental Activities for Children*, M. J. Caduto & J. Bruchac (1997) and "Nanaboozo Saves Nokomis" in *Tales of Nanabozho*, D. M. Reid (1963).

Educators should take additional time to study and learn about the importance of storytelling according to Anishinaabe ways of knowing. It is evident across many Indigenous cultures that while storytelling is an art, more importantly, stories emerge from Land and they embody ancestral knowledge and intelligence of Indigenous people that stretches back centuries.

We strongly recommend building relationships with Elders, Knowledge Holders, and your local Indigenous community. Please seek advice for protocols in storytelling; some stories are recited at certain times of the year (e.g. Nanabozho stories are only recited when Creation is resting during the winter months).



Connection to Curriculum (Ontario Curriculum Guidelines)

Note: page numbers noted below are found in this document:
<http://www.edu.gov.on.ca/eng/Curriculum/elementary/scientec18currb.pdf>

Science and Technology (2007)

Grade 7 - Understanding life systems interactions in the environment.

Overall Expectation(s) addressed:

3. Demonstrate an understanding of interactions between and among biotic and abiotic elements in the environment.

Specific Expectation(s) addressed:

3.9 Describe Aboriginal perspectives on sustainability and describe ways in which they can be used in habitat and wildlife management.

Grade 8 (Cells)

Overall Expectation(s) addressed

2. Investigate functions and processes of plant and animal cells;

3. Demonstrate an understanding of the basic structure and function of plant and animal cells and cell processes.

Mathematics (2005)

Extension: Grade 7

Overall Expectation(s) addressed:

NSN - Demonstrate an understanding of proportional relationships using percent, ratio, and rate;

DM - Make and evaluate convincing arguments, based on the analysis of data.

Specific Expectation(s) addressed:

Determine, through investigation, the relationships among fractions, decimals, percents, and ratios;

Read, interpret, and draw conclusions from primary data and from secondary data presented in charts, tables, and graphs.

Grade 8

Overall Expectation(s) addressed:

NSN - Solve problems by using proportional reasoning in a variety of meaningful contexts;

M - Research, describe, and report on applications of volume and capacity measurement;

GSS - Solve problems involving lines and triangles;

DM - Apply a variety of data management tools and strategies to make convincing arguments about data.

Specific Expectation(s) addressed:

Identify and describe real-life situations involving two quantities that are directly proportional;

Solve problems involving proportions;

Research, describe, and report on applications of volume and capacity measurement;

Determine the Pythagorean relationship, through investigation using a variety of tools;

Read, interpret, and draw conclusions from primary data and from secondary data, presented in charts, tables, and graphs;

Compare two attributes or characteristics, using a scatter plot, and determine whether or not the scatter plot suggests a relationship.

ACTIVITIES

1 - Activating Prior Knowledge

Purpose

This activity introduces students to the structures of trees, issues of climate change, and the impacts of climate change on landscape (i.e. maple trees).

Time: 20 mins

Activity Instructions

Teachers show a cross-section of a tree on the smart board or other projection device.

Or

Teachers can explain that as the climate warms (changes) in areas rich with sugar maple trees, the ability to collect high volumes of maple sap will decrease. For example, maple trees in Quebec are not sustainable in the northern region, which stresses the importance that climate change will have long-term impacts on maple syrup production in Canada.

- Read the link "Maple Trees Have Nowhere to Go" (provided in this lesson plan) to introduce students to issues of climate change.

- Use prompt questions to stimulate thinking and discussion: "What do you notice?"; "What do you wonder?"

Guiding question for the educator:

How are your students 'seeing it (the vision)'?

This activity is designed to connect with learners with these learning styles...

- Physical (e.g., Tactile, Experiential, Visual) Learners
- Intellectual (e.g., Rational, Logical) Learners

... in the following ways:




Physical learners - can interact with the image of a cross-section of a tree, which will generate questions through inquiry.

Intellectual learners - For climate change, having an article read aloud will make content accessible to learners, particularly when including a whole-class discussion with prompting questions.

Materials

Click the 'Link' to open and view videos.

To open and print files, please go to the 'files' folder accompanying this downloaded lesson plan.

Resource Title	Type
One source for an illustration of a cross-section of a tree: Tree Growth and Structure	Link 
This link provides information and a diagram to review prior learning about tree rings.	
Article by scientist Lin Anh Cat: "Sugar Maple Trees Have Nowhere To Go Under Climate Change"	Link 
This is background reading in preparation for the class discussion. Note: Always read with critical lens and identify bias of the writer before making an informed decision or showing to students.	
Maple Sugar Videos	Link 

Resource Title	Type
<p>These videos provide a general overview in the process of making maple syrup from start (tree identification) to common practices for storing maple sugar. Each video is approximately 10-12 minutes in length, which is ideal for learners of all ages.</p> <ol style="list-style-type: none">1. Stories (11:41)2. Language (7:43)3. Collecting Sap (12:48)4. Trees (11:20)5. Maple Sugar (14:25)	

TEACHING NOTES

2 - Exploring the Structure of a Maple Tree and Impacts of Climate Change

Purpose

This activity allows the student to explore maple trees and to identify the different structures within them. This is also an activity to explore the impacts of climate change on maple trees.

Time: 45 mins

Activity Instructions

Students examine a cross-sectional slice of a maple tree trunk (if you do not have access to maple tree slices use a digital image, such as the one shared in the first activity). Students then Identify:

- Heartwood - this is the dark non-living wood at the core of the tree's trunk. Heartwood forms when the xylem cells plug up with resins and minerals. Heartwood supports the tree.
- Xylem - this transports sweet water (sap) up from the roots to the leaves. It is also known as sapwood.
- Cambium - this is the growing layer of cells. The cells divide, producing phloem to the outside and xylem to the inside of the tree.
- Phloem - this is the tissue in the tree that transports sweet water (sap) down from the leaves to the roots. When phloem dies it becomes bark.
- Bark - this is the dead, outside covering on trees. The bark protects the trees from excessive water loss, injury, insects, disease, weather, herbivores, etc.

Students can create their own cross-sectional representation of a maple tree trunk, identifying each of the structures and note their function(s). Students can work individually or collaboratively. Their cross sections can be simple drawings or more creative 2-D or 3-D representations.

For climate change inquiry, students identify the locations where maple sugar trees grow naturally (consider by region for example). Students can ask themselves: "Why might sugar maple trees grow more easily in the Deciduous Forest Region as opposed to other regions more north or south?", "Perhaps animals, soil, and temperature are potential factors?", "What are other possible considerations?"

In connection with the video resources provided with this lesson plan series, please have students investigate what might happen if Indigenous people are unable to practice collecting and processing maple sap each spring.

Guiding questions for the educator:

- "How are your students 'relating to' the vision?"
- "How are your students 'figuring it (the vision) out'?"

This activity is designed to connect with learners with these learning styles...

- Physical (e.g., Tactile, Experiential, Visual) Learners
- Intellectual (e.g., Rational, Logical) Learners

... in the following ways:

Physical learners will be able to interact with the cross-sectional slice of the tree to explore the structural elements of a tree.

Intellectual learners will be able to consider the functions of the different structures of the trees and how these functions support the production of sweet water. The climate change activity involves scientific research, which will be intellectually stimulating when exploring different regions.

TEACHING NOTES

3 - Maximum/Minimum Scatter Plots and Cross Section

Purpose

This activity allows students to explore:

- i) maximum/minimum scatter plots and;
- ii) how temperature impacts the flow of sweet water.

Time: 30 mins

Activity Instructions

Option 1 - Climate Change and Mathematics:

Students explore maximum/minimum temperature graphs; teachers can relate this to the flow of sweet water. While exploring scatter plots for maple syrup harvesting season, ask students to make predictions about when the flow rate of the sweet water will be at its peak.

Examples of scatter plots are found in Finding the sweet spot: Shifting optimal climate for maple syrup production in North America. This open source paper is useful background reading when considering the impacts of climate change on maple syrup production.

<https://www.sciencedirect.com/science/article/pii/S0378112719303019>

To establish comparison data, students can collect and represent their own maximum/minimum temperature data over a short period of time. It is ideal to conduct this activity during the maple syrup harvesting season so students can identify what days and weeks might yield high volumes of sweet water.

Option 2 - Science (Cross Section):

- The class, as a whole group, becomes familiar with a cross section of a tree.
- Students then break into small groups to investigate the different components of a tree's structure and the role each component plays in supporting the life of the tree, e.g. bark, roots, leaves, etc.

Guiding questions for the educator:

- How are your students 'relating to' the vision?
- How are your students 'figuring it (the vision) out'?

This activity is designed to connect with learners with these learning styles...

- Physical (e.g., Tactile, Experiential, Visual) Learners
- Intellectual (e.g., Rational, Logical) Learners

... in the following ways:

Physical learners will be able to interact with the graphs and collect their own temperature data outside their school. While doing research on the component of the tree (i.e. bark) that was assigned to their small group, students can also post their findings on a life-sized tree cut-out in the classroom.

Intellectual learners will be able to consider how maximum/minimum temperature allows us to make predictions about the best time to harvest sweet water and when one might yield high volumes.

Materials

Click the 'Link' to open and view videos.

To open and print files, please go to the 'files' folder accompanying this downloaded lesson plan.

Resource Title	Type
Journal Article: Finding the sweet spot: Shifting optimal climate for maple syrup production in North America	Link 

Resource Title	Type
<p>For exploring scatter plots. Source: <i>Forest Ecology and Management</i>, vol. 448, Sept 2019, pp. 187-197. Authors: Joshua M. Rapp, David A. Lutz, Ryan D. Huish, Boris Dufour, Selena Ahmed, Toni Lyn Morelli, Kristina A. Stinson</p>	

TEACHING NOTES

4 - Consolidation and Reflection

Purpose

This activity allows time for the students to consolidate and reflect on their learning.

Time: 15 mins

Activity Instructions

- i) Educators begin with a guided discussion as a whole class for students to reflect upon their learning.
- ii) Their learning concepts, gleaned through the class discussion, can be summarized using either science or mathematics.

Guiding Questions to the students:

"What captured your attention and what was new information?" This applies to the graphing, cross-sectional, and inquiry research projects on climate change.

"Consider the implications of climate change in light of the exploration of maximum/minimum temperature. Referring to NCCIE's videos and the *Nanabozho and the Maple Trees* story (see Lesson Plan Foundations), what might be the consequence or impact of climate change on maple trees? How might not practicing the harvesting of maple sap as much, due to climate change, be problematic for Anishinaabe and other Indigenous Peoples who have strong relationships with Land?"

Guiding question for the educator:

"How are your students 'doing' the vision?"

This activity is designed to connect with learners with these learning styles...

- Spiritual (e.g., Relational) Learners
- Physical (e.g., Tactile, Experiential, Visual) Learners
- Intellectual (e.g., Rational, Logical) Learners
- Emotional (e.g., Feeling, Intuitive) Learners

... in the following ways:

Spiritual and emotional learners can relate the impacts of climate change to: i) human's relationship with maple trees; and ii) the Indigenous teachings shared while collecting and processing sweet water.

Intellectual learners can reflect on the impacts of climate change with regard to the sweet water yield, both for Indigenous Peoples and Canada's maple syrup industry.

Physical learners can reflect on the tactile object (life-size tree cut-out) they produced as a class, which explains each component of the tree's cross-section as it relates to the tree's ability to live.

TEACHING NOTES

ASSESSMENT



This section contains information for assessing progress in students' learning. While Indigenous approaches to assessment may be highlighted, conventional assessment methods may also be discussed.

There is no formal summative assessment ('Assessment of Learning') in this lesson; assessment is integrated within the learning tasks to inform the next steps of the lesson. It is a supportive learning situation that is not focused on specific task outcomes but on developing an understanding of the importance of relationship with the trees. However, one potential form of Indigenous assessment could be through holding a sharing circle where students are asked to share what they learned or found to be important to themselves. Prompting and guiding questions (in the 'Activities' section of this lesson plan) can easily be adapted to 'Assessment for, as, and of Learning'.

ADDITIONAL RESOURCES

Click the 'Link' to open and view videos.

To open and print files, please go to the 'files' folder accompanying this downloaded lesson plan.

Resource Title	Type
Teaching by the Medicine Wheel: An Anishinaabe Framework for Indigenous Education	Link 
This article by Dr. Nicole Bell provides educators with an opportunity to familiarize themselves with the Medicine Wheel and how learning commences through each of the four quadrants.	
Maple Sugar Videos	Link 
<p>These videos provide a general overview in the process of making maple syrup from start (tree identification) to common practices for storing maple sugar. Each video is approximately 10-12 minutes in length, which is ideal for learners of all ages.</p> <ol style="list-style-type: none"> 1. Stories (11:41) 2. Language (7:43) 3. Collecting Sap (12:48) 4. Trees (11:20) 5. Maple Sugar (14:25) 	

HOLISM AND ALL OUR RELATIONS

This lesson plan has been developed with an Indigenous lens that is holistic in nature, a way of being and knowing that acknowledges our relationships with 'all our relations', including plants and animals, other human beings, the water, land, wind, sun, moon, stars, and more - everything seen and unseen. With 'all our relations' in mind, this lesson plan has been developed with a focus on:

Relationship with the land
Through their explorations of maple trees, consideration of care for the trees, and sharing activities, students will develop a relationship with the land. Students will also recognize that we are only to collect what the trees give us and we must be careful in not overharvesting so future generations can reap the same benefits. This lesson will also help students realize that trees and plants are living beings, they are our teachers because they carry knowledge to share. It will also instill environmental stewardship as climate change is also impacting maple trees and not just humans.
Participatory and experiential learning activities
Language and Culture
Depending upon the video used, the Ojibwe language can be introduced, explored, and developed through this lesson.
Connections are made with everyday life

Maple syrup has become a staple of Canadian homes. This lesson plan aims to develop a greater understanding of, and appreciation for, the Indigenous Knowledge that underpins the harvesting and production of maple syrup. Trees, in addition to providing maple syrup, help clean the air and provide us with materials that heat our homes or 'warm bodies when the wind becomes cold'. Climate change is a serious issue that should not be taken lightly. The impacts of climate change do not solely affect people, Creation is also experiencing impacts from climate change.

Intergenerational learning with Elders/Knowledge Holders

Were Elders or Knowledge Holders involved in the development of this Lesson Plan? Yes
 Can Elders or Knowledge Holders be invited to help teach part of this lesson plan? Yes

Intergenerational learning with Elders/Knowledge Holders

Ethics in the classroom: care, truthfulness and trust, respect, integrity

Care and Respect - for the climate and the trees; the need to look after and nurture the trees for future generations.
 Truthfulness and Trust - the trust that is placed in us all to look after the climate and not exploit the gifts of the trees.
 Integrity - that we will do the right thing with regard to the climate and our relationship with the trees. We will embody environmental stewardship and advocate for the protection of Land and Creation.

Different learning styles; attention given to mind, body, and spirit

Personal reflection time (connecting with thoughts and feelings)

The reflection time in this lesson is part of the consolidation of learning when educators ask students questions about the impact of climate change on sweet water production. Students reflect on their learning when they come together and share their thoughts and feelings from the research and exploration activities in this lesson. Sharing circles are ideal, as doing so provides each student space to share their learning, thoughts, and questions.

OTHER DETAILS

RELATED LESSON PLANS

- Ratios of Maple Syrup and Sweet Water
- Sirop d'érable et changements climatiques
- Measuring Sweet Water and Maple Syrup
- Tree Tapping
- The Seasons

CONTRIBUTORS

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QUESTIONS/MORE DETAILS

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