Teaching Mathematics in a First Peoples Context

Grades 8 and 9

A PUBLICATION OF

fnesc

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The *Mathematics 8 and 9 (2008)* curriculum document is available online at www.bced.gov.bc.ca/irp/welcome.php

Part I: Bow Hunting

Context

In Aboriginal traditions, everyone has a role and responsibilities. Historically this was necessary for the survival of the community. Being able to contribute to the community and having a role and responsibilities keeps the individual and community strong. When someone takes on a new role in a community, whether through inheritance, maturity, or through their actions a feast is held so the community can witness what has been done. As a young man of 19, Patrick shot his first moose this year. His family held a feast to celebrate this event. Patrick served the moose to people in his family and community and everyone congratulated him. He asked his granny why the feast was so important and his Granny said to him: “It is because you are now a man. You can provide for your family. This is to be celebrated.”

This section looks at the bow, a hunting tool historically used by First Peoples, and compares the force required to pull back the bow string a certain distance. Students will use a bow and a force meter to determine the linear relationship between force applied and draw distance using Hooke’s Law: F=kd (F = force applied, d = distance the bow is pulled back, and k is the spring constant that relates the force and distance).

They will record their data in a table, graph the relationship, determine the spring constant for the bow they are using, and answer one step algebra equations using Hooke’s Law.

It is important to note that guns were introduced with European contact and ever since have been used for hunting. Today, many people — Aboriginal and non-Aboriginal alike — use bows of varying sophistication for hunting and recreation.

Prescribed Learning Outcomes

This unit can be used to help students achieve the following Prescribed Learning Outcomes for Mathematics 9:

B2 graph linear relations, analyse the graph, and interpolate or extrapolate to solve problems

B3 model and solve problems using linear equations of the form

- $ax = b$
- $\frac{x}{a} = b, a \neq 0$
- $ax + b = c$
- $\frac{x}{a} + b = c, a \neq 0$
- $ax = b + cx$
- $a(x + b) = c$
- $ax + b = cx + d$
- $a(bx + c) = d(ex + f)$
- $\frac{a}{x} = b, x \neq 0$

where a, b, c, d, e, and f are rational numbers

Vocabulary: draw distance, force, bow, linear relationship, table of values, ratio, independent variable, dependent variable, interval.

Prior Learning

Students should have had instruction in solving one step linear equations by dividing and multiplying.

Materials

- archery bow (contact the local archery club), or simple bow constructed from simple bow constructed from a string/elastic and a flexible stick such as willow or alder; arrows not required and **not** recommended
- 50 N force meters
- graph paper
- rulers

Suggested Instruction and Assessment Approach

Invite an Elder to visit the class and talk about the roles and responsibilities of young men and women in the community. Ask them to discuss what happens when a young person shoots their first large animal and can now provide for their family. If it is not possible to have an Elder come in, you could discuss this with the class using the information presented in the overview. Ensure students know that although the bow is a traditional means of hunting, the majority of Aboriginal hunters now use guns when they go hunting.

Use the First Kill story provided here for additional context-setting information as required. Alternatively, substitute these stories with information from the local First Peoples community.

> *First Kill — from the Gitxsan tradition*
>
> A young boy was taken out with the hunters so he could observe. He had to learn to practice good luck, by sleeping in the four directions of the fire, fasting for four days and bathing and drinking a solution of devil's club. In this way he would lose his human scent and smell like the forest and walk among animals. He was taught that he could not waste the animal that was sacrificed for him and he had to treat all living things with great respect.
>
> When he was finally allowed to kill an animal he had to drink the blood of his kill while it was still warm. This was so he could take on the fierceness of an animal with the strong will to survive. The young boy, becoming a man, took his first kill and distributed it to the Elders in the village.

Show students the bow, and ask them to think-pair-share on the following question: What is going to make an arrow go further? (Possible answers: Heavier/longer arrow, pull back further, bigger bow, stronger person, shorter feathers on arrow, etc.) Record students' ideas on the board.

Explain that we are going to see if there is a relationship between how strong someone is, and how far they can pull the bow string back. What could we do to find out if there is a steady relationship between the force used to pull back the string, and how far the string gets pulled back? How are we going to know if there is a relationship that is steady/constant?

Tell students they will have a bow, and a force meter. Give students 5 minutes to work in pairs and decide what they will do, and how they will record their data. Then distribute the Bow Hunting handout (provided at the end of this unit), and have students complete the worksheet as you conduct the demonstration.

Step 1: Determine the experiment
Create a table of values (horizontal or vertical) – draw this on the board and have a student record the data. Depending on your class, you may want to have a sheet created ahead of time.

Sample data:

	Trial 1	Trial 2	Trial 3	Trial 4
Force (N)	10 N	20N	30N	40N
Distance (m)	8 cm = 0.08 m	16 cm = 0.16 m	24 cm = 0.24 m	32 cm = 0.32 m
Spring constant N/m	125	125	125	125

Step 2: Collect the data
Students hold the bow up against the board. Then, using a Newton meter*, one student pulls the bow back with 10 N of force, and another student records the draw distance (distance of string from resting position). Repeat for several more trials increasing the force applied each time by 10 N.

(*If you don't have access to a Newton meter, a fish meter can also be used. However it will measure in grams or kilos rather than Newtons, so will need to be converted — multiply the kg by 10 to determine the Newtons.)

- How much more force is added per trial?
- How much greater is the distance stretched each time? (It should be the same for each increase in force.)
- What is the ratio for the amount of force to the spring distance for each time you pull the string back? (force/draw distance)

Step 3: Draw the graph
Draw a graph with Force (N) on the horizontal, Distance (m) on the vertical. Demonstrate this for students, and then have them create their own independently.

Step 4: Writing the equation
Use the calculated ratio (force/draw distance) to create the Hooke's Law equation of F=kd (F = force applied, d = draw distance, and k is the spring constant that relates the force and distance). Show students that the constant relationship they found between the force and distance is the constant value in the equation that they can then use. If their relationship is not exact for each trial, they can average the trials, discarding any outliers.

Step 5: Using the equation
(You may need to modify these questions with different values, depending on the bows you have available.)

Use your equation (for example F=1.4d) to answer the following questions (include units in your answers):
a. What force would be required to pull the string back 0.32 m?
b. What force would be required if a draw distance of 0.40 m is used?
c. Which distance would cause the arrow to travel the furthest?
d. If 30 N of force was applied, what would be the draw distance?
e. If 50 N of force was applied, what would be the draw distance?
f. Which applied force would cause the arrow to travel the furthest?

Step 6: Extending the understanding
If a different bow had a spring constant of 4.3

a) What would the new equation be?
b) How much force would be required to pull the string back 0.35 m?
c) If 40 N was applied, what would be the draw distance?

Summary

Ask students what they have determined about the relationship between the force applied to a bow string and the distance the string can be pulled back. Who would be able to apply more force and thus pull the bow string back further? How does this relate to how far an arrow would travel, and how much impact it would have on an animal? What are other factors that would affect someone's hunting success other than how strong they are?

Extensions and Cross-Curriculum Links

- Set up an archery target outside for students to test the force, or distance and see how it is related to the distance the arrow travels to its target. Use hay bales with a printed or spray painted target. Use a plumb bob hanging from the tip of the bow as the reference point for the draw distance. One student would draw back the bow, one would use a ruler to measure the draw distance, one to measure the distance travelled, and one to record the data. They already have an equation to relate the force applied to the draw distance.

- Extend Hooke's law to other contexts (a spring scale and masses) and give a variety of situations and parts of the equation and they can solve for the different variables.

- Science classes can experiment with other factors that affect how far an arrow travels (length of arrow, number of feathers, angle of projection, etc.). The following link would be an interesting starting point to look at several of the factors that would influence the distance an arrow could travel. http://library.thinkquest.org/27344/archphy.htm

  Using a projector connected to the computer, do the trials with input from students on what adjustments are required to make the arrow hit the target.

- Social studies or art classes could build simple bow and arrows.

- PE classes and science classes could invite someone from an archery club to give instruction in archery.

Part II: Moose Tracks

Context

Land use and territorial allocation are traditional concepts for all First Peoples. The territories and the animals and plants within them are inherited (e.g., by certain clans), and must be cared for by the group who is responsible for them. Traditionally clans would meet and discuss the resources in their territory and determine the best course of action to maintain the resources.

Today there are many other people utilizing the resources that are on traditional territories. As well, many Aboriginal groups are unsure of the use of their territories by their own members. First Nations have many means of gathering information about resources on their territories. The individuals who have hunted in an inherited area know a great deal about the resources from their repeated observations as hunters on the territories. The value of such knowledge is beginning to be recognized by scientists and is referred to as Traditional Environmental Knowledge. There are also many non-Aboriginal math and science means that can be utilized by First Peoples groups to help manage the resources on their land.

The intent of this lesson is to provide the opportunity for young people to see the connection between non-Aboriginal math and science concepts and the traditional management of Aboriginal territories.

Prescribed Learning Outcomes

This unit can be used to help students achieve the following Prescribed Learning Outcome for Mathematics 9:

B4 explain and illustrate strategies to solve single variable linear inequalities with rational coefficients with a problem-solving context

Suggested Instruction and Assessment Approach

Read the story, Revenge of the Mountain Goat (provided as teacher resource at the end of this unit). Alternatively, locate and share read a similar story from a local culture, telling about a young person who has not followed the "rules" as to how resources should be used responsibly, and the consequences they and their community must endure.

Invite an Elder into class to explain how wildlife has been managed on the territory. Prepare for the visit by brainstorming and discussing questions to ask the Elder. Sample questions could include the following, although not all will apply to your area:

- How do hunters know if the animal populations of an area are decreasing, increasing, or staying the same?
- When does a hunter make the decision not to hunt in an area?
- Who has the right to hunt on your territory?
- How is territory passed down?
- Who else hunts on your territory?
- How does your clan/house group know how many moose have been taken from your territory in a given year?
- What do the Elders and hunters think must be done to ensure there will be enough moose left to reproduce and sustain the next generation that depends on the territory?

You may also want to invite a wildlife biologist or conservation officer to your class to talk about moose management in your area.

Teacher-Led Discussion

Wild game has been and still is a very important food source for many First Peoples communities.

Lead-in questions will change depending on your class. (Examples could include: How many of you have eaten wild game? How many of you have been hunting? Have you ever tried to figure out how much game is required to feed a certain number of people?)

Explain that we can use math to figure out how many moose we would need to feed all of our families. In math terms, this is called recognizing and writing inequality statements.

- How many students are in our class?
- Approximately how many people are in each family?
- If 1 moose will feed 8 people for a winter (as one source of protein), how many moose would we need to feed our families? (total people in families/8)
- How many moose would be not enough? $M <$ _________
- How many moose would be just enough? $M =$ _________
- How many moose would be more than enough? $M >$ ___________
  Write an inequality that represents enough moose for all of our families.
- $M \geq$ __________

Show the inequality on a number line

Writing equations using inequalities

- If 20 salmon is the food equivalent of one moose and there are 260 extra salmon caught, how many fewer moose do you need?
- Use your number from the previous example as the number of moose you started with (example: 17.2 moose).
- How are we going to decrease the number of moose? (the number of extra salmon/the number of salmon that is equivalent to one moose: 260/20)
- Is the number of moose we need going to increase or decrease? (decrease)
- So how are we going to change the equation? (take away the number of the moose that would be represented by the salmon: $M \geq 17.2 - \text{extra}/20$)
- Solve the equation to determine the new number of moose needed.

Factors that Influence a Moose Population

Distribute the worksheet, Moose Tracks, provided as a handout at the end of this unit. Have students work through the exercises in pairs or small groups. An “answer key” for this worksheet is also provided.

Bow Hunting

Context: How are force and draw distance related when using a bow?

Observations:

- Your teacher will tell you what force increment to use.
- A trial is when you change the force applied to draw the string back.
- Distance is the distance you draw the bow string back from its resting position.

	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6
Force (N)						
Distance (m)						
Force/distance						

a. How much force is added per trial? _____________

b. What is the difference in the distance between each trial? ______________

c. Calculate the ratio of force/distance (divide force by distance) for each trial and record it in the table. Your ratio for each trial should be close.

Creating and using a graph

Using graph paper provided by your teacher, put the Force (N) on the horizontal axis and the Distance (m) on the vertical axis. Give your graph a title. Plot your data.

Reading from the graph:

a. How much force is required to pull the string back 0.15 m? ____________

b. How much force is required to pull the string back 0.23 m? ____________

c. How far back will the string go when you pull back with a force of 30N? __________

d. How far back will the string go when you pull back with a force of 55 N? __________

Writing the equation for your bow

Your calculated force: distance ratio is the “spring constant” for your bow. Hooke’s law for springs (like a bow) says that the Force applied = Spring constant x Distance (F = kd). Using “f” to represent force and “d” to represent distance, and your spring constant that you calculated, write the equation that relates force to distance for your bow.

____

Using your equation (for example F=85d) answer the following questions on a separate paper (write the equation, substitute the values, solve the equation, and include units in your answers):

a. What force would be required to pull the string back 0.32 m?

b. What force would be required if a draw distance of 0.40 m is used?

c. Which distance would cause the arrow to travel the furthest?

d. If 30 N of force was applied, what would be the draw distance?

e. If 50 N of force was applied, what would be the draw distance?

f. Which applied force would cause the arrow to travel the furthest?

Extending the understanding

If a different bow had a spring constant of 4.3

a. What would the new equation be?

b. How much force would be required to pull the string back 0.35 m?

c. If 40 N was applied, what would be the draw distance?

Summary

a. What is the relationship, or pattern, between the force applied and the draw distance?

b. Express the relationship in words

c. Express the relationship algebraically with symbols

d. Who in your class would be able to pull the bow string furthest back?

e. Does this mean they would be the best hunter in the class?

f. What other skills or characteristics does a successful hunter have?

Revenge of the Mountain Goat

Preface: Lack of Respect

Down through the ages, since the beginning of time, the *Gitxsan* Elders gave a warning to their people: do not be cruel to animals. The heart must be kind to fish, birds, goats and all the creatures the Creator has given. Through the ages, if meat was required then the animal was killed and eaten. The ancient people did not waste any part of an animal they killed. All parts of the slain animal were used. This to the early *Gitxsan* was the sacred law.

◆ ◆ ◆

Story

by Dr. M. Jane Smith

Life was good in the first *Gitxsan* Village of *T'emlax̲amit*. The people did not want for anything. The hunters and the fishermen of the village provided very well for everyone. It was the hunters who made the mistake. They forgot the sacred law. The mountain goats were plentiful on *Sdik̲yoodenax̲* (mountain). The hunters started hunting for sport. No one needed the meat and the smokehouses were full. After killing the mountain goat, the hunters would take certain parts for a delicacy or leave the entire carcass on the mountain. They could only carry so much.

One day a hunter brought back a live mountain goat as a toy for the children. The *Gitxsan*, in their time of plenty, forgot the sacred law. There would be dire consequences. The children loved to taunt the helpless live toy. They started to torture the kid. No one stopped them. Many of the hunters laughed while the children threw the little animal into the *'Xsan*, and threw rocks at it while the kid frantically tried to swim to safety. Then the children would rescue the wet kid and put him close to the fire. When the kid yelped in pain from the burns the children would throw him into the river again. Their laughter brought another young boy to the banks of the *'Xsan*. The young man had been counselled by his grandfather about the sacred law. The young man remembered his teachings. The young man took the kid from them and put red ochre (*mas*) on the kid's wounds. The kid was marked with red from the *mas* and black from the scorching of his hair. The kind young man carried the kid to the base of *Sdik̲yoodenax̲* and gave him back to the mountain.

Meanwhile, the mountain goats on *Sdik̲yoodenax̲* were having a meeting. The mountain goats did not mind that the *Gitxsan* took from their tribe to feed and clothe themselves. They understood the law. They voiced their concerns about the harsh treatment of their brothers and sisters at the hands of the *Gitxsan*. The terrible treatment of one of their children was the final insult. The mountain goats decided that the *Gitxsan* needed to be reminded of the sacred law. The mountain goats decided to have a great feast in which they would invite the *Gitxsan* of *T'emlax̲amit*.

Three *T'ets* (messengers) were sent to invite the *Gitxsan*. The three mountain goats looked like humans to the *Gitxsan*. The *Gitxsan* quickly assembled themselves: the Chiefs and the young adults would go. The Elders and the children would remain at the village. The *Gitxsan* brought out food for the *T'ets*, but they refused to eat. The *T'ets* explained that they would go and rest in the field while they waited. Children were playing nearby and the three messengers lay down and nibbled on the green grass. The children went to report this to their parents and were dismissed as having active imaginations.

(*The Gitxsan made significant mistakes that day. First of all, a large feast is never on the same day that the T'ets arrive. Secondly, visitors never refuse food that a chief offers to them. Thirdly, someone should have investigated the reports of the children).*

The *Gitxsan* loved to attend feasts and they set off with the visitors. They completely trusted the messengers. They did not know where they were going. They were climbing up *Sdik̲yoodenax̲*, but the power of the mountain goats made them believe they were on level ground. Soon they arrived at a magnificent feast hall. The *Gitxsan* were amazed that the hosts knew the names and ranks of the high chiefs. They were seated accordingly. The kind young boy who had saved the injured kid was among the visitors at the great feast hall. The kind young man was tapped on the shoulder by a young man wearing a black and red robe. The kind young man was seated by a house post.

The *Gitxsan* were served mountain goat meat that had been barbecued by the open fire in the great feast hall. Mountain berries were served in huge wooden bowls. This was a magnificent feast. Then the entertainment began. The dancing was spectacular. The fascinated *Gitxsan* watched as the dancers leapt high into the air as the beat of the drum quickened their heartbeats. Next the dancers all moved to one side of the feast hall. The host chief shouted and the house began to fall. The dancers moved to the other side and the host chief shouted and the remainder of the house fell. The *Gitxsan* fell to their deaths. Their bodies were strewn all over the mountain like the *Gitxsan* hunters had done to the mountain goats.

The kind young man who had shown kindness to the kid who was tortured by the children, clung to the house post and watched the others fall to their deaths. The kind young man understood what was happening. The mountain goats revealed their true form. It was the revenge of the mountain goats. The young man who had seated him came over. He was really a mountain goat. He reminded the kind young man of how he had helped a little goat and now he was being rewarded. The mountain goat gave the kind young man his robe and shoes and instructed him to say, "*Xsimoos*," (like a thumb) and a piece of rock would jut out of the rock face. The kind young man was told to leave the robe and shoes at the base of the mountain. The kind young man turned to thank his friend, but there was no one there. The kind young man returned to the village to tell the others of the mountain goat feast. The *Gitxsan* mourned their dead and remembered the sacred law and honoured it.

Moose Tracks: Inequalities and Moose Populations

Brainstorm: what could change the moose population on your territory?

Increase population	Decrease Population

Moose populations and wolves

Scientists have looked at the relationship between moose populations and their predator, the wolf. They have determined that moose population declines when there are 20 or fewer moose per wolf in an area.

a) How can we show when moose populations decline in relation to their predator using our knowledge of inequalities?

Let m represent the number of moose. The number of moose must be

______________________ 20 per wolf.

Write the inequality ______________________

b) How can we show this inequality of moose and wolf populations using a number line?

c) Each number below represents the number of moose per 1 wolf in an area. Will the population increase or decrease for each given number?

i) 9 moose/wolf _________________ ii) 25 moose/wolf _______________

iii) 20 moose/wolf _______________

iv) Suggest one possible value for the number of moose that would decrease the population if there was 1 wolf. ____________

Home study: Ask your Elders and hunters in your communities what they have seen about moose and wolf populations. Is there anything they do when the wolf population is "too big" on your territory?

Using helicopters to estimate moose populations

Biologists estimate moose population for an area by counting the moose they see from a helicopter, and making mathematical "corrections" for the type of vegetation they are flying over. For example if they are flying over a forest, they won't be able to see the moose that are there as easily as if they were flying over an open swampy area. Biologist's models for estimating moose populations are more certain when there is less than 40% of heavy forest cover in the area they are looking at.

a) How can we write an inequality to show when biologists are more certain about their moose population estimates? Let *f* represent forest cover. Biologists are more certain about their population estimates when

____

Write the inequality ______________________

b) How can we show this inequality of forest cover and effect on population estimates using a number line?

c) Each number below represents an amount of forest cover. For each figure, determine how the population estimate of moose in an area is going to be affected:

i) 65% ____________ ii) 34% ____________ iii) 70% _________

iv) Suggest one possible for forest cover that will make biologists estimations more accurate.

____

v) Suggest one possible for forest cover that will make biologists estimations less accurate.

____

Home study: Ask your Elders and hunters in your communities how they know about the moose population on the territories. What signs do they see? What stories do they have about changes in moose (animal) populations?

Writing inequality equations: Comparing foot and helicopter surveys

Moose can be surveyed on foot or from a helicopter. If you survey on foot, each straight line across the survey area (transect) will find 12% of the moose sign in an area. From a helicopter, each transect will find 23% of the moose sign in an area. Using a helicopter is more effective, but way more expensive. If you did 100 transects by helicopter, how many would you have to do by foot to get better information than the helicopter survey?

Let f = # transects by ____________

Let h = # transects by ___________

Use variables and % effectiveness to show that you want the foot transects to be more effective than the helicopter transects.

Write the equation and solve it to find the number of foot transects required to get better information than 100 helicopter transects.

Write a sentence that answers the question.

If you had to do a survey of moose on your territory, would you choose a helicopter survey or foot survey? Why? How could they be used together?

Summary: Ask your Elders and hunters in your communities how they know about the moose population on the territories. What signs do they see? What stories do they have about changes in moose (animal) populations? How could scientists and hunters work together to manage moose populations on your territories?

Moose Tracks — Answer Key

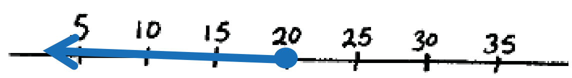
Effects on moose population — *sample responses*

Increase population	Decrease Population
♦ a warm winter with little snow so calves survive and are healthy ♦ animals expend less energy surviving and more energy thriving ♦ hunting pressure decreases ♦ predator population decreases ♦ more of a different wolf prey available (e.g., deer, rabbit)	♦ animals die because the food supply decreases ♦ a disease is introduced ♦ there is a cold winter or one with a lot of snow so the calves don't survive ♦ hunting pressure increases (e.g., road access changes, regulations change, poaching happens) ♦ predator (wolf) population increases ♦ less of a different wolf prey available

Inequality Example 1: Moose populations and wolves

a) Let m represent the number of moose.
The number of moose must be less than or equal to 20 per wolf.
The inequality is $m \leq 20$

b)



$m \leq 20$

c) i) decrease ii) increase iii) decrease iv) any number less than or equal to 20

Inequality Example 2: Estimating moose populations using helicopter viewing

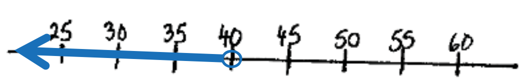
a) How can we write an inequality to show when biologists are more certain about their moose population estimates.

Let f represent forest cover

Biologists are more certain about their population estimates when there is less than 40% forest in the study area.

$f < 40\%$

b)



$f < 40$

c) i) less certain ii) more certain iii) less certain iv) any value less than 40% v) any value greater than 40%

Writing inequality equations: Comparing foot and helicopter surveys

Let f = # transects by **foot**

Let h = # transects by **helicopter**

Equation: $0.12f > 0.23h$

$0.12f > 0.23(100)$

Isolate f (# foot transects) by dividing both sides by 0.12.

$f > 192$

You would have to do more than 192 foot transects to be more effective than helicopter transects.

If you had to do a survey of moose on your territory, would you choose a helicopter survey or foot survey? Why? How could they be used together? Possible answers:

- Using hunters could lead to better information because they can see more signs.
- Use foot transects in areas where it would be hard to see by helicopter.
- Use helicopter when it would be hard terrain to access (long hike in, lots of gullies).