Teaching Mathematics in a First Peoples Context

Grades 8 and 9

Math First Peoples

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fnesc

Acknowledgments

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

Contents

T his document is designed to help teachers of Mathematics 8 and 9 in British Columbia (BC) extend their existing practice to incorporate new approaches that make the BC school system more reflective of the realities of First Peoples in this province and improve overall levels of student success when it comes to meeting provincially prescribed standards for mathematics at these grade levels. It is based on the belief that by bringing content, perspectives, and teaching approaches associated with First Peoples into the math classroom, teachers will

- help all students better appreciate the presence and importance of mathematics and mathematical thinking within all human cultures and activities
- give all students a better sense of the significant place of First Peoples within the historical and contemporary fabric of this province
- help their Aboriginal students in particular to feel more comfortable in mathematics learning situations and more motivated to participate and focus – thus becoming able to learn more effectively, experience increased academic success, and develop numeracy concepts and skills for lifelong use.

Recognizing that effective teaching practice involves balancing a large number of pedagogical considerations, this guide offers not only some instructional planning suggestions, but also

- some guiding principles associated with First Peoples learning and teaching and some explanations of what is involved in culturally sensitive education
- suggestions for identifying and addressing the needs and interests of individual students
- concrete and specific ideas for obtaining help creating an authentic First Nations context for learning
- selective suggestions and evaluations regarding additional resources that can be accessed for further material.

Further, recognizing the wide diversity that exists among students with respect to background, learning style, and personal preference, this teacher guide situates mathematics in relation to different areas of study as well as in relation to a variety of job-specific applications within the world of work.

We trust you will find it helpful!

What Is Math First Peoples?

Math First Peoples is an initiative of First Nations Education Steering Committee to make the wisdom of Elders and educators within British Columbia's First Peoples communities a part of mathematics teaching and learning around the province. Supported by the BC Ministry of Education, Math First Peoples is grounded in the acknowledgment that increased levels of academic success among students need not necessarily require modification of the provincially prescribed curriculum for this subject. Rather, increased success can be achieved adjustments in pedagogy and approach that can make mathematics feel more inclusive and engaging – especially for students who may until now have had difficulty perceiving its importance and relevance in their lives.

A succinct expression of the shared wisdom of Elders and educators within British Columbia's First Peoples communities is captured within the **"First Peoples Principles of Learning"** and the related **"First Peoples Principles of Mathematical Teaching."**

First Peoples Principles of Learning

First identified in relation to English 12 First Peoples, the following First Peoples Principles of Learning apply to all areas of the curriculum:

- Learning ultimately supports the well-being of the self, the family, the community, the land, the spirits, and the ancestors.
- Learning is holistic, reflexive, reflective, experiential, and relational (focused on connectedness, on reciprocal relationships, and a sense of place).
- Learning involves recognizing the consequences of one's actions.
- Learning involves generational roles and responsibilities.
- Learning recognizes the role of indigenous knowledge.
- Learning is embedded in memory, history, and story.
- Learning involves patience and time.
- Learning requires exploration of one's identity.
- Learning involves recognizing that some knowledge is sacred and only shared with permission and/or in certain situations.

Because these Principles of Learning attempt to capture common (shared) elements in the varied approaches to pedagogy that prevail within particular First Peoples societies, it must be recognized that they do not capture the full reality of the approach used in any single First Peoples society. When making connections with the local First Peoples community, teachers and students may therefore find it helpful to investigate how pedagogy is articulated and actually practiced within that community, so as to expand upon or qualify these "generic" principles. This investigation is likely to happen incrementally over time, as the pedagogical approach articulated and practiced within the local communities will not necessarily be set out in an easy-to-summarize form.

Ultimately, pedagogy in First Peoples societies, like pedagogy practised in non-Aboriginal societies, is both dynamic and culturally specific – grounded in a distinctive language and way of looking at the world. The following is an example of principles of teaching and learning as specific to the Lil'wat peoples.

LIL'WAT PRINCIPLES OF TEACHING AND LEARNING

Cwelelep — being in a place of dissonance, uncertainty in anticipation of new learning, to spin like a dust storm

Kamucwkalha — the felt energy indicating group attunement and the emergence of a common group purpose, group is ready to work together, to listen to one another and speak without fear

Celhcelh — each person is responsible for her or his learning. The concept means finding and taking advantage of all opportunities to learn, and maintain openness to learning. Each person must take the initiative to become part of the learning community by finding his or her own place and fitting into the community. It means offering what knowledge and expertise you have to benefit the communal work being carried out.

Emhaka7 — each person does the best she or he can at whatever the task, and keeps an eye on others to be helpful. The concept also means to work respectfully and with good thoughts and good hands.

Responsibility — each person is responsible for helping the team and the learning community to accomplish the task at hand in a good way, entering the work clear of anger and impatience.

Relationship –throughout the course each person will be conscious of developing and maintaining relationships — with the people, the task, the teachers and guides, and the communities beyond the learning community. It also means relating what you are experiencing to your past knowledge and to what you will do with what you are learning.

Watchful listening –an openness to listening beyond our own personal thoughts and assumptions, being aware and conscious of everything around you as you focus on the task at hand.

A7xekcal — how teachers help us to locate the infinite capacity we all have as learners. Developing one's own personal gifts and expertise in a holistic, respectful and balanced manner.

Kat'il'a — finding stillness and quietness amidst our busyness and the need to know

The First Peoples Principles of Mathematical Teaching extend from the First Peoples' Principles of Learning. They indicate (at a strategic level) how teachers might go about implementing the Principles of Learning in relation to mathematics teaching.

First Peoples Principles of Mathematical Teaching

Respecting Indigenous Knowledge *

1. Build on indigenous knowledge systems.
2. Relate story teachings to mathematical processes (e.g., how characters solve problems).
3. Make connections to a wide range of differing contexts (daily activities, traditional practices, activities in the workplace) and integrate learning related to mathematics and other subject areas in project assignments.
4. Find ways to build learning relationships with the local Aboriginal/cultural community (Elders, artists, people in various walks of life, including emergent business and industry).

Respecting the learner

5. Build on what students are already familiar with (both abstract "knowledge" and concrete knowledge).
6. Explore and build on students' interests (asking learners about what is important to them is a good way to identify what context will prove meaningful to them as a basis for learning mathematics).
7. Present mathematics problems of various sorts in varied ways (visual, oral, role-play, and experiential problems as well as word and symbol problems).
8. Stimulate students' innate curiosity and desire to explore.

Fostering the development of positive attitudes

9. Communicate a positive and enthusiastic attitude toward mathematics (be willing to take risks and make mistakes and encourage students to do the same).
10. Promote and reward perseverance (give necessary time for difficult problems and revisit them on multiple occasions).
11 Use humour and celebrate successes.

Fostering transformation for both teacher and student (transformative pedagogy)

12. Reflect on and revise your own practice with respect to teaching mathematics (including mistakes).
13. Find ways to build learning relationships with various professional communities where mathematics plays an important role.
14. Share what you are doing as a teacher with other colleagues, and use colleagues to support self-reflection.
15. Encourage students to reflect on and be explicit about their own thinking processes and the transformations in their own understanding.

* Indigenous Knowledge (IK) can be broadly defined as the knowledge that an indigenous (local) community accumulates over generations of living in a particular environment. This definition encompasses all forms of knowledge – technologies, know-how skills, practices and beliefs – that enable the community to achieve stable livelihoods in their environment. […] IK is unique to every culture and society, and it is embedded in community practices, institutions, relationships and rituals. […It] represents all the skill and innovations of a people and embodies the collective wisdom and resourcefulness of the community.

definition from www.unep.org/IK/

Making Connections

Math
First
Peoples

As is clear from the "**First Peoples Principles of Learning**" and the "**First Peoples Principles of Mathematical Teaching**," teaching mathematics in a First Peoples context is to a considerable extent about making connections –

♦ with members of local First Peoples communities
♦ with the indigenous knowledge that exists within local First Peoples communities
♦ with the interests, learning needs, and personal realities of your students (especially your First Nations, Métis, and Inuit students)
♦ with themes and issues that are commonly associated with First Peoples traditions and cultures.

Making Connections with Members of Local First Peoples Communities

(*Much of the material in this section is adapted from various BC Ministry of Education publications.*)
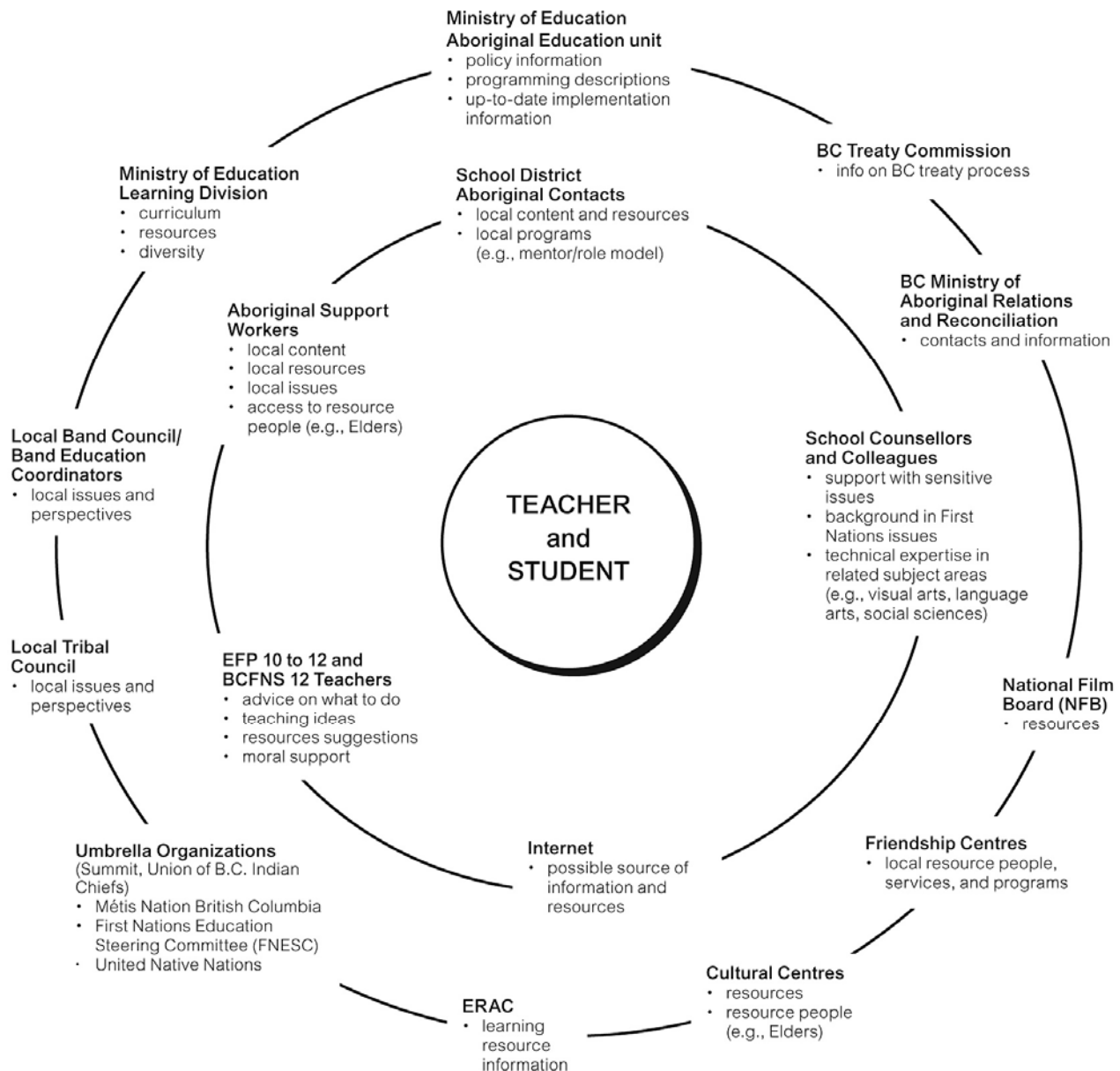
The support and participation of First Peoples teachers, Elders, and other knowledgeable members of your local Aboriginal community(ies) will be critical in helping you bring information about First Peoples into the classroom in a way that is accurate and that reflects First Peoples concepts of teaching and learning. Building strong community links — engaging in consultation with local First Peoples and seeking their support for what is being taught — will allow you to provide active, participatory, experiential learning and to localize course content. The accompanying diagram, "**Building Support Networks**" (next page) illustrates various points of contact you might look to for help.

Prior to initiating contacts with the chiefs, Elders, or other authorities in the local First Nation, you might wish to consult colleagues and local school district Aboriginal contacts who already have some experience working with the community on educational matters. District Aboriginal contacts, in particular, can prove extremely helpful in securing local community support (a list of school district Aboriginal contacts is available online at www.bced.gov.bc.ca/apps/imcl/imclWeb/AB.do).

Beyond this, to ensure that experiences involving members of the community (e.g., visits from guest speakers and field studies) are both educationally relevant and culturally appropriate, you might wish to apply procedures such as the following.

♦ Consult your local Aboriginal education coordinator to ensure that proper protocols are followed. Find out if your school or district has any support documents to assist teachers (www.ccl-cca.ca/pdfs/fundedresearch/Graham-Toolkit-AbL2006.pdf is one such example).
♦ Determine the nature of the presentation (e.g., lecture, question-and-answer, debate, response to students' presentations, facilitating a simulation or case study). Ensure that the guest speakers are clear about their purpose, the structure, and the time allotted. There should be a direct relationship between the content of the presentation and the prescribed learning outcomes. Review any materials they may use, especially any handouts, for appropriateness.
♦ Be aware of any district guidelines for external presenters, and ensure that your guests will meet these guidelines.
♦ Where appropriate, have students take responsibility for contacting the guests beforehand and making any logistical arrangements.
♦ Provide time for students to prepare for the guest by formulating focus questions.
♦ If the guests are willing, ask students to audio or video tape the interview rather than take notes. Have students then present to the class what they have learned from the process.
♦ Begin the guest presentation with an introduction to the topic and end with a debrief.

Building Support Networks

Ministry of Education Aboriginal Education unit
- policy information
- programming descriptions
- up-to-date implementation information

BC Treaty Commission
- info on BC treaty process

Ministry of Education Learning Division
- curriculum
- resources
- diversity

School District Aboriginal Contacts
- local content and resources
- local programs (e.g., mentor/role model)

BC Ministry of Aboriginal Relations and Reconciliation
- contacts and information

Aboriginal Support Workers
- local content
- local resources
- local issues
- access to resource people (e.g., Elders)

Local Band Council/ Band Education Coordinators
- local issues and perspectives

School Counsellors and Colleagues
- support with sensitive issues
- background in First Nations issues
- technical expertise in related subject areas (e.g., visual arts, language arts, social sciences)

TEACHER and STUDENT

Local Tribal Council
- local issues and perspectives

EFP 10 to 12 and BCFNS 12 Teachers
- advice on what to do
- teaching ideas
- resources suggestions
- moral support

National Film Board (NFB)
- resources

Umbrella Organizations
(Summit, Union of B.C. Indian Chiefs)
- Métis Nation British Columbia
- First Nations Education Steering Committee (FNESC)
- United Native Nations

Internet
- possible source of information and resources

Friendship Centres
- local resource people, services, and programs

ERAC
- learning resource information

Cultural Centres
- resources
- resource people (e.g., Elders)

Making Connections between Mathematics and Indigenous Knowledge

It is easy to imagine how your personal relationships with community members can create opportunities for students to interact directly with Elders and other members of the local Aboriginal community. At the same time, however, those personal relationships can become a source of opportunities to explore connections that might exist between your Mathematics program and

- Indigenous Knowledge (see definition provided in connection with the Principles of Mathematical Teaching, in the previous section, "What is Math First Peoples?"
- features of the community that might only be known by long-time residents.

In undertaking this kind of exploration, it can be helpful to keep in mind the work of researchers and educators in the field of ethno mathematics, who, among other insights, have identified six areas in which connections between mathematical thinking and Indigenous Knowledge are certain to exist. For example, in *Mathematical Enculturation* (1991, Kluwer Academic Publishers), A.J. Bishop has identified six areas of human activity that both embody mathematical thinking and occur within all cultures. These are

♦ measuring
♦ locating
♦ playing
♦ counting
♦ designing
♦ explaining.

> Further detail about how these processes are manifest in various cultures can be obtained by consulting Bishop's publication (available online through Google Books) and others in the field of ethno mathematics.

For practical purposes, this set of six processes can serve as a starting point for identifying and exploring activities within the Indigenous Knowledge base of your local First Peoples community that involve the use of mathematical thinking (and especially mathematical thinking covered in the Grade 8 or Grade 9 Mathematics curriculum).

Exploring the connections between Mathematics and Indigenous Knowledge or day-to-day community activities can occur informally, in the course of your day-to-day interactions with community members in a range of situations. As well, though, it can be done more formally, using a questionnaire such as the accompanying (see next page) to conduct cultural interviews. In this case, it helps to approach the interview as a conversation where you are trying to discover more about how this person uses mathematics to measure, locate, play, count, design, or explain.

If using this questionnaire, it may also be helpful to consider that
♦ not all questions listed here will be necessarily appropriate for your particular interview
♦ there should be something to learn in all six categories, so try to question in all of them
♦ although many community members (artisans, carpenters, mechanics, hunters, fishers, cooks) may be interested in helping you with this interview, some may not. Those who are uncomfortable with answering your questions may simply feel that they don't have the right or ability to represent the community or share their understanding of Indigenous Knowledge; some may just be plain busy.
♦ your district's Aboriginal education coordinator may be able to help, if you have difficulty finding people to interview
♦ it is important to add a short piece when you are done, describing the insights you have gained, and how you might apply them.

As described here the cultural interview is something for you, the Grade 8-9 mathematics teacher to use as a way to enhance your practice. In some situations, however, the mathematical cultural interview is something that can be undertaken by students themselves to spur learning and build connections between school and community. For this to be successful, the focus of the activity might need to be narrowed and the questions simplified. (The "Show Me Your Math" project carried out by educators with the Mi'kmaq Nation provides an example of how a student-conducted exploration of this sort might look, although the focus of the organized contest was as much on "math in the community and in daily life" as on "uncovering the connections between math and traditional practice." For more on locating information about this project, check out the "Show Me Your Math" citation in the Resources section at the end of this guide.)

Cultural Math – Interview Guide

Survey Developer: Dr. Jim Barta, Utah State University

Date:_____   Interviewer: _____

Person being interviewed: _____

Title/Occupation: _____

Counting How do you count things in what you do? ♦ Special names for counting numbers? ♦ Written symbols? ♦ How do you describe "zero"? ♦ How do you describe "infinity"? ♦ Are numbers represented using body parts or gestures? ♦ Do you count in any special groups such as by 5s or 10s? Are certain things counted in groups? ♦ Are large numbers used? How are large numbers described? Do certain numbers have special significance? What else can you do with your numbers besides count with them? - subtract, multiply, divide? Are fractions used? Other?	
Measurement Do you use a particular standard unit of measurement in what you do? Do you use parts of the body as specific units? Are specific tools used as measurement devices? ♦ How are small things measured/described? ♦ How are large things measured/described? ♦ How are great distances measured/described? ♦ How is rate/speed measured/described? ♦ How is weight measured/described? ♦ How is time (hours, minutes, etc.?) measured/described? ♦ Is some sort of calendar used? ♦ How is temperature measured/described? ♦ How are perimeter, area, and volume measured/described? Other?	

Locating Are "maps" used? What are the meanings of certain place names? How are things described spatially — their orientation in a particular place? ♦ Left/right? ♦ Up/down? ♦ Above/below? ♦ Depth/height? ♦ Horizontal/vertical? ♦ Cardinal directions? How does navigation occur? Is sorting/classifying (of objects) used in any way? Other?	
Designing What shapes are used for various purposes? ♦ Names of shapes and what the names represent? ♦ Spiritual significance of shapes? ♦ Angles (square angle)? What patterns are important and how are they constructed (tessellations)? Are particular designs used for clothing, pottery, etc.? Other?	
Explaining Are specific values recorded in any way (e.g., graphs)? How is wealth/prominence shown? Other?	
Playing Are special games played and how? ♦ Special tokens used? ♦ How are things scored? ♦ Do certain movements and/or words indicate counting or scoring? Other?	
Comments/Insights of Interviewer: 	

Making Connections with Your Students

Educators have long recognized that when entry to Grade 8 (or Grade 9) coincides with arrival at a new school (e.g., moving from an elementary to a secondary school), students need extra help adjusting to the new situation. Steps such as the following are needed to help them feel included, "at home," and comfortable in the new setting:

♦ student (and parent) orientation sessions for an entering cohort
♦ school-wide community-building activities
♦ allocation of dedicated counselling resources, with provision for year-over-year continuity as students progress to higher grade levels.

Such quasi-social support strategies can all prove valuable and can make a big difference to students' success in school. And regardless of the subject(s) you teach, your participation in this type of "get-to-know-you" activities can yield important benefits subsequently in your classroom.

In your role as a teacher of mathematics, however, you will naturally also need to focus on "get-to-know-you" activities that relate more specifically to students' learning in the field of mathematics – activities that allow you to assess their existing math skills, prior math learning, and learning needs. In connection with this type of formative assessment, practices associated with successfully teaching math in a First Peoples context are entirely consistent with many of today's widely accepted progressive assessment practices, particularly those that involve going beyond the exclusive reliance on traditional paper-and-pencil tests of computational skills to include more frequent and varied assessment activities that promote development of mathematics concepts.

In support of this approach, the following pages suggest three assessment activities that are drawn from actual classroom experience. These have been successfully used to make skills assessment more fun and engaging for students while revealing where particular students might have gaps in their foundational skills or require some review, recognizing that

♦ provincial K-7 curriculum standards notwithstanding, your students will typically arrive in Grade 8 (or Grade 9) along a "ragged front" – with varying levels of math proficiency and with varying math learning backgrounds
♦ you no doubt already conduct some sorts of initial assessments, for which these activities can serve as fresh supplements
♦ increased exposure to formative assessment activities of this sort will not only reduce students' stress around math skills assessment, but also provide increased opportunities for them "to reflect on and be explicit about their own thinking processes" (as articulated within the First Peoples Principles of Mathematical Teaching).

Further, recognizing that another important Principle of Mathematical Teaching is to "explore and build on what students are interested in," you will also find here a questionnaire, "Math and Me" that can be used to go beyond assessment of students' mathematical skills (i.e., their computational and problem-solving skills) to finding out about their attitudes and interests – something that will allow you to better select instructional activities and projects that they will find engaging and meaningful.

The "Math and Me" questionnaire has been formatted to facilitate copying for use with your classes. A follow-up Response Analysis Key has also been provided to indicate how particular responses might be interpreted and to suggest directions you might pursue.

Suggested Formative Assessment: Opening Day Test
[from writing team contributor]

In order to determine students' levels of math accomplishment when they first arrive in my classroom, and to remind the students of the concepts they had been exposed to and learned in the previous course, I give the students a "Review Test." This test is made up of one or two questions from each of the topics covered in previous grades, often taken from the textbook or final exam, totalling no more than 20 questions. I tend to take mid-level questions, with just a few that require multiple steps. The test is not for marks, and the students are told they are being evaluated on their previous knowledge, ability to work together, and follow instructions.

All questions on the test are to be answered before the students hand in the test. They are told to complete in 45 minutes, but in practice I give them as much time as needed to complete the entire test. While the students are completing the task, I check in with individuals and groups, getting a feel for the class level and abilities. The students are allowed to ask others in the class for help, but are not allowed to ask the same person with help for more than one question in a row. They must seek help from someone else, recognizing that this is not a team test! If the person they asked does not know how to solve the question, they can ask a third person, together. If that third person doesn't remember how to answer the question, the three students are to ask a fourth. If none of them remember how to do the question, as a group (of 4) they are to come and ask me how. This ensures that I am not spending my time putting out little fires, and it allows me to identify areas or concepts that will need immediate review and possible re-teaching. It is also a good way to visually see if there are a lot of students that are in need of assistance. In this way the students reinforce each other's knowledge and problem-solving skills, and it gives them an immediate sense of ownership over their learning, which I then reinforce throughout the year.

Finally, I mark the test myself, so that I can see whether their prior learning is still solid or whether it needs tweaking. It also shows me if the mistakes made were simple mechanical errors, or cause for further investigation. Often this test will pinpoint individuals that are in need of Learning Assistance or testing for possible diagnosis.

Suggested Formative Assessment: Math Wars
[from writing team contributor]

I have used this activity to review concepts and skills I have taught, often before a test, but also at the start of the year to remind students of past skills we will be building on.

The class is separated into teams of three or four members. Each team contains members who have varying levels of math proficiency (either I create the groups so teams contain a mix of proficient and less-proficient students, or else I have students write their names on slips of paper and have designated team Captains pick teams at random by drawing from a bowl).

Students congregate at given locations that are equidistant from the board, which is sectioned off so that each team has a designated writing spot. I will then either flash a question up on the overhead, or give it orally. The student from each team assigned to that question must run to the board and begin work. The students at the board must show all their work and work by themselves. When a student indicates she or he is done, I will look at the work and either say, "YES" or "NOT YET." If the student gets a "NOT YET," he or she must correct it, but is allowed to get help from the other team members. The team is not allowed to supply actual corrections, but can say things such as "Look at line 2!" or "Check your division!" (things that a teacher would normally say to help a student along). Each student has a turn at the board in sequence until everyone has had a chance.

The teams are given points based on who completes the question first, second, third etc.

The winning team may be given the title of Math Victors for the week with their picture on the wall, a prize (cool pencil or eraser and stickers), or a bonus mark on the upcoming test. I generally make note of students who appear to repeatedly struggle with their questions, and I then follow up one-on-one with those students during times that I regularly set aside for individual or group work.

Caution: This game tends to be loud, close your doors.

Suggested Formative Assessment: Snowball Math   [from writing team contributor]

I use this activity to help students review for a test or practice a difficult concept.

The class is given 2 sheets of paper, and told to rip/cut them in half. On each of the resulting four pieces of paper, the students are to write their name, along with a question based on the work we are doing. The students must pick one easy question, two mid-level questions, and one hard one. They can make the questions up, or take them from the textbook or quizzes. On a separate sheet of paper, the students are to write their questions, complete with their own solutions to the questions.

The class is divided into 4 teams. Teams are given 7 minutes to construct a "snow fort," out of desks, chairs etc., with one "snow fort" to occupy each corner of the room (though you will want them to construct the "snow forts" sufficiently close together that crumpled paper balls can be thrown from one to another)! Forts must be safe, and free of danger of toppling. Question sheets are then crumpled into "snowballs" for their team. I generally give each team extra snowballs I had constructed beforehand. All snowballs are held in their own fort.

On my mark, the students have 5 minutes to toss their snowballs at the other forts. Students are allowed to get wayward snowballs from the centre of the field, in order to throw them again. If they do, any snowballs that hit them are also given to their team for throwing. Note that you, the teacher must play referee!

At the end of the five-minute free-for-all, any snowballs in the centre are divided among the forts by the teacher. Any snowballs inside the fort become the property of that fort. Students in each fort must then divide between them the snowballs in their fort, before opening them up and telling me how many questions they have to complete. This makes sure all questions are answered, and that all snowballs are found! The forts are torn down and the room reassembled.

Students must answer all their snowball questions. If a student cannot complete a particular question, he or she is to go to the student who made the snowball and get help. If the students disagree on the answer, or the snowball-maker has a wrong answer, then the snowball comes to me, and the maker has to complete another question, chosen by me.

Caution: This activity gets very loud. Doors should be closed, so as to prevent wayward snowballs, and neighbouring classes may appreciate advance warning.

Math & Me: Questionnaire

Name:_____

Your answers to this questionnaire will allow your math teacher to organize activities that allow you and the other members of the class to best learn and be successful in mathematics this year. There are no correct or incorrect responses. Just read each statement and choose the response that seems closest to what you think, what you like, or how you tend to work. Feel free to use blank spaces or margins to add any extra information you would like to share about any of these questions.

1. Circle **your favourite** school subjects out of the choices below (you may circle more than one).
   a) English
   b) Other language
   c) Science
   d) Math
   e) Social Studies
   f) Fine Arts – music
   g) Fine Arts – dance
   h) Fine Arts – drama
   i) Fine Arts – visual arts
   j) Physical Education
   k) Technology Education
   l) Home Economics

2. Circle the subject that you think is **the most important** in preparing you for your future.
   a) English
   b) Other language
   c) Science
   d) Math
   e) Social Studies
   f) Fine Arts – music
   g) Fine Arts – dance
   h) Fine Arts – drama
   i) Fine Arts – visual arts
   j) Physical Education
   k) Technology Education
   l) Home Economics

3. Circle areas of life where you think math skills are important (you may circle more than one).
   a) resource harvesting (e.g., fishing, forestry, mining, agriculture, hunting/trapping)
   b) medicine & health care
   c) engineering and construction
   d) raising a family
   e) business & administration
   f) art & culture

4. Which of the following do you enjoy doing or do a lot when you are not in school? (you may circle more than one)
   a) sports (team and individual)
   b) outdoor activities (on land, water,…)
   c) computer games and other computer-related activities (e.g., online)
   d) reading
   e) creating or performing various types of art (music, drawing, dancing,…)
   f) building, making, or fixing things
   g) food preparation
   h) working to earn money (How? Please specify:_____)

5. Why do you think math is important? (you may circle more than one)
   a) it teaches me to think and be successful
   b) it helps me better understand my community and my culture
   c) it's useful for jobs and careers I might be interested in after high school
   d) I do not think it is important
   e) I need it to graduate from high school

6. Circle the answer that best describes your opinion about math.
   a) math is interesting and I enjoy the challenge of solving problems
   b) I try as hard as I can, even though I don't always "get it"
   c) if I pass I'm happy
   d) I'm not very good at math, so why bother
   e) I don't like or care about math

7. How would your previous math teachers describe you?
   a) generally gets homework done on time and tries hard
   b) not working to his/her potential
   c) enjoys math but struggles with understanding and needs extra time
   d) Is always distracted, does not seem to enjoy math, and does not work hard in class or at home

8. Circle the best ending to this sentence. When I get my report cards, ...
   a) math is usually my best mark
   b) math is usually my worst mark
   c) I am often not happy with how I'm doing in math
   d) I am usually satisfied with how I'm doing in math

9. Circle the answer that best states your attitude about your math assignments.
   a) I am always ahead of everyone and I enjoy helping other students who are stuck on a question
   b) I like to work fast so that I can be the first one done
   c) it takes me time to work through the questions and sometimes I need help but I usually finish it all
   d) sometimes I answer a few questions, but I do not like doing math questions so I don't try that hard

10. Circle the answer that best describes your attitude toward math tests.
    a) I like tests and they are usually a good way for me to show what I can do
    b) tests make me nervous and stressed out and I often don't do very well
    c) I have no special feeling about math tests

11. Who is most likely to help you with math homework problems?
    a) someone at home (parent, brother/sister, grandparent, aunt/uncle, caregiver)
    b) an Elder or other respected adult in your community
    c) a friend or classmate
    d) a tutor
    e) no one

12. Which of the following types of math activities do you like best?
    a) adding, subtracting, multiplication, or division drills
    b) math projects
    c) solving word problems
    d) solving number problems to improve my computational skills
    e) learning new concepts in geometry or algebra that I haven't tried before
    f) hands-on activities with counting blocks, games, cards, puzzles, etc.
    g) computer games, puzzles, and simulations

13. I do my best math work under the following conditions (you can circle more than one):
    a) when it's about things I am interested in
    b) when it's about things I am familiar with
    c) when I can work quietly on my own
    d) when I can work in a group with friends
    e) when I can work with one other partner
    f) when I can build things and work on projects
    g) when I get to use computers
    h) when I can show my thinking and solution visually or in stories (with drawings, manipulatives, dance, etc.)

14. Circle the answer that best describes how you deal with a math question you do not understand.
    a) I put up my hand and wait for the teacher to help me
    b) I ask my classmate or friend to help me
    c) I put my pencil down and my head on my desk and give up
    d) I try the question anyways and move on to the next one

15. Circle your response when you find out there is going to be a math test.
    a) I get ready by creating a study schedule so I am prepared for the test
    b) I usually cram the night before a test on my own or with a friend
    c) I don't study
    d) I hire a tutor

16. Circle what most often happens when you are given riddles or puzzles to solve
    a) I get right to them and enjoy the challenge of solving them
    b) I work until I get stuck on a hard one and often don't make it past that point
    c) I try each one, and move on to the next if I can't get it fairly quickly
    d) I do not bother trying because I know I won't get them

Use the space on the back to provide any other information about your experience with math that your teacher should know in order to help you learn better. Examples of things you might want your teacher to know about could include
♦ problems you have with your homework environment
♦ problems you have with the amount of time available to do math homework
♦ people in your life who are especially good at or interested in math
♦ previous math-related activities or experiences that you really liked.

Math & Me: Questionnaire Response Analysis

1.	Circle **your favourite** school subjects out of the choices below (you may circle more than one). a) English b) Other language c) Science d) Math e) Social Studies f) Fine Arts – music g) Fine Arts – dance h) Fine Arts – drama i) Fine Arts – visual arts j) Physical Education k) Technology Education l) Home Economics	Students' answers to questions 1 and 2 can reveal where their strengths and interests lie, when it comes to school learning. By building connections with students' preferred subject areas, you may be able to boost their interest and motivational levels with respect to learning math. Many of the math units in this resource use FN stories or legends as a context setting strategy. These can be discussed as "texts" (connection with English); FN cultural contexts can also be discussed in relation to Social Studies topics such as local history, and similarities and differences among cultures.
2.	Circle the subject that you think is **the most important** in preparing you for your future. a) English b) Other language c) Science d) Math e) Social Studies f) Fine Arts – music g) Fine Arts – dance h) Fine Arts – drama i) Fine Arts – visual arts j) Physical Education k) Technology Education l) Home Economics	Beyond this, if your students checked off any of the following subjects, there are units in this resource that could appeal to them: ♦ Science -- Unit 5: Hunting, Unit 8: Statistics and Salmon, Unit 2: Mapping and Transportation ♦ Social Studies -- Unit 2: Mapping and Transportation, Unit 6: Circle Dwellings ♦ Fine Arts, music, dance, drama: Unit 4: Games of Chance ♦ Fine Arts, visual arts -- Unit 3: Bentwood Boxes, Unit 7: Button Blankets ♦ Physical Education -- Unit 2: Mapping and Transportation, Unit 5: Hunting ♦ Technology Education -- Unit 3: Bentwood Boxes, Unit 6: Circle Dwellings, Multimedia Unit ♦ Home Economics -- Unit 1: Cooking with Fractions, Unit 7: Button Blankets Additional units that provide cross-subject as well as First People connections can be created, modelled on the samples provided in this Guide (e.g., see Themes etc. section for some suggestions on getting started). See also the Resources section of this Guide for other sources of relevant material.
3.	Circle areas of life where you think math skills are important (you may circle more than one). a) resource harvesting (e.g., fishing, forestry, mining, agriculture, hunting/trapping) b) medicine & health care c) engineering and construction d) raising a family e) business & administration f) art & culture	Applications of mathematics in the real world matter to many students and can motivate them to focus on and master math assignments. If your students checked off any of the following areas of life, there are units in this resource that could appeal to them: ♦ Resource Harvesting -- Unit 8: Statistics and Salmon, Unit 5: Hunting ♦ Medicine & health care – create a unit focusing on contemporary health topics with an aboriginal "angle" (e.g., nutrition) ♦ Engineering and Construction -- Unit 6: Circle Dwellings ♦ Raising a family -- Unit 1: Cooking with Fractions ♦ Business -- Unit 8: Statistics and Salmon, Multimedia Unit ♦ Art & Culture -- Unit 3: Bentwood Boxes, Unit 4: Games of Chance, Unit 7: Button Blankets

4. Which of the following do you enjoy doing or do a lot when you are not in school (you may circle more than one)? a) sports (team and individual) b) outdoor activities (on land, water,...) c) computer games and other computer-related activities (e.g., online) d) reading e) creating or performing various types of art (music, drawing, dancing,...) f) building, making, or fixing things g) food preparation h) working to earn money (How? Please specify:_____)	Making connections to students' extracurricular interests is another way to motivate them to focus on and master math assignments. Almost every activity can be looked at from a math perspective. For example the multimedia unit provided in this course might appeal to students who enjoy computer-related activities (see Resources list too). Practical financial applications of grade-level math concepts may be quite interesting for students who put a lot of out-of-school time working to earn money; see also the discussion re question 11 (concerning homework demands where students are attempting to balance school and work).
5. Why do you think math is important (you may circle more than one)? a) it teaches me to think and be successful b) it helps me better understand my community and my culture c) it's useful for jobs and careers i might be interested in after high school d) I do not think it is important e) I need it to graduate from high school	Are students motivated by intrinsic interest in the material (mathematics)? Are they motivated by thoughts of their work aspirations? Are academic requirements a motivator? Knowing this can help you decide how best to structure and plan your teaching.
6. Circle the answer that best describes your opinion about math. a) math is interesting and I enjoy the challenge of solving problems b) I try as hard as I can, even though I don't always "get it" c) if I pass I'm happy d) I'm not very good at math, so why bother e) I don't like or care about math	
7. How would your previous math teachers describe you? a) generally gets homework done on time and tries hard b) not working to his/her potential c) enjoys math but struggles with understanding and needs extra time d) is always distracted, does not seem to enjoy math, and does not work hard in class or at home	Questions 7 and 8 elicit information about students' personal history with math. When students self-report a history of either "success" or "failure" in relation to past math study, compare this with what his or her actual academic record states. This can reveal whether students are lacking confidence, overly confident, or excessively self-critical when it comes to math. These attributes can in turn reveal whether the student may have developed computational skills at the expense of real understanding or ability to apply the mathematics to solve real-world problems.
8. Circle the best ending to this sentence. When I get my report cards, ... a) math is usually my best mark b) math is usually my worst mark c) I am often not happy with how I'm doing in math d) I am usually satisfied with how I'm doing in math	Further, students who circle 7c, 7d, 8b, or 8c may be revealing that they have a gap in their grasp of foundational math concepts from earlier grades (e.g., adding two fractions requires that they have a common denominator).
9. Circle the answer that best states your attitude about your math assignments. a) I am always ahead of everyone and I enjoy helping other students who are stuck on a question b) I like to work fast so that I can be the first one done c) It takes me time to work through the questions and sometimes I need help but I usually finish it all d) sometimes I answer a few questions, but I do not like doing math questions so I don't try that hard	Students' answers to this question can help you decide when, whether, or how to assign work to same-ability or varied ability groups. Answers to this question can also help you plan for the amount of encouragement, activity monitoring, or instructional time that will be needed to help particular students.

10.	Circle the answer that best describes your attitude toward math tests. a) I like tests and they are usually a good way for me to show what I can do b) tests make me nervous and stressed out and I often don't do very well c) I have no special feeling about math tests	Students who find tests stressful can be supported by using tests as a learning tool (formative assessment), so they become a more-familiar, less-threatening experience. Consider giving quizzes as assignments and having students debrief their answers in pairs, comparing their approaches to finding the solutions they think are "correct."
11.	Who is most likely to help you with math homework problems? a) someone at home (parent, brother/sister, grandparent, aunt/uncle, caregiver) b) an Elder or other respected adult in your community c) a friend, or classmate d) a tutor e) no one	Students' learning situations and home supports can have a great impact on their success at school. Depending on students' responses to this question, you may wish to revisit and/or and clarify your expectations with respect to homework. Options to consider include ♦ discussing overall homework load and support strategies with other colleagues and school administrators (e.g., pedagogical pros and cons of "reduced homework" policies) ♦ establishing a school-based mentoring or tutoring system in which students with stronger or more advanced (e.g., Grade 10) math skills help grade 8-9 students who require the support ♦ more (formal and/or informal) communication with students' parents or guardians regarding what is realistic and appropriate with respect to homework ♦ determining whether a math-specific solution is needed or whether the student needs support with generic study skills (e.g., from the school's learning assistance specialists)
12.	Which of the following types of math activities do you like best? a) adding, subtracting, multiplication, or division drills b) math projects c) solving word problems d) solving number problems to improve my computational skills e) learning new concepts in geometry or algebra that I haven't tried before f) hands-on activities with counting blocks, games, cards, puzzles, etc. g) computer games, puzzles, and simulations	Consider using the information gained from answers to questions 12 and 13 to provide activities that alternatively cater to and seek to extend students' predispositions and preferences re learning approach.
13.	I do my best math work under the following conditions (you can circle more than one): a) when it's about things I am interested in b) when it's about things I am familiar with c) when I can work quietly on my own d) when I can work in a group with friends e) when I can work with one other partner f) when I can build things and work on projects g) when I get to use computers h) when I can show my thinking and solution visually or in stories (with drawings, manipulatives, dance, etc.)	
14.	Circle the answer that best describes how you deal with a math question you do not understand. a) I put up my hand and wait for the teacher to help me b) I ask my classmate or friend to help me c) I put my pencil down and my head on my desk and give up d) I try the question anyways and move on to the next one	A large number of a) and c) responses reveal that your group feels quite needy and dependent on you. Teacher help rules can help you manage the demands from these students. For example, insist that students who don't understand an assignment first ask your neighbour, then another, and if you still don't get it, ask the teacher. Students who answer b) are naturally independent and can be relied on to help manage their learning in an effective and realistic way; students who answer d) may seem independent, but need to be monitored carefully, since they could pretend to understand even when they don't.

15.	Circle your response when you find out there is going to be a math test. a) I get ready by creating a study schedule so I am prepared for the test b) I usually cram the night before a test on my own or with a friend c) I don't study d) I hire a tutor	Students who answer anything other than a) probably need help with study skills. In the lead-up to a test, those who do not study well or at all can be given assignments that effectively constitute study for the test (e.g., practice tests worked on with a partner).
16.	Circle what most often happens when you are given riddles or puzzles to solve a) I get right to them and enjoy the challenge of solving them b) I work until I get stuck on a hard one and often don't make it past that point c) I try each one, and move on to the next if I can't get it fairly quickly d) I do not bother trying because I know I won't get them	Student answers to this question can reveal what kinds of encouragement and support they require. They also give an indication of how much difficulty you can incorporate into the challenges that you give students.

School-Wide Responses to Student "Math Gaps"

When history and current assessments indicate that your incoming student cohorts are regularly arriving in Grade 8 (or Grade 9) along a "ragged front" – with varying levels of math proficiency and with varying math backgrounds – you may require solutions that extend beyond the individual classroom to include the entire school. Such solutions may include extra-curricular math enrichment opportunities or implementation of a more diversified set of math class offerings in which smaller groups of students work on specific areas of mathematics at differing levels, according to their assessed learning needs. Such a system is described in the following program profile.

Program Profile: A School-Wide System to Address Gaps and Student Needs

The students who come to our school have serious gaps in their education. Many of the youth, who are in grade 8-9, by age, still have difficulties with long division (grade 5/6 level). About 95% of the youth will do the grade 10 Applications and Workplace math and provincial exam. To address this situation, rather than place the students into standard grade 8 or 9 math classes, we place them all in "pre-10" math, a grouping where the objective is to get them ready to deal with the demands of one of the provincially examinable grade 10 math courses.

Within this "pre-10" math grouping, there are 4 levels: level 1 (pre-grade 5), level 2 (grade5/6), level 3 (grade7/8), level 4 (grade 9); these levels in turn have multiple sub-levels. The levels are defined in a manner that considers the provincial curriculum, but the emphasis is on the very specific problems that students are actually experiencing and on "what students really need to know." Students can move from one level to the next as soon as they demonstrate competency at their level. The idea is to move the student along as fast as possible with the knowledge they require; not to hold them back. The plan is to also have all teachers, educational assistants, and any able adult instructing small groups, all at the same time. There is a focus on using "hands on" activities to instruct the lesson – the students learn best when they are "doing."

As students complete level 4 they are directed into the grade 10 math course that fits best with their goals and learning needs: either Apprenticeship and Workplace Mathematics or Foundations of Mathematics.

[from writing team contributor]

Making Connections with First Peoples Themes and Topics

One of the most readily implemented ways to begin teaching Mathematics in a First Peoples context is to establish meaningful connections for students between mathematics skills and "content" and First Peoples themes and topics. To be meaningful, connections must not only be identified at the outset of a teaching unit, but must be systematically revisited at appropriate intervals. Certainly, the tokenism of periodically introducing one-off, trivial examples or contrived problem situations that pander to simplistic, stereotypical aspects of First Peoples traditions will be obvious to most students and completely fail to achieve any meaningful result.

That said, there are a variety of themes and topics that are characteristically associated with the worldview of many First Peoples that can be meaningfully connected with topics and processes covered in Grade 8 and Grade 9 mathematics. The following table identifies a number of these themes and topics and how they might relate to the mathematical learning addressed in the grade 8 and 9 curricula (the bracketed alphanumeric codes within the table refer to individual grade-specific learning outcomes set out in BC's 2008 Mathematics 8 and 9 curriculum document). To show how these connections can be meaningfully developed to support your mathematics teaching several of them have been worked up into exemplary instructional units in the next section of this resource.

THEMES	Sub-topics	Grade 8 Math Concepts	Grade 9 Math Concepts
Family & Ancestry	Family trees	• number percentages (A3) • fractions (A6)	• powers and exponents (A1)
Travel and Navigation	Stars and landmarks	• Pythagorean theorem (C1) • rates ratios & proportional reasoning (A5) • operations with integers (A7)	
	Tides	• 2-variable linear relations (B1) • linear equations (B2) • data presentation (D1)	• generalizing patterns using linear equations (B1) • graphing linear relations (B2) • modeling & solving linear equations (B3)
	Canoes (e.g., how they move, wakes relative to boat length and speed, *d=rt*) — *see Unit 2 for an example*	• perfect squares & square roots (A1) • approximate square roots (A2) • 2-variable linear relations (B1) • graph linear equations (B2) • views of 3D objects (C5)	• square roots (A5) • approximate square roots (A6) • generalizing patterns using linear equations (B1) • graphing linear relations (B2) • scale diagrams of 2-D shapes (C4)
Games	Games of chance (e.g., Lahal, bone game) — *see Unit 4 for an example*	• data presentation (D1) • chance and probability (D2)	• role of probability in society (D4)
Land, Environment, & Resource Management	Hunting — *see Unit 5 for an example*		• generalize a pattern (B1) • graph a linear relation (B2) • model & solve linear equations (B3) • single-variable inequalities (B4)
	Salmon (e.g., serving sizes, estimated catches, population dynamics) — *see Unit 8 for an example*	• number percentages (A3) • rates & ratios (A4) • proportional reasoning problems (A5) • linear relations (B1) • statistics and probability (D1, D2)	• populations vs. samples (D2) • data analysis plan (D3)

THEMES	Sub-topics	Grade 8 Math Concepts	Grade 9 Math Concepts
	Food Gathering, (e.g., serving sizes, time management, storage capacities, predicted yields)	• number percentages (A3) • rates & ratios (A4) • proportional reasoning problems (A5) • fractions (A6) • integer work (A7) • linear relations (B1) • statistics and probability (D1, D2)	• powers and exponents (A1) • rational numbers (A3)
	Pollution/ Contamination (e.g., monitoring toxicity levels in drinking water, aquatic life) — *see the Supplemental Unit for an example*	• proportional reasoning problems (A5) • linear relations (B1) • linear equations (B2) • statistics and probability (D1)	• generalizing patterns using linear equations (B1) • graphing linear relations (B2) • solving linear equations (B3) • data analysis (D1, D2, D3, D4)
	Cedar Harvest (e.g., calculating yield, sustainability)	• surface area (C3) • volume (C4)	• generalizing patterns using linear equations (B1) • single-variable inequalities (B4) • polynomial expressions (B5)
Community Profiles	Contemporary & historical demographics	• number percentages (A3) • data presentation (D1)	• data analysis (D1, D2,D3, D4)
Artwork	Totem Poles/ Monuments (e.g., designing, raising)	• Pythagorean theorem (C1)	• ratios & scale (C4) • symmetry (C5)
	Bentwood Boxes — *see Unit 3 for an example*	• ratios & scale (A4) • 3-D nets (C2) • surface area (C3) • volume (C4) • views of 3-D objects (C5) • transformations – tessellation (C6)	• surface area of composite 3D objects (C2) • ratios & scale (C4) • line and rotational symmetry (C5)
	Blankets — *see Unit 7 for an example*	• transformations – tessellation (C6) • Pythagorean theorem (C1)	• generalizing patterns using linear equations (B1) • polygons (C3) • ratios & scale (C4)
	Drums (e.g., building, decorating, rhythms)	• 3-D nets (C2) • surface area (C3) • volume (C4) • multiply & divide positive fractions & integers (A6) • transformations – tessellation (C6)	• circle geometry (C1) • surface area (C2) • scale diagrams (C4) • line and rotational symmetry (C5)
Nutrition	Cooking, Feast — *see Unit 1 for an example*	• number percentages (A3) • rates & ratios (A4) • proportional reasoning problems (A5) • multiply & divide positive fractions & integers (A6)	• fractions, decimals, percentages (A3)
	Diabetes (e.g., rates, trends)	• statistics and probability (D1, D2)	• data analysis (D1, D2,D3, D4)
Dwellings	Circle dwellings (e.g., kickwilly/kekuli, igloo) — *see Unit 6 for an example*		• circle geometry (C1) • surface area (C2) • scale diagrams (C4) • line and rotational symmetry (C5)

THEMES	Sub-topics	Grade 8 Math Concepts	Grade 9 Math Concepts
	Longhouse	• perfect squares & square roots (A1) • approximate square roots (A2) • number percentages (A3) • proportional reasoning problems (A5) • views of 3-D objects (C5)	• surface area (C2) • polygons (C3) • scale diagrams (C4) • line symmetry (C5)

This is by no means a finite list of possibilities. Other First Peoples themes and topics that you might consider exploring to establish connections with Grade 8 and Grade 9 mathematics (and to develop your own instructional units or activities) include the following:

- the seasonal cycle in relation to traditional ways of life (relationship to seasons)
- place and relationship to the natural world
- relationality (interdependence) & connectedness
- language & worldview
- family (extended family), genealogy, & lineage
- sustainability & continuity

- balance
- learning (how to learn; roles of teacher & learner); schooling vs. education
- nurturing
- sharing & generosity
- culture, tradition, and ceremony
- rhythm in song, dance, etc.
- transformation
- diversity
- historical and contemporary Aboriginal demographics

- technology (traditional and contemporary)
- art & functional art
- collaboration and cooperation
- roles, inclusivity, & belonging
- decision making
- governance
- structure and hierarchy within traditional societies

Sample
Unit Plans

Math
First
Peoples

T his section of the Teacher Resource Guide contains a series of sample unit plans for Mathematics 8 and 9. Each is based on a theme or topic that is commonly associated with traditional and/or contemporary First Peoples realities or that will resonate readily with students from First Peoples families or communities:

Grade 8 Unit Plans	*Grade 9 Unit Plans*
Unit 1: Cooking with Fractions	Unit 5: Hunting
Unit 2: Mapping and Transportation	Unit 6: Circle Dwellings
Unit 3: Bentwood Boxes	Unit 7: Button Blankets
Unit 4: Games of Chance	Unit 8: Salmon Populations

Note that in addition to these sample unit plans, this Teacher Resource Guide contains a Supplemental Unit Plan. This Supplemental Unit Plan is distinctive in that it is specifically designed to complement a "multimedia" Grade 8-9 student learning resource available from FNESC, free of charge (see Supplemental Unit Introduction).

About the Sample Unit Plans

The sample unit plans provided here have been numbered and organized by grade for ease of reference. This, however, is not meant to suggest that they should be used sequentially – or as a basis for your entire year's instructional planning. Although cumulatively, the sample unit plans address virtually all aspects of the Grade 8 and 9 Mathematics curriculum for BC, they are not all necessarily complementary. In fact, you will find them quite varied in terms of organization, tone, and pedagogy. And recognizing that teaching approaches and learning situations vary enormously throughout the province, they have deliberately NOT been designed to fit a template or follow a tightly standardized format.

That said, there are some common assumptions and features that all of these sample unit plans tend to share:
♦ The emphasis in each unit is on establishing a First Peoples context, not merely as an initial motivational set that persuades students to endure a subsequent diet of computational practice, but as a recurring focus that you regularly revisit as students work through the various mathematical concepts and processes associated with the unit.
♦ Although many of the units provide detailed examples of the kinds of explanations you can use to introduce particular grade-specific mathematical concepts, all of them assume that you do not need to have either the mathematics or the grade level curriculum explained in detail and that you are either a specialist mathematics teacher or a trained generalist teacher with the necessary mathematical proficiency to handle the conceptual and computational demands identified in the provincially prescribed curriculum for Grades 8 & 9.
♦ Each unit assumes that your teaching mandate is to cover grade-level mathematics as a discrete subject, working with a consistent class of students within a specified school schedule. Although opportunities for curricular integration and individualized student learning can certainly be developed using these unit plans as a starting point, suggestions to that effect have not been provided here.

Further, although the units are somewhat varied in terms of organization and structure, each contains the following elements:
♦ an overview that helps establish a context for the material provided in the unit
♦ a listing of the prescribed learning outcomes that can be addressed by that unit (recognizing that you may wish to emphasize or de-emphasize the focus on particular outcomes or decide to target additional outcomes from the lists of the Prescribed Learning Outcomes and associated achievement indicators provided in the *Mathematics 8 and 9 (2008)* curriculum document, available online at www.bced.gov.bc.ca/irp/welcome.php)

- a listing of supplemental resources (generally available online) that you could use to enrich or expand on the unit material
- information about approximate instructional time required to conduct the unit
- assessment suggestions and student handouts as applicable.

Ultimately, the hope is that you will find here something compatible with your pedagogical preferences and existing practice that you will be able to adopt (and adapt as needed) with a minimum of risk and disruption. Above all, you should feel free to select, ignore, adapt, modify, organize, and expand on the unit plans, as needed to
- meet the needs of your students
- integrate your own teaching strategies for particular mathematics topics
- respond to local requirements
- incorporate additional relevant learning resources.

For example, several of the units include a traditional story that serves primarily to enrich the context being established for subsequent mathematics activities. In each case, the story is drawn from the oral tradition of a particular First Nations community and has been chosen because it relates closely to the theme of the lesson it accompanies. As you become more familiar with the traditions and stories of the First Nation(s) in your area, you may discover comparable stories that could serve a similar purpose in relation to the unit plan. If so, you would probably find that substituting the local story for the story supplied here will make your teaching feel even more relevant and inviting to students – and especially to those who belong to the community in question. The same is true for other resources suggested in the unit plans.

Unit 1:
Cooking with Fractions

Context

First Peoples, like people in many other cultures, love to bring food when friends and family come together for cultural gatherings and special occasions. Many of the recipes used do not have specific measurements due to the recipes being passed on by an Elder who may use terms like "a handful of this," "a pinch of that," "enough water to feel right."

Prescribed Learning Outcomes

This unit can be used to help students achieve the following Prescribed Learning Outcomes for Mathematics 8:
A3   demonstrate an understanding of percents greater than or equal to 0%
A4   demonstrate an understanding of ratio and rate
A5   solve problems that involve rates, ratios, and proportional reasoning
A6   demonstrate an understanding of multiplying and dividing positive fractions and mixed numbers

Resources

♦   student handout: Converting Fractions, Decimals, and Percents (distribute this at any point during the unit for student reference)
♦   student handout: Recipes (sample recipes to be used for various activities, particularly if students are not able to bring in their own from home)

Materials Needed

♦   imperial measuring cups, measuring spoons, larger 2+ cup measurer
♦   recipes
♦   water for measuring

Suggested Instruction and Assessment Approach

Introduction

Ask students how many of them have experience with cooking, either at home or at school. What types of measurements do they use? Point out that, although metric measurements are the official standard in Canada, and often the standard used in schools, most homes in North America still use imperial measurements — cups, tablespoons, etc. — for cooking. (Note that both metric and imperial measurements are used throughout this unit; you may wish to focus on only one measurement system, and/or have students convert from one to the other as an extension activity.)

Bring in an Elder to demonstrate the making of fry bread or another dish of their choice. In most cases the Elder will prepare the recipe "by hand," not with measuring instruments. This is a good opportunity for the students to try and match the "hand" measurements with the appropriate measuring cup/spoon. Once the students identify the correct measurements they may proceed with the making of the fry bread (a recipe is provided at the end of this unit).

Ask students to bring in recipes from home; these recipes will be used as a basis for practising multiplication and division of fractions, as well as proportional reasoning. Discuss with students

how it is beneficial to understand fractions when cooking. They may need to know how to make a recipe larger or smaller, depending on the size of the group they may be feeding.
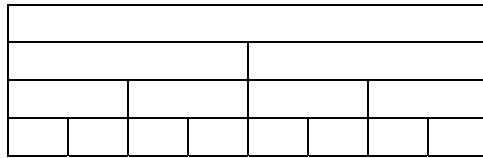
Lesson 1 – Multiplying and Dividing Fractions

PLO A6

Have students share their recipes with you and choose one that can be used as an example for multiplying fractional measurements. Use repeated addition to show how a fraction can be multiplied by a whole number. Explain that we need to triple the recipe (3x) for the family dinner. Demonstrate, using water, how for example, ¾ c x 3 = ¾ + ¾ + ¾ = 2 ¼ (pour water into larger 2+ cup measurer). Many learners retain the information if they can use hands-on methods. Triple the remaining fractions in the recipe. For example:

$$\frac{1}{2} \times 3 , \qquad \frac{1}{4} \times 3, \qquad \frac{2}{3} \times 3, \qquad \frac{1}{8} \times 3, \qquad 1\frac{1}{2} \times 3, \qquad 2\frac{1}{4} \times 3, \qquad 1\frac{3}{4} \times 3$$

Demonstrate how something can be divided by taking the water from the measuring cup. (1 ½ ÷ 3: "If you have 1 ½ c of soup and want to share it between 3 people, how much does each person each get?"). Using one of the students' recipes, divide it by 2.

Another good way to demonstrate dividing is to make a cake and then use it like fraction strips. So a 9 x 11 inch cake can be used to illustrate halves, quarters, and eighths:

To help reinforce their multiplying and dividing fractions skills by increasing and decreasing the serving size in a recipe, have students:

1. Find a recipe that contains at least 3 fractions.
2. Rewrite the recipe for half as many people.
3. Rewrite the recipe for three times as many people as the original recipe.
4. Using the fry bread recipe (see the student handout), have the students double the recipe, triple it, multiply it 10 times.
5. Choose 2 more recipes, one is to be multiplied by 1 ½, doubled, and multiplied 5x. The other recipe is to be divided into thirds and halves.

Eventually the students will have the opportunity to make a class lunch of venison stew with scow (or fry) bread. Invite Elders, family, or whole school if appropriate.

Lesson 2 – Rates, Ratios, and Proportions

PLOs A4, A5

Define ratio: a relationship between two numbers of the same kind. In cooking, an example of a ratio would be one cup of sugar for every 5 cups of berries, which would be expressed as a ratio of 1:5. A ratio can also be written as a fraction: $\frac{1}{5}$

Show how you can use this ratio to adjust a recipe for larger quantities: How many cups of sugar would you need for 15 cups of berries? For 40 cups of berries?

Explain to students what proportions are and how they go hand-in-hand with fractions; using the measuring cups/spoons to give visuals. Demonstrate how for every cup of flour needed for fry bread, 1 tsp. of baking powder is needed: 5 cup of flour requires 5 tsp. of baking powder. $\frac{1\,c\,=\,1\,tsp}{5\,c\,=\,5\,tsp}$
For every cup of flour put into the larger measuring cup, put 1 tsp. of baking powder into a separate measuring spoon.

Show how a larger recipe can be converted to feed only 1 person. Take a recipe that is designed to feed a family of 4.

Example: Apple Crisp – apples, 1 cup flour, 1 cup oatmeal, 1c sugar, and 1 cup butter (feeds 4)
$\frac{1\,cup\,=\,4\,people}{x\,cup\,=\,1\,person}$ 1 cup ÷ 4 = ¼ c per person

Demonstrate how to cross multiply and divide to find the missing proportion. Use manipulatives (e.g., jelly beans) to illustrate cross multiplying. For example: If you have 50 jelly beans and 10 students in the class, how many jelly beans does each student get? Using the board, show that:

	50 jelly beans	= 10 students
then	? jelly beans	= 1 student

$$\frac{50}{x} = \frac{10}{1}$$

$\frac{50}{x} \diagdown\diagup \frac{10}{1}$ ➔ $50 \times 1 = 10 \times x$ ➔ $50 = 10x$ ➔ $x = 5$

We multiply both sides of the equation by one of the denominators (in the above case, the x). Repeat to eliminate the second denominator (1 for the above). Then divide both sides by the coefficient (10) to complete the equation.

Explain the advantages of knowing how to lay this proportion out.

Expand: Give the students a variety of recipes (taken from the collection brought in from their homes), and have them practise making recipes larger or smaller using the proportion method.

Additional Problems

1. If 3 kilograms of salmon costs $65, how many kilograms can you buy for $100?

2. If 1 pizza will feed 8 people and there are 24 students in the class, how many pizzas are needed to feed everyone?

3. One salmon feeds 8 people and a single batch of fry bread will feed 4. How much of each do you need to cook to feed a group of 20 people?

4. You and a friend have gone fishing for salmon and you caught 7. If 1 salmon can feed 8 people, and you have 4 people in your family, how many meals can you get from your catch?

5. Your family has decided to can the salmon that they caught. Each jar will hold ¾ of a cup of salmon; 1 salmon will fill 10 jars. How many jars of canned salmon will be made from the 28 salmon caught? How many cups? If your family uses 5 jars a week, how many cups of salmon is being eaten? Using 5 jars a week, how many weeks will the canned salmon last?

6. To make soapberry ice cream, it takes 1/3 cup of berries for 1 serving. It takes 10 minutes to pick 1 cup of berries. If you need to make soapberry ice cream for 25 people, how many cups of berries do you need? How long will it take to pick the berries?

Lesson 3 – Percentages

PLOs A3, A4

Define percent a fraction of a number out of 100. A ratio can also be written as a fraction, which can be converted into a percentage:

$$10 : 100 \; = \; \frac{10}{100} = 10\%$$

$$\text{ratio} = \text{fraction} = \text{percentage}$$

To convert a fraction into a percent: take what you have been given and divide it by the total number. This gives you a decimal. To convert this into a percentage, simply multiply the decimal by 100 and add a % sign.

$$\frac{part \; = \; \%}{whole \; = \; 100\%} \quad \rightarrow \quad \frac{part}{whole} = \frac{\%}{100}$$

Demonstrate examples such as:

$$\frac{?l = 75\,\%}{4\,l = 100\,\%} \qquad \frac{6\,cups = ?\,\%}{12\,cups = 100\,\%} \qquad \frac{3\,tbsp = 60\,\%}{?tbsp = 100\,\%} \qquad \frac{6\,tsp = 15\,\%}{?tsp = 100\,\%} \qquad \frac{?cups = 4\,\%}{22\,cups = 100\,\%}$$

Choosing from the student recipes again, challenge students to
♦   increase all of the ingredients by 60%, 75%, and 150%
♦   decrease all of the ingredients by 10%, 25%, and 50%

Example Problems:

1. 10% of a 500 ml container of yogurt has been eaten. How many millilitres of yogurt are left?

2. If you were to eat 5/8 of a tomato, what percent did you eat?

3. You made 20 pieces of fry bread for a gathering, and 4 pieces were leftover at the end. What percentage of bread was eaten?

4. The price of salmon is $32 kg. If the price was to be raised 25%, how much is the new salmon price?

Extension

Work with a cooking class to plan a year-end, whole school feast. Have students find the recipes, adjust the quantities to feed the number of people, and prepare the food.

Converting Fractions, Decimals, and Percents

A fraction to a decimal

Divide the denominator (the bottom part) into the numerator (the top part).

$$\frac{1}{4} = 1 \div 4.00 = 0.25$$

A fraction to a percent

Multiply the fraction by 100 and reduce it. Then, attach a percent sign.

$$\frac{1}{4} \times \frac{100}{1} = \frac{100}{4} = \frac{25}{1} = 25\%$$

A decimal to a fraction

Starting from the decimal point, count the decimal places. If there is one decimal place, put the number over 10 and reduce. If there are two places, put the number over 100 and reduce. If there are three places, put it over 1000 and reduce, and so on.

$$0.25 = \frac{25}{100} = \frac{1}{4} \qquad 0.5 = \frac{5}{10} = \frac{1}{2}$$

A decimal to a percent

Move the decimal point two places to the right. Then, attach a percent sign.

$$0.25 = 25\% \qquad 0.4 = 40\%$$

A percent to a decimal:

Move the decimal point two places to the right. Then, drop the percent sign.

$$25\% = 0.25 \qquad 60\% = 0.6$$

A percent to a fraction:

Put the number over 100 and reduce. Then remove the percent sign.

$$25\% = \frac{25}{100} = \frac{1}{4}$$

Recipes

VENISON STEW

2 lbs. meat cut into 1-inch cubes
1/2 c. flour
2 tbsp. oil
1 bay leaf
1 1/2 tbsp. Worcestershire sauce
3/4 med. chopped onion
1 1/4 c. beef bouillon
1/3 tsp. pepper

2 1/4 tsp. sugar
1 1/4 tsp. salt
5 carrots, peeled, sliced and quartered
3/4 c. sliced celery
3 med. potatoes, peeled and cut into eighths
5 c. water

Coat meat with flour; set excess flour aside. In large skillet, heat oil. Add meat and brown. In slow cooker, combine browned beef, bay leaf, Worcestershire sauce, chopped onion, bouillon, pepper, salt, sugar and vegetables. Pour water over all. Cover and cook on low 8-10 hours. Turn control to HIGH. Thicken with flour left over from coating dissolved in a small amount of water. Cover and cook on HIGH 25-30 minutes or until slightly thickened

FRY BREAD (Bannock)

3 c. flour
1 tbsp. baking powder
1/2 tsp. salt
1 c. warm water

Combine flour, baking powder and salt in a large mixing bowl. Add warm water in small amounts and knead dough until soft but not sticky. Sometimes more flour or water will be needed. Cover bowl and let stand for about 15 minutes. Pull off large egg sized ball of dough and roll out into round about ¼ inch thick. Punch hole in centre of each round piercing several times with fork to allow dough to puff.

In a heavy skillet fry (deep fry) rounds in lard or other shortening until bubbles appear on dough, turn over and fry on other side until golden.

Scow bread (baked) – instead of frying the bread, place dough in a bread pan. Spread out evenly. Bake at 350° for about 40 min.

Use fry bread to make a **Bannock Taco***:* cover the fry bread with layers of taco seasoned ground venison meat sauce, shredded lettuce, cheddar cheese, chopped onions, and diced tomatoes. Cover the top with sour cream and salsa according to taste.

For more about bannock/fry bread, visit www.for.gov.bc.ca/rsi/fnb/fnb.htm

Part I: A Map of Home

Context

First Peoples historically have lived off the land. The intricate relationships between people and the land that were necessary for survival are reflected in the stories, art, worldviews, and cultural identity of First Peoples. Many First Peoples have continued their intimate relationship with the land, while others still hold onto the symbolism that connects them. Knowing your way on the land was something that you knew from being on the land. Names of places in the indigenous languages describe what was in that place (e.g., Gitwingax — People of the Place of Rabbits).

Now, knowledge of the land, and the ability to communicate location with other interest groups, demands an understanding of maps, their limitations, and the mapping technology available. Such information is critical for land use management decisions. This activity introduces students to maps, scale, and identifying their personal landmarks on topographical maps.

Note: The ideas presented in this unit were gathered from Gitxsan First Nation. It is **strongly** recommended that, wherever possible, you conduct research prior to initiating this unit to identify landmarks and stories of significance to the local First Peoples.

Prescribed Learning Outcomes

This unit can be used to help students achieve the following Prescribed Learning Outcomes for Mathematics 8:
A5   solve problems that involve rates, ratios, and proportional reasoning
C1   develop and apply the Pythagorean theorem to solve problems

Setting the Scene

Every community will have its special stories of travel. Ask if there is an Elder available who would come in and talk about what it was to travel on the land. Alternatively, you could make this assignment for students to ask someone in their family or community, and present the information in a report or poster. Ask students to suggest questions that could guide this investigation. Sample questions could include:
♦   Why did people travel? (to collect food, to hunt and trap and fish, to visit family, for feasts, for warfare, for basketball games)
♦   Where did Aboriginal people travel to around your area? (berry patches, traplines, fishing areas, out to the coast, along the grease trails)
♦   How long did it take them? (hours and days)
♦   How did they travel? (horseback, dogsled in the winter, walking)
♦   Who would travel? (e.g., During the Residential School era, children would often be taken out on the land in September to keep them away from the Indian Agents who would be looking for children to be taken away to school).

- How did people find their way in the bush when they were out hunting, in the days before GPS and before reliable maps? (landmarks, time spent on the land develops familiarity, information passed down from the hunters before you)
- How were boundaries of hunting areas or berry patches traditionally defined? (Definable landmarks like rivers, creeks, ridges etc.).

Activity 1: A Map of Home

See the student handout provided at the end of this unit (A Map of Home) for an activity using a created map of a fictional territory. You can use this worksheet to introduce the concept of scale and unit conversion, as well as basic map reading skills to your class. Discuss with students why using maps today is an important skill (e.g., hunting, fishing, travelling, hiking). Also, if they have map reading skills they will feel more comfortable taking part in the discussions around territory management and land claims. Encourage students' interest in this area by mentioning its applications for potential careers and lifelong activities in areas such as hunting and fish guiding, parks and recreation management, geography, geology, land use management, geomatics, or GIS (computer mapping).

Activity 2: Maps of Your Territory

After you have worked with the sample map and used the scale to find real life distances, you can use maps of your area and maps with the territories of the students on them. Working with maps that are meaningful to them helps to get students involved in this activity.

- Find places that are meaningful to your students: village sites (old or current), berry patches, traplines, fishing sites, etc.
- Locate them on the maps using coordinates, which is a great introduction to the coordinate geometry section of the course.
- Find the scale on the map and talk about what it means.
- Measure the straight line distance between the chosen meaningful locations in centimetres on the map, then using the scale, find the distance in reality.
- Look at the contours and rivers and see if the chosen path was actually reasonable. Find a reasonable route and then redo the measuring and use the scale factor to find the distance of the reasonable route.
- Apply the Pythagorean theorem by using three locations on the map connected by a right angle triangle. Calculate the distance of a reasonable path (around a mountain or swamp) and then use the Pythagorean theorem to determine the shortest distance between two points the points. Then check it with actual measurements and using the scale factor.

Invite a member of the local First Peoples community who is working in a field that requires the use of maps (e.g., in fisheries, forestry, land use management). Ask the guests to bring some maps with them and show the students where they work, how they use the maps and to discuss their job and what they had to do to get their job.

Strategies for working with maps as a class

- Use an overhead projector or smart board to display the map (e.g., the Map of Home handout supplied with this unit, or any topographical map). Depending on the technology you use, you may need to create a scan of the map or photocopy it onto an overhead sheet; the idea is that you will be able to "write" on it while you are discussing the scale.
- Photocopy sections of the map you need (11 cm x 17 cm) and put the scale onto the photocopy (be careful of enlarging/reducing as it changes the scale). Students then can do their work on the map.

- ♦ If you have a computer with reliable Internet connection and a projector, Google Earth allows students to see what topographical maps are built from, and gives them a "bird's eyes view" of their territory.

Where to find topographical maps:
- ♦ Geography or Forestry class
- ♦ Band Office, or Fisheries, or Land Management office.
- ♦ Regional District Office
- ♦ Public Library
- ♦ Online (multiple sources, including http://webmaps.gov.bc.ca/imfx/imf.jsp?site=imapbc)

Other activities using scale:
- ♦ Visit a local village and measure the long house/totems/canoes. Use the measurements and an appropriate scale to build models.
- ♦ Use a model replica of a building or landmark from your community, and determine the scale factor.

Part II: Crossing the River

Context

British Columbia is laced with rivers, and BC's First Peoples used canoes on rivers and lakes for travel, hunting, and fishing. The word for February in the Gitxsan language (Lasa hu'mal) means "when the cottonwood trees snap because of the bitter cold" and "when the false thaw comes and ice melts and canoes can be used on the rivers." Today, First Peoples still use canoes, but also use rafts and jet boats for fishing and travel on the rivers and still have to account for the current and wind when crossing a waterway.

Crossing a river is tricky business and canoeing the waterways of BC requires skill and experience. If you want to get to the opposite side directly across from where you start, you can't just head straight across. The river's current will be pushing you downstream while you are paddling to the opposite side. This activity looks at how a canoe crossing a river is influenced by the current and uses the Pythagorean theorem to calculate the diagonal distance traveled by the canoe.

Beaver Story

Tell students the following story to set the context:

> In earlier times two Gitxsan clans lived on either side of the Skeena River. A giant beaver lived on the river and kept digging at both riverbanks, causing slides that were potentially dangerous to both clans. This was unacceptable. So together the warriors of each clan went out in their canoes to try and destroy the beaver.

> One day the beaver was killed, but they did not know which arrow had killed it. The two Gitxsan clans started quarrelling with each other. It was important to know whose arrow had killed the beaver because whoever had killed the giant beaver could take it as a crest for their clan.

So a wise chief among them took the giant beaver and split it down the middle and gave half to each clan. All the Gitxsan clans were happy and a war among clans was prevented. Today the split beaver design is a popular motif in Gitxsan art.

Introducing the Pythagorean Theorem

As an introduction to Pythagorean theorem, you may want to try the following proof that uses area to show students that the sum of the squares of the legs of a right angle triangle really does equal the square of the hypotenuse.

♦ Use graph paper with a 1 cm grid and draw a 90° triangle with Side A = 8 cm, Side B = 6 cm, and side C = 10 cm. (You may wish to provide this for students.) Have students label each side of the triangle with its length.
♦ Have students use rulers to draw squares off each of the sides of the triangle (this is a good time to review that a square is the same length along each side).
♦ Use the grid to count up the area of each of the squares, and then calculate the area of the square (side^2). Label each square with its area.
♦ Get them to add the areas of the two squares formed by the legs of the triangle. They should see that this is equal to the area of the square formed by the hypotenuse. Write this in math language (the equation) in the square formed by the hypotenuse.
♦ Lead them through their discovery to the language of the Pythagorean theorem: the sum of the squares is equal to the square of the hypotenuse. How would we write that as an equation? ($a^2 + b^2 = c^2$)
♦ How could we look at this if we want just the length of the hypotenuse? Do a quick review of perfect squares, and their relation to square roots, and lead them to the rearranged equation:

$$c = \sqrt{(b^2 + a^2)}$$

Canoe Model Activity

This activity can be done as a demonstration, or as a math lab in small groups. Students will be using a fan, a water container, and a model canoe to demonstrate how current or wind affects the path of a canoe across a river or lake. You can show students a video of someone ferrying a canoe across a river after the activity.

Materials needed (per group of 2-3):
♦ large plastic container (4 L storage bin, bathtub, fish tank, wave tank from physics dept., etc.) to replicate a lake or river
♦ photocopied canoe pattern from www.wackykids.org/paper_canoe1.htm
♦ poster board or old file folders
♦ dull pencils or a medium ball point pen and scissors
♦ pencil crayons
♦ fan (household fan or small handheld fan)
♦ photocopies of the handout, Crossing the River (provided a the end of this unit)

For the model:
1. Display on the overhead a copy of the canoe figure from the handout, or draw it on the board and discuss how students are going to use Pythagorean theorem. Ask students:
   ♦ How could we find out how far the canoe travels? (Measure with a metre stick, can we use anything we know about math? Point out the 90° angle).
2. Build the canoes from poster board and tape. Trace the paper copy of the canoe with a dull pencil or medium ball point pen and press down hard, you will see the indented outline of the

canoe on the poster board. Colour the designs and tape them on (glue will dissolve in the water). This stage is best done the day before the lab.

3. Set up the large plastic containers and fill them with water.
4. Students measure the length and width of the container and record these values on the diagram.
5. Set up the fan at one end (the narrow end/width) of the container and set the speed and distance from the container so that the canoe moves steadily along the length of the container when it is pushed across (but doesn't capsize, or go straight to the end). You may have to change the setting on the fan, or move the fan closer or further from the end of the container. Experiment with this before students start the activity (you may want to do this before the students).
6. Without the fan running, determine how much of a push will make the canoe drift to the other side.
7. Run the fan and give the canoe a steady push across the "river" (container).
8. Mark (with erasable marker) where the canoe gets to the other shore, and measure the distance along the container from the starting end to where the canoe touched the other shore (Side A) .
9. Measure the distance across the river, the width of the container (Side B).
10. Use the Pythagorean theorem to calculate the distance that the canoe travelled.

$$a^2 + b^2 = c^2 \quad \rightarrow \text{ rearranged as } \rightarrow \quad c = \sqrt{b^2 + a^2}$$

Use a metre stick to measure the diagonal distance travelled and compare this value to the calculated value for the hypotenuse.

A Map of Home

Maps are obviously not the same size as real life. We are trying to put real life on a piece of paper, but we still want the distances between places to be related in the same way as in real life.

Here is a map of a village site, one of the fishing sites and a berry patch. If you look on the map, the fishing site is about twice as far from the village as the berry patch is from the village. We can use the idea of scale to use a map to find the real distances between places.
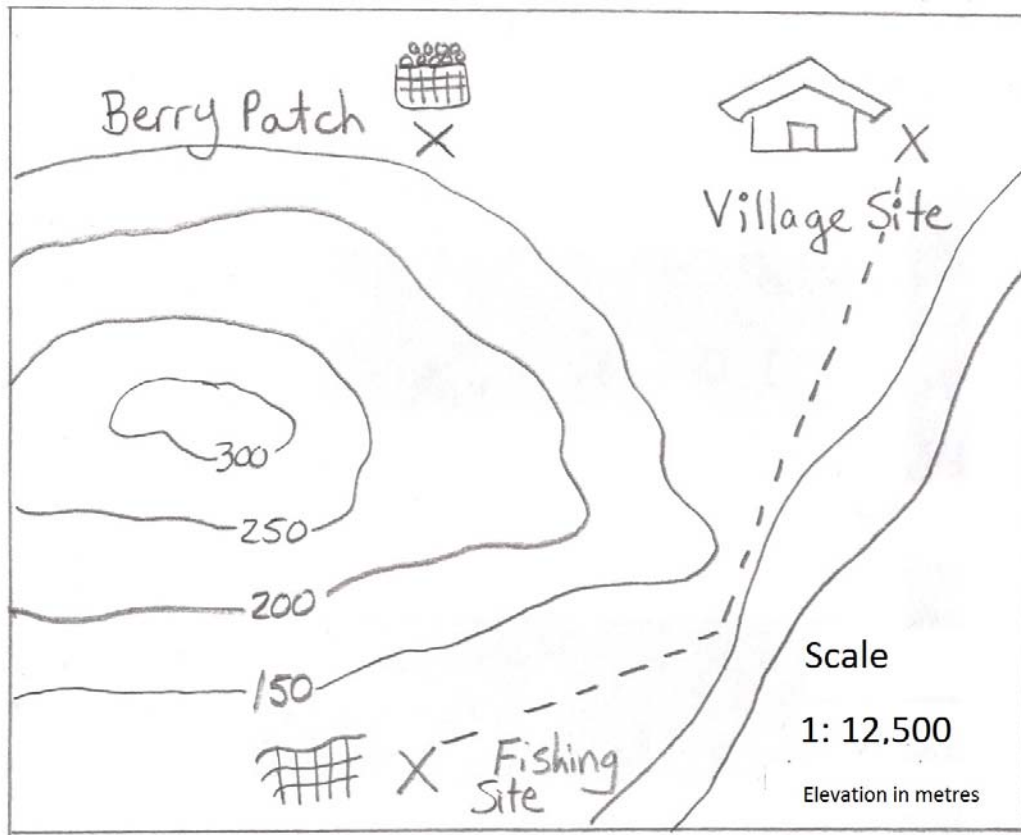
On this map the scale is 1:12,500. The first number in the "scale factor" is the distance on a map (or drawing) and the second number is the distance in real life.

The scale factor is a ratio that shows the relationship between the distance on the map, and the distance in real life. A scale of 1:12,500 means that 1 cm on the map represents (or shows) 12,500 cm in real life. It may seem strange to talk about 12,500 cm, but keeping the units the same (centimetres) for both parts of the ratio makes it easier to do the calculations. We can change centimetres to metres or kilometres later.

Try it out: measure the distance from the village site to the berry patch (measure from the centre of each X).

1.   What is the distance from the village site to the berry patch?

      a) Measure the map distance with a ruler. _____ cm.

b) What is the real-life distance? You can set it up as a proportion (two equal ratios), where the map distance is on the top in both ratios, and the real life distance is on the bottom in both ratios.

$$\frac{1\ cm}{12{,}500\ cm} = \frac{\text{distance you measure on map (D)}}{\text{distance you want to find in real life (R)}}$$

c) Use cross-multiplying and dividing to find the missing part of the proportion. Here we are looking for the real life distance (R).

$$R = \frac{D \times 12\,500\ cm}{1\ cm}$$

so R = _____cm.

d) You usually count how far you walk in metres or kilometres rather than centimetres, so we can change the 12 500 cm to metres. We know that 1 m = _____ cm, and we can use this to find how many metres are in _____ cm (the real-life distance, R, that you found).

$$\underline{\quad\quad} cm \times \frac{1m}{100\ cm} = \underline{\quad\quad}m$$

so R = _____ m.

2. How far is it from the fishing site to the village? (follow the example of finding the distance from the village to the berry patch)

a) Measure the path length in cm: _____ cm

b) Set up a proportion using the scale factor (1: 12,500) as one of your ratios.

$$\frac{1cm}{12{,}500cm} = \frac{\text{distance you measure on the map (D)}}{\text{distance you want to find in real life (R)}}$$

c) Solve the proportion for the "distance you want to find in real life" by using cross multiplying and dividing.

d) Change the centimetres distance into metres.

e) The real life distance from the fishing site to the village is _____ m.

3. The Elders take the path along the river through the village to get from the fishing site to the berry patch. The young folks take the short cut and run over the hill. How much distance do they save by going over the hill? Complete this question on a separate piece of paper, showing your work just like you did in the previous two examples. Write a sentence sharing your final answer.

4. Can you use the Pythagorean theorem to determine the shortest straight line distance (aka hypotenuse) between the fishing site and the village site? Then use your skills with scale factor to calculate the straight line distance between the fishing site and the village site. How close are your numbers? Why might they be different?

Crossing the River

British Columbia is laced with rivers. First Peoples often used canoes on rivers and lakes for travel. Crossing a river is tricky business. If you want to get to the opposite side across from where you start, you can't just head straight across. The river's current will be pushing you downstream while you are trying to get across. It's the same idea when you are crossing a lake: you have to consider the effect the wind will have on your path.

Materials

- Large plastic container (your river or lake) filled with water
- Model canoe that you made
- Erasable marker
- Fan (the current or wind)
- Metre stick or measuring tape

Directions

1. Set up the fan at one end of your water container (river) as shown in the figure on the next page.

2. Measure the distance of side B (the width of the river), and record it in the table on the next page. This will be the same value for each river crossing.

3. Give your canoe enough of a push so it can reach the other "shore" (other side of container).

4. Use the same amount of push and set up your fan on the lowest speed so that it will blow your canoe downstream, while still allowing your canoe to reach the other shore. With the fan blowing, push your canoe across the river.

5. Use the marker to put a line where the canoe hits the other shore. Measure alongside A (distance canoe travels downstream), and record this distance in the table.

6. Repeat steps 3-5 on medium speed.

7. Repeat steps 3-5 on high speed.

Reminder: the longest side of this triangle (that is opposite the 90° corner) is called the

_____.

Diagonal distance canoe travels (SIDE C)

River (water container)

Distance canoe travels down stream (SIDE A)

Distance canoe travels across stream (SIDE B)
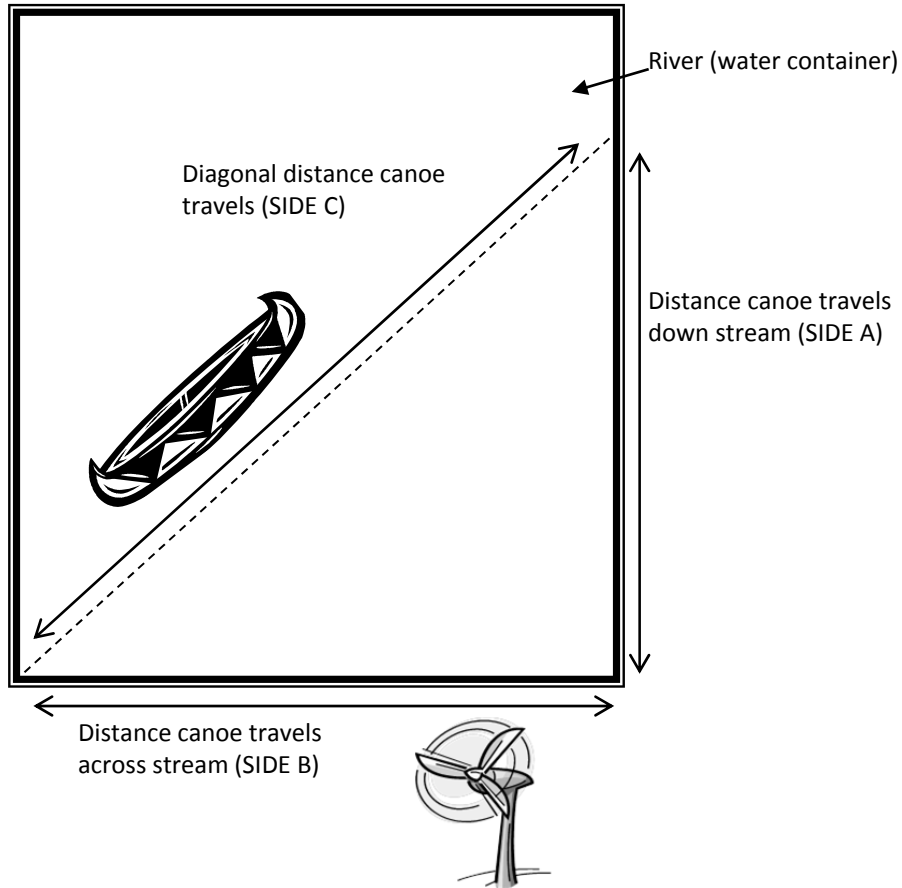
Finding the distance travelled (hypotenuse)

Fan speed	Side A (cm)	Side B (cm)	Side C (cm) (show your work for the hypotenuse)
Low			
Medium			
High			

Extension

1. Do a few trials to figure out what combinations of push power and wind (fan speed or distance from canoe) **won't** allow the canoe to get to the opposite shore (the canoe will hit the end of your water container before it gets to the other shore).

2. Record the following data

What happens when you don't reach the opposite shore?

	Wind (fan speed, or distance)	River width	Width minus distance still from shore	Distance downstream
Trial 1				
Trial 2				
Trial 3				
Trial 4				

3. Use the data from the table above and find the diagonal distance the canoe actually travelled. (Hint: You are going to be using Pythagorean theorem to find the diagonal distance.)

   $C^2 = A^2 + B^2$ is related to your situation as follows:

   $$\text{Diagonal distance} = \sqrt{(\text{river width} - \text{distance still from shore})^2 + (\text{distance downstream})^2}$$

4. What "wind" or "current" conditions left you the furthest from the opposite shore?

5. Do you have any ideas of how a real canoe could go **directly** across a river with a strong current?

6. Find someone who is familiar with canoeing, and ask him or her how they canoe on a lake in the wind, or across rivers when the wind or current is strong. (You could also search "ferrying a canoe" online.)

Context

This unit uses the *adawx*, "Raven Steals the Light" as a context for exploring the geometry of space and shape in the grade 8 curriculum. "Raven Steals the Light" is an important story to many different Aboriginal communities. An *adawx* is the Smalya'ax word for a story that is believed to be true. It is not a myth for entertainment purposes or a lesson to be learned (which has a separate word). That said, it seems impossible to actually fit all the stars, sun, and moon into a small box.

We can look at the boxes as representing actual space metaphorically, with the first and smallest box holding the sun representing our solar system, the mid-sized box holding the large stars representing the Milky Way Galaxy, and the largest box holding the smaller stars in addition to the other boxes representing the Universe. Astronomers today calculate the size, volume and mass of stars, galaxies and astronomical entities such as nebulas to help in the understanding of our place in the universe and other possibilities that are present. While their calculations are much more complex in nature, the goals and essential processes are the same.

Bentwood boxes were traditionally used as water-tight boxes for the storage and transportation of items that could get ruined or unusable if wet, or that were wet themselves. This would include blankets, berries, oolichan grease, tobacco, or trade goods among others. Bentwood boxes were made in a variety of sizes and often followed rectangular shapes, although some were trapezoidal. The boxes were made from one piece of cedar, cut in such a way that they could be bent when softened by steam, and then given a lid that was tight fitting and oversized. In this way, there was very little opportunity for water to enter the boxes. Boxes could be made for daily use, or given as a gift.

For instructions on building a bentwood box, go to www.flickr.com/photos/adavey/3842498533/ follow the detailed photos to several blog sites about the art involved with the boxes and totem poles. A follow-up video with the artist can be found at www.youtube.com/watch?v=Pf7soOLyb0o. Another site to check would be www.wackykids.org/main_b-box.htm, or an additional video using less traditional means can be found at www.youtube.com/watch?v=m0rwVHz2t1M. Or, consult with your school's visual arts department, which may have books and other resources picturing this artform.

A preliminary lesson on faces, vertices, and edges should be done to help facilitate the understanding of the objects and vocabulary.

Prescribed Learning Outcomes

This unit can be used to help students achieve the following Prescribed Learning Outcomes for Mathematics 8:
C2   draw and construct nets for 3-D objects
C3   determine the surface area of
– right rectangular prisms
– right triangular prisms
– right cylinders
to solve problems

C4   develop and apply formulas for determining the volume of right prisms and right cylinders
C5   draw and interpret top, front, and side views of 3-D objects composed of right rectangular prisms

Materials Needed

♦ Bentwood Boxes handout — worksheet and assessment tool — one per student (review the lesson procedure and determine whether you will distribute this worksheet/assessment tool all at once or incrementally at various points in the unit)
♦ templates for triangular prism, right angle pyramid, cylinder, and cone, 1 copy per student (several sources online, including www.korthalsaltes.com/index.html)
♦ isometric dot paper, 1 cm (several sources online, including www.incompetech.com/graphpaper/isometricdots/)
♦ images illustrating top, corner, front, and right views of 3-D objects such as longhouses and bentwood boxes (consult with the school visual arts department, which may have suitable texts to use)

Suggested Instruction and Assessment Approach

Volume

Begin with the story of "Raven Brings the Light" (or Steals the Light), available from sources such as
♦ "Txamsm Brings Light to the World" handout provided at the end of this unit
♦ Legends of the Old Masset Haida: Gaaw Xaadee Gyaahlaangaay — beginning approximately at approximately at 42:01 www.cbc.ca/video/news/audioplayer.html?clipid=1455862175
♦ www.nativeonline.com/legends.html
♦ other local versions available in print form

As First Peoples cultures tell their stories orally, the story should be read aloud (if using a print version), played on CD, or from the website listed if using the CBC version. There are different versions of the story in many different nations, all of which should work for this project. For dramatic effects, tell the story in the dark, with flashlights to represent the stars, a spotlight or overhead projector to represent the moon, and the overhead ceiling lights for the sun. Copies of the story should not be given out for students to read along or for reference.

Given the box Raven steals from the Old Man needs to hold three sizes of stars, how big does the box need to be? If you only needed to hold the smallest stars how big does the box need to be? What dimensions would give that amount? Can you determine another 2 sets of dimensions that give the same volume?
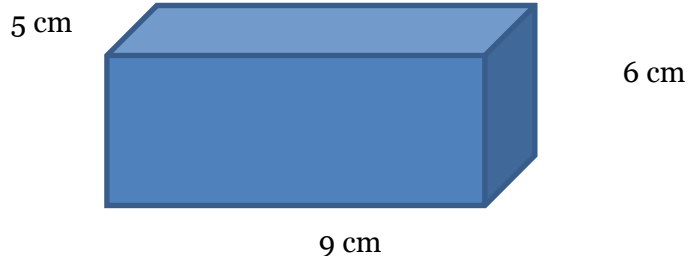
Example: If you have a rectangular container with depth measuring 5 cm, height of 6 cm, and length of 9 cm, calculate the volume using the traditional formula of width (w) times length (l) times height (h).

$$w \; x \; l \; x \; h = Volume$$

5 cm   5 cm x 9 cm x 6 cm = Volume   6 cm

45 cm² x 6 cm = Volume
270 cm³ = Volume

Is there another set of dimensions that also gives the same volume?

9 cm

Assume the container has one side that is the same length.

$w \times l \times h = Volume$

w x 9 cm x h = 270 cm³

w x h = 30 cm²

The factors of 30 are {1 x 30, 2 x 15, 3 x 10, 5 x 6}. Since 5 x 6 was already used, the next logical factors would be 3 x 10, but the others are equally true.
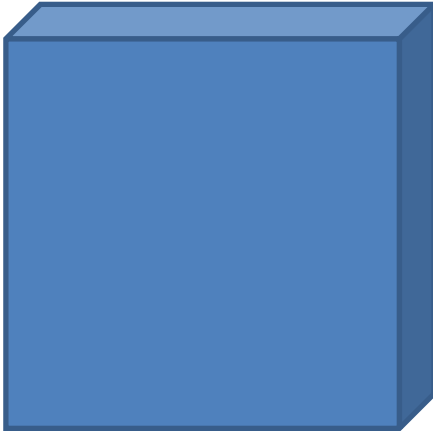
Try to determine another set of dimensions, using a different side.

Repeat example using no known sides, but possible factors of a box with volume of 288 cm³.

A right angle prism is simply a 3-D rectangle split in half on the diagonal, creating 2 triangle shaped 3-D shapes. In order to reflect this, the calculated volume of the rectangle must be divided in 2 equal portions. Therefore the new formula is

$$\frac{w \times l \times h}{2} = Volume \ (of \ a \ triangle \ prism)$$

Therefore: in the first example given, the total volume of a right angle prism would be

$$\frac{270 \ cm^3}{2} = Volume \ of \ a \ triangle \ prism$$

135 cm³ = *Volume of a triangle prism*

What would the volume of a right angle prism be with the dimensions shown?

Width = 8 cm

Depth = 13 cm

Height = 9.5 cm

If the area of a circle is found using the formula $A = \pi r^2$, then how would you determine the volume of a cylinder? The area of a coin with radius 2 cm would be

A = 3.14 x (2 cm)²

A = 12.56 cm²

If we wanted to determine the volume of a stack of 5 coins, we would have to multiply that amount by 5. Therefore the new formula must include the number of coins, or, the height of the stack.

$Volume = height \times \pi r^2$

Volume = 5 x 3.14 x 2 cm²

Volume = 5 x 12.56 cm²

Volume = 62.80 cm²

ACTIVITY: Go to www.fourmilab.ch/cgi-bin/Yoursky and set the parameters to the specifications as laid out in the Star Map handout provided at the end of this unit.

Have students view the site, and either on the screen or a printout of the screen, tally the number of each size of star.

Tell the students the stars have the assigned volumes of 8mm³ for small stars, 64mm³ for large stars, 1 000 mm³ for the moon, and 1 728 mm³ for the sun. (Answer keys for both are included at the end of this unit.) Note: If you do not want to invest the time for students to count individual stars

and view the star chart online, have students calculate the dimensions of a set of boxes with volumes of 500 mm³, 1250 mm³, 1980 mm³.

Determine the total volume for each star category. Using the volume formula, calculate possible dimensions of the boxes. Draw and label a 3D rectangle for each.

Compare dimensions determined by the class. Discuss: Is there a pattern? (Keep these for a future lesson!) What are the dimensions of a right angle prism with the same volumes? What dimensions would give that same volume for a cylinder? (hint: divide by π)

Viewpoints of 3-D Objects

A 3-D object has measurements in 3 directions: height, length and depth (or width). If you had a set of 3 Lego pieces, there are a number of ways you can put them together. Often, a picture of the object is given as "corner shot" or "architectural view." The use of isometric dot paper allows the correct orientation of the 3-D object representation. Ensure students are using the paper correctly, as it is sometimes difficult for students to visualize this aspect.

Have students draw a brick on isometric dot paper (see the Materials list for online sources of isometric dot paper). Can they draw three bricks stacked like stairs?

The object can then be represented in its entirety by drawing it in 2-D from the front view, the top view and the side view (usually the viewer's right side). To follow the standard form of representing an object using the three viewpoints, the format described should be used.

The object's corner shot is placed in the top right corner of a paper separated into four quadrants.

To its LEFT the object is drawn from above, in a perpendicular manner. This is to be labeled "Top View." Below this, the object is drawn square on the face or front. This is to be labeled "Front View." In the final quadrant, the bottom right, below the original object corner shot, the object is drawn from the right. This is to be labeled "Right Hand View."

Some students find it easier to draw the Front View first, and then the Top View. Drawing order does not matter, lay out is more important for continuity. Example: Architectural drawing viewpoints.

| Top View | Corner Shot |

Front View	Right Side View
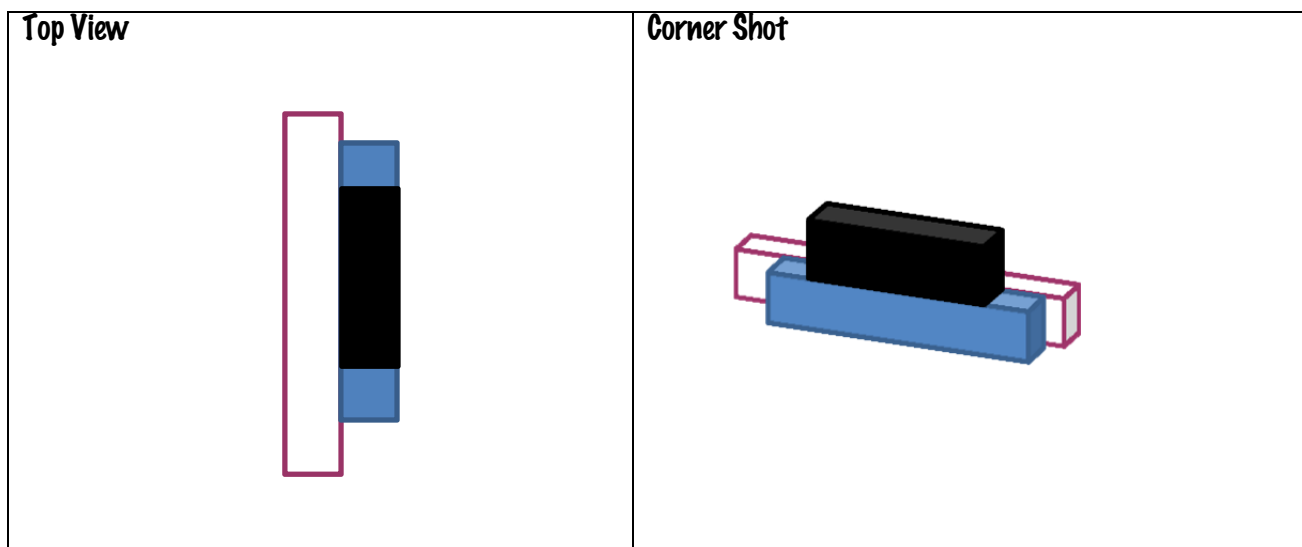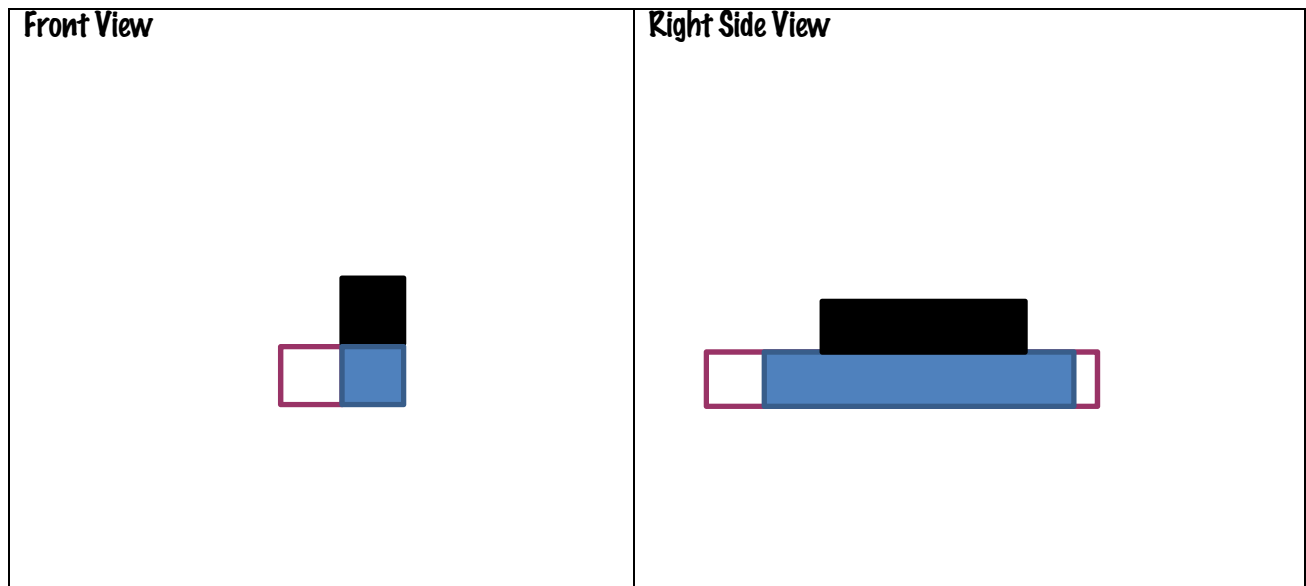
If the Left Side View is required, place the Left Side View in the lower left quadrant and the Front View in the lower right quadrant.

Move yourself around the object, so that you do not confuse the faces or views. Always be sure to draw the object as a flat 2-D shape. There is no dimension to the viewpoint.

Activity: Using visual arts texts or online sources such as Google Images, find examples of BC First Peoples items such as carvings or bentwood boxes, or buildings such as longhouses. Be sure to select pictures that are architectural views. Start with simpler images, and expand to more complex shapes and/or compound structures.

To identify what view is being shown, the web site below has step by step examples that can be used to introduce the topic before student undertake independent work:
www.fi.uu.nl/toepassingen/00198/toepassing_wisweb.en.html

A great website quiz to try as a review is found at
www.fi.uu.nl/toepassingen/00207/toepassing_wisweb.en.html and
www.fi.uu.nl/toepassingen/00208/toepassing_wisweb.en.html

Assessment Activity

Have students prepare a viewpoint sheet of their bentwood box (as laid out in the worksheet provided at the end of this unit). This activity might be easier to do at the end of the unit as part of the summation, once the box is actually built and decorated.

Surface Area

Demonstration: Now that the dimensions of the box that can contain all of each of the 3 star types, and the dimensions of the box that could contain every star, have been determined, how much wood would the Old Man have needed to create those boxes? In order to determine the amount needed, the surface area must be calculated.

Example: A rectangular shape with dimensions of width 5 cm, depth 3 cm and height 4 cm has a total of 6 sides. Each side is part of a matched pair. In order to determine the surface area of one side of the box, you must multiply two adjacent sides together (i.e., height x width). Once you have completed this for all six sides, you can add them together to determine the total surface area of the rectangular shape. In this way we can determine the surface are of our example shape to be:

3 cm

A: Depth x Width = 3 cm x 5 cm = 15 cm²

B: Depth x Height = 3 cm x 4 cm = 12 cm²

C: Width x Height = 5 cm x 4 cm = 20 cm²

D: Depth x Width = 3 cm x 5 cm = 15 cm²
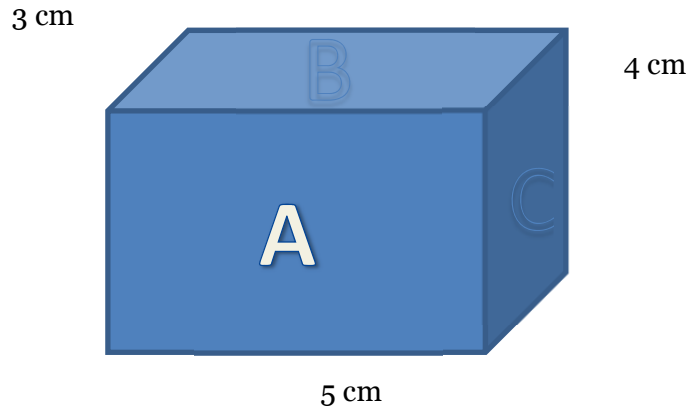
E: Depth x Height = 3 cm x 4 cm = 12 cm²

F: Width x Height = 5 cm x 4 cm = 20 cm²

4 cm

Total surface area of rectangular shape is then:

5 cm

> A + B + C + D + E + F = Total surface area
>
> 15 cm² + 12 cm² + 20 cm² + 15 cm² +12 cm² +20 cm²= Total surface area
>
> 94 cm² = Total surface area

What do you notice about the above measurements and calculations? There are 3 different measurements that repeat.
> A = D
> B = E
> C = F
>
> Therefore the equation could also be written as:
> 2 x A + 2 x B +2 x C= Total surface area

Or   2A+ 2B+ 2C = Total surface area
         (2 x 15 cm²) + (2 x 12 cm²) + (2 x 20 cm²) = Total surface area
         30 cm² + 24 cm² + 40 cm² = Total surface area
         94 cm² = Total surface area

How much additional surface area does a rectangular shape have with following dimensions:

> Depth 4 cm, Width 5 cm, Height 4 cm

Calculate the surface area of a box with dimensions: Depth 14 cm, Width 8.5 cm, Height 18 cm Using the information from the Volume notes, how would you determine the length of a missing side based on a given surface area and 2 sides?

Calculate how much cedar would be needed to construct the 3 separate boxes, and then the final large box for Raven, based on the measurements you determined in the Volume exercise. Keep these measurements for future use!

3-D Nets

Background: Visit www.isotropic.org/polyhedra/ to view and print nets of polyhedrons to build. Another site to visit is www.adrianbruce.com/math/3d-shapes.

Have students work through the 3-D Nets portion of the assessment worksheet.

Demonstrate how to draw nets using common items in the classrooms as nets (e.g., an eraser, a coffee mug, a pencil, a cell phone).

Building a Bentwood Box

After students have completed all the worksheets, have them draw a net to scale that represents their boxes for Raven to carry. Using cardstock, a side of a cereal box, cardboard, or a bentwood box kit (available for purchase), students should cut out and create their boxes, making sure they nest. Students should submit their final boxes for assessment along with their worksheets and calculations.

As an extension, students can decorate their bentwood boxes with traditional designs, integrating multiple lines of symmetry and tessellations.

Txamsm Brings Light to the World

After the flood, Txamsm started to travel around the world to see how many people were saved. At that time the world was in darkness. Txamsm was looking for the chiefs house where light was kept.

He came to the house of the chief who had the moon. The moon was kept in a large box. Inside this box were ten smaller boxes. In the smallest box was the moon sewn up in a bag made of hide. The chief had a daughter and she was always kept on a platform where no one could see her.

Txamsm flew outside and waited. When he saw the girl coming out of the house he turned himself into a pine needle and fell into the water. She was drinking and she swallowed the pine needle.

Soon the woman became pregnant and gave birth to a boy. He grew very rapidly and every day grandfather took the boy and stretched him until he was nearly full grown.

The child would cry. He pointed to the box where the moon was kept. After he had cried for a while the chief took down the box and untied it. He gave the boy the moon ball to play with. Every day he would go under the smoke hole of the house, but this was always closed when he was playing with the moon ball.

One day he was playing with the ball under the open smoke hole. Txamsm turned himself into a raven and, taking the moon ball, he went up through the smoke hole and flew away with it. He traveled for a long time until he came to where he heard the people were fishing for oolichans.

He called out, "Give me some oolichans, and I will give you light." The people who were fishing in the dark called out, "You are tricking us. You are a liar. You can't give us light." This made the raven mad. He had now turned himself into a human being. He took the moon ball and opened it a little.

Then the people fishing saw for themselves and they gave him many oolichans. When they had done this the man opened the moon ball and gave them light. He broke off a piece of the moon. He broke it piece by piece into smaller pieces. He said, "These will be the stars," and threw them into the sky.

After this, the man turned himself back into a raven and then into an old woman. He saw a reflection of himself as an old woman. He became ashamed at his long nose. He cut off part of his nose and used it as a labret. This was how the labret originated.[1]

[1] **Wilt Dagoydiksdit Txasms Goy'pa Da Ha'lidzoox, Txamsm Brings Light to the World.** From a narrative told by J Bradley originally titled "The Raven and the Flood." Retold in Sm'algyax by Mildred Wilson with the Sm'algyax Language Committee. Illustrated by Bill Helin. Published by the Tsimshian Nation and School District #52 (Prince Rupert) in Prince Rupert, British Columbia.

Star Map

www.fourmilab.ch/cgi-bin/Yoursky

Settings:

Date and Time
- ○ Now
- ◉ Universal time: | 2011-06-21 0:00:0|
- ○ Julian day: | 2455733.50000 |

Observing Site
- Latitude: | 49°19'12 | ◉ North ○ South
- Longitude: | 123°4'48 | ○ East ◉ West

(Set for nearby city)

Display Options
- ☐ Ecliptic and equator
- ☐ Moon and planets
- ☐ Deep sky objects of magnitude | 2.5 | and brighter

Constellations:
- ☐ Outlines
- ☐ Names ☐ aligned with horizon?
- ☐ Boundaries

Stars:
- Show stars brighter than magnitude | 3.0 |
- ☐ Names for magnitude | 2.0 | and brighter
- ☐ Bayer/Flamsteed codes for mag. | 2.5 | and brighter
- ☐ Invert North and South

Image size: | 640 | pixels

Colour scheme: | Black on white background ▼ |

These settings will result in a simplified star chart. Alternatively, select "Show stars brighter than magnitude 4.0" for a more complex star chart.

Bentwood Boxes

Calculating Star Volumes

Using the star chart:

Type of Star	Number of stars	Volume of one star	Total Volume of star type (mm³)
Small Stars		8mm³	
Large stars		64mm³	
Moon	1	1 000 mm³	1 000 mm³
Sun	1	1 728 mm³	1 728 mm³

To calculate the volume needed for each of your three boxes, use the above data, and the table below.

Box	Contents	Dimensions (w x l x h)	Total volume (mm³)
1 (smallest)	Sun		
2 (medium)	Box 1, Large stars and Moon		
3 (largest)	Box 2 and small stars		

Draw a box with possible dimensions for each of the above boxes.

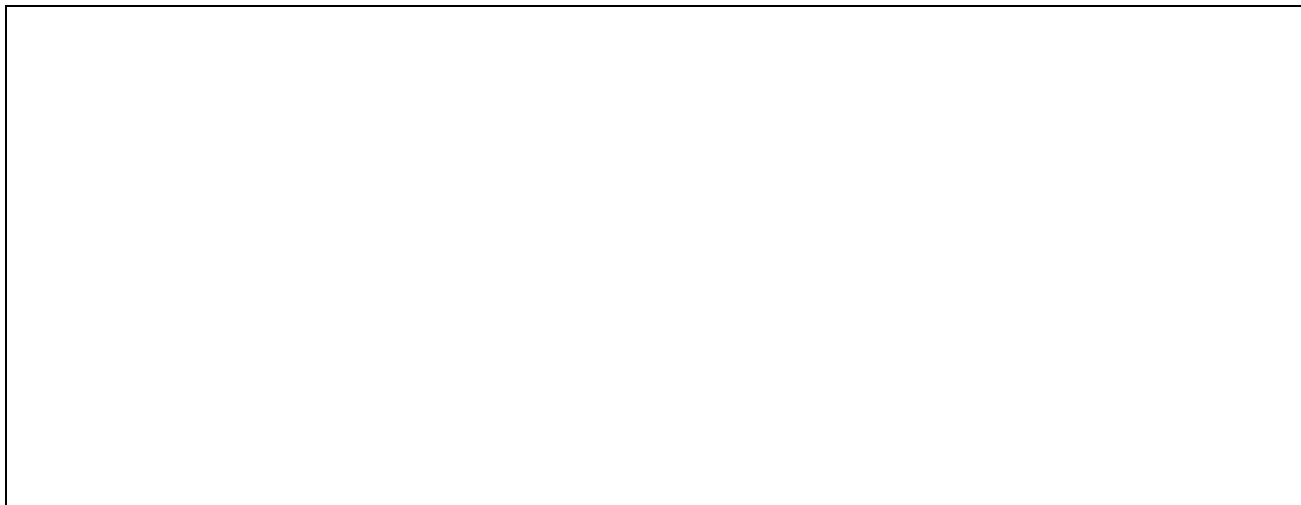Box 1

Box 2

Box 3

What are the dimensions of a right angle prism that would hold the same volume as Box 2?

What would be the dimensions for a cylinder of the same volume as box 3? Draw a labeled diagram.

Point Of View

Using the dimensions detailed above, draw one of your boxes in the frames below.

Top View	Corner Shot
Front View	**Right Side View**

Surface Area

Calculate the surface area of the boxes. Show your work.
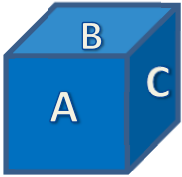
Box 1:

Total Surface Area:	

Box 2:

Total Surface Area:	

Box 3:

Total Surface Area:	

3D Nets

Imagine how much easier it would be to build a box if you laid out all the pieces in the order that you would join them together in, rather than stacking up all the parts. Imagine laying out the sides of a die:

B
A C

A die has 6 sides, consisting of squares of equal length and width.

A B C D E F

If you were to lay out the squares/sides so that the adjoining sides in the three dimensional object are touching at least one other side you could start with the three in the centre.

B D F

E A C
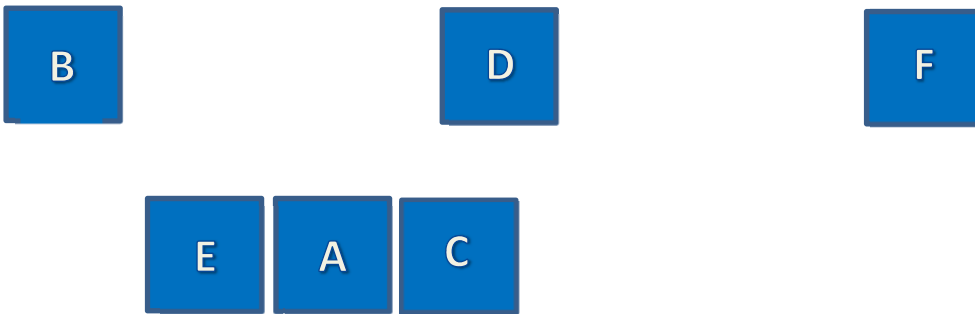
From there, attach the top and bottom to the centre square on the respective sides.

F

B

E A C

D

This diagram, if folded along the lines, would create a box with an open back. F represents the back of the die. Where does the final side go?

In reality, it could legitimately go on any one of the outer squares.
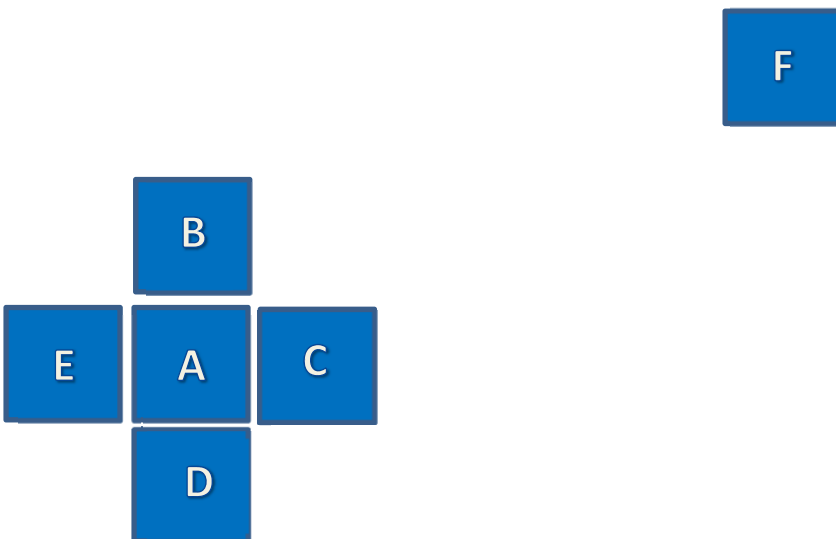
```
        F
        B
    E   A   C
        D
```

```
        B
    E   A   C
        D
        F
```

```
        B
    E   A   C   F
        D
```

```
        B
    F   E   A   C
            D
```
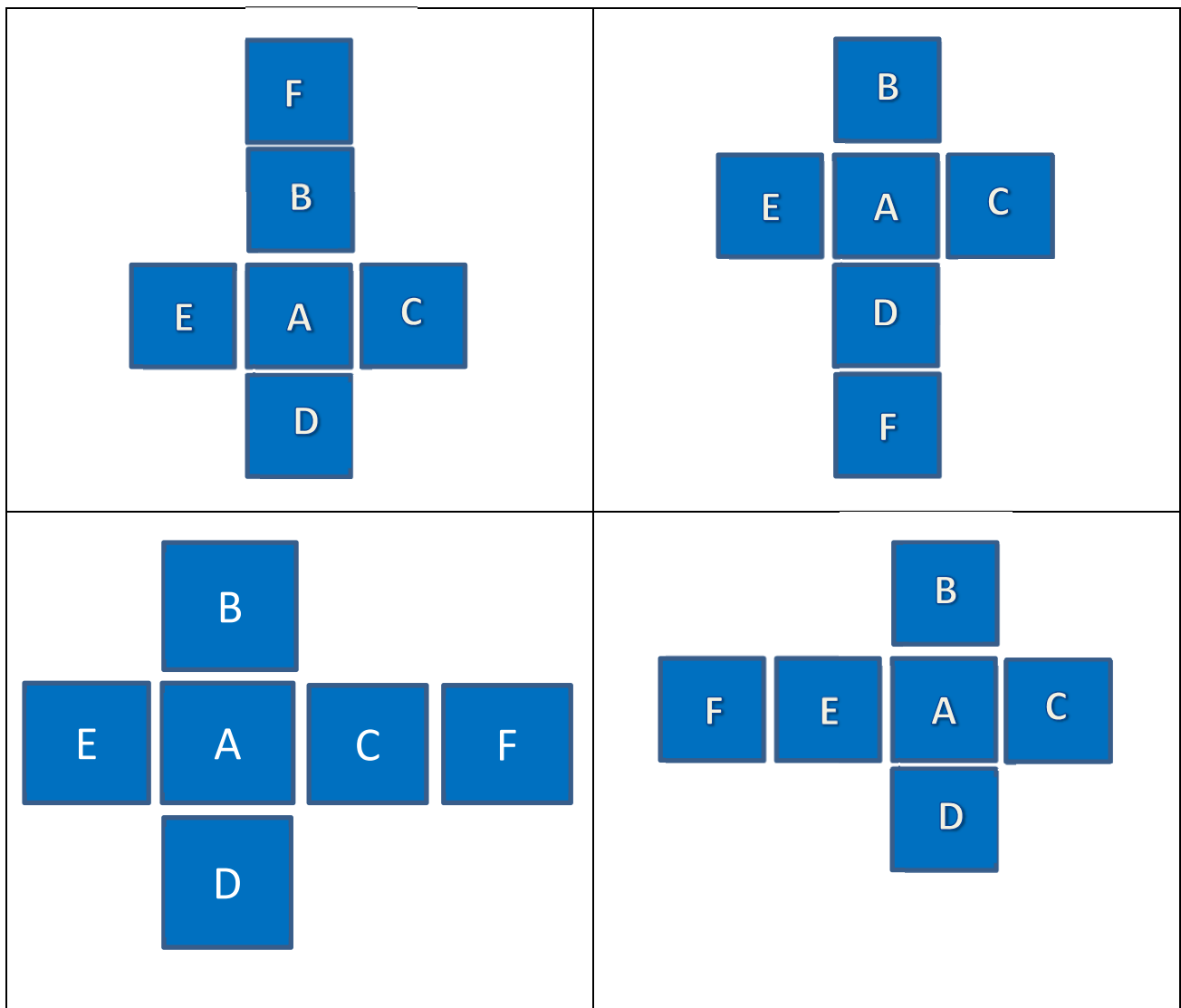
All nets must include measurements of sides!

This can be done for any shape. Circles and domes are tricky, but can be achieved with a series of alternating triangles. The more triangles involved, the more curved the object becomes when folded.

Imagine a can, how many sides will be represented in your net? (2 circles and a rectangle)

Now it's your turn: Draw a net of one of your bentwood boxes. Be sure to include the measurements of the sized box you choose to draw.

Draw the net of a cylindrical container that would be easier for Raven to carry. Label your diagram with dimensions.

Bentwood Boxes: Worksheet Answer Key

Calculating Star Volumes

Using the (simple/complex) star chart:

Type of Star	Number of stars	Volume of one star	Total Volume of star type (mm³)
Small Stars	Simple: 58 Complex: 160	8mm³	Simple: 464 mm³ Complex: 1280 mm³
Large stars	Simple: 25 Complex: 79	64mm³	Simple: 1600 mm³ Complex: 5056 mm³
Moon	1	1 000 mm³	1 000 mm³
Sun	1	1 728 mm³	1 728 mm³

To calculate the volume needed for each of your three boxes, use the above data, and the table below.

Box	Contents	Possible Dimensions ($w \ x \ l \ x \ h$)	Total volume (mm³)
1 (smallest)	Sun	16mm x 9mm x 12mm	1 728 mm³
2 (medium)	Box 1, Large stars and Moon	Varies	Simple: 4328 mm³ Complex: 7784 mm³
3 (largest)	Box 2 and small stars	Varies	Simple: 4792 mm³ Complex: 9064 mm³

Answers for the given values instead of using the star charts:

Box	Contents	Possible Dimensions ($w \ x \ l \ x \ h$)	Total volume (mm³)
1 (smallest)	Sun	10mm x 5mm x 10mm	500mm³
2 (medium)	Box 1, Large stars and Moon	10mm x 11mm x 18mm	1980mm³
3 (largest)	Box 2 and small stars	14mm x 16mm x 10mm	2240mm³

Draw a box with possible dimensions for each of the above boxes.

Answers will vary dependant on calculated dimensions.

Give the dimensions of a right angle prism that would hold the same volume as Box 2?

Answers will vary dependant on calculated dimensions.

What would be the dimensions for a cylinder of the same volume as box 3? Draw a labeled diagram.

Answers will vary dependant on calculated dimensions.

Point Of View

Using the dimensions detailed above, draw one of your boxes in the frames below.
Diagrams will vary based on the dimensions calculated.

TOP VIEW	Corner shot
FRONT VIEW	RIGHT SIDE VIEW
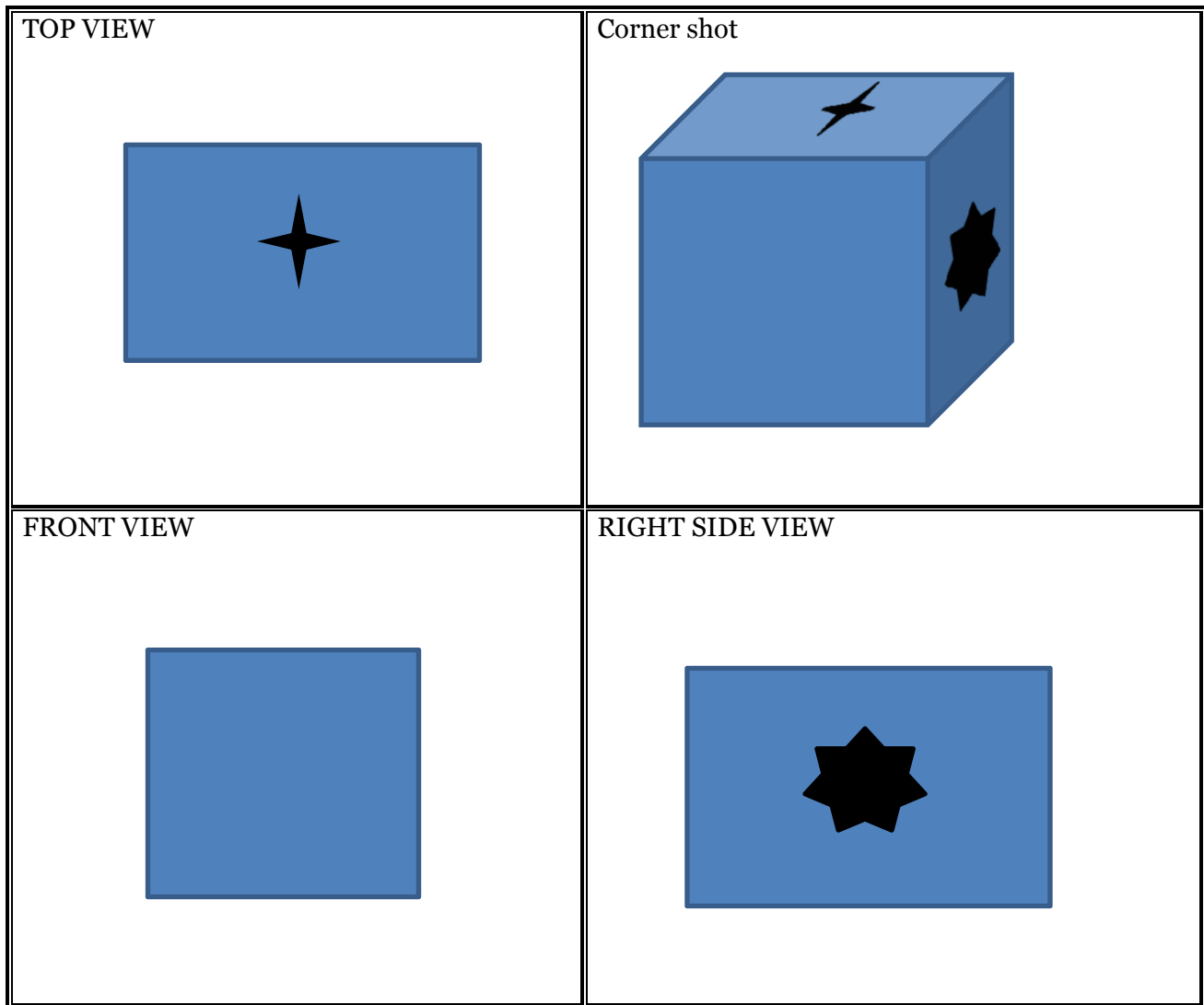
Surface Area

Box 1:
Answers will vary dependant on calculated dimensions.
***For given values: $2(10 \times 5) + 2(10 \times 10) + 2(5 \times 10) = SA$

Total Surface Area:	***400 mm²

Box 2:
Answers will vary dependant on calculated dimensions.
*** For given values: $2(10 \times 11) + 2(10 \times 18) + 2(11 \times 18) = SA$

Total Surface Area:	***976 mm²

Box 3:
Answers will vary dependant on calculated dimensions.
*** For given values: 2(14 *x* 16) + 2(14 *x* 10) + 2(16 *x* 10) = SA

Total Surface Area:	***1048 mm²

3D Nets

Draw a net of one of your bentwood boxes. Be sure to include the measurements of the sized box you choose to draw.
Answers may vary but should include 4 rectangles and 2 squares, or 6 congruent squares/rectangles. One possible version of the orientation:
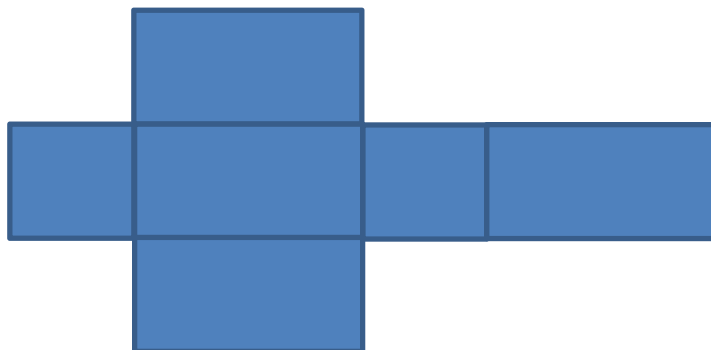
Draw the net of a cylindrical container that would be easier for Raven to carry. Label your diagram with dimensions.
Answers may vary, but should consist of 2 circles and a rectangle or square. Shown is one possible version of the orientation. Students' rectangle or square should be large enough to cover the circumference of the circles.
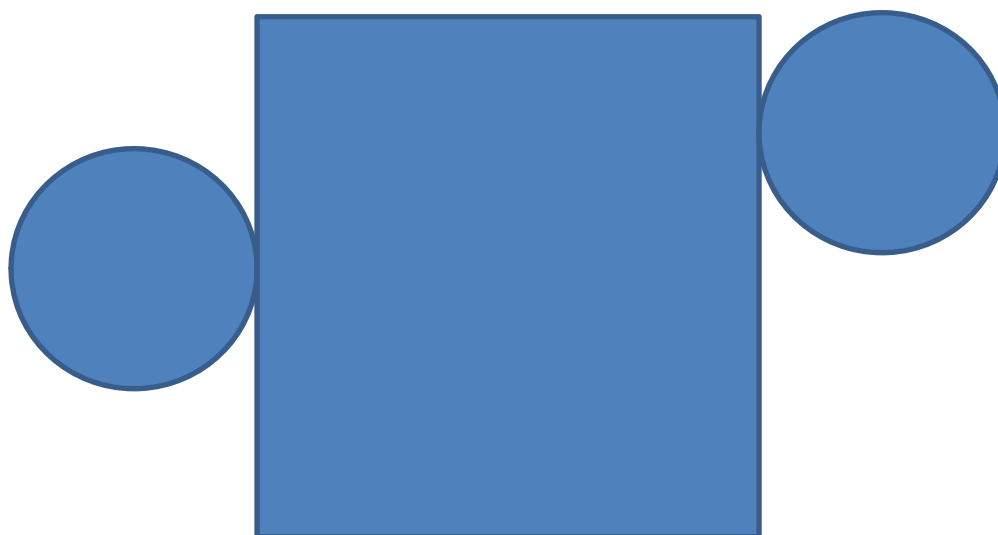
Context

We have all been caught staring out the window on an overcast morning of a fishing trip crossing our fingers for good weather, eagerly scratching a lottery ticket in the hopes we might win, or flipping a coin to make a decision. People have always been fascinated with trying to determine the likelihood of events occurring. Rock, Paper, Scissors is a cornerstone of playground decision-making, and students also love to play guessing games and other games of chance for entertainment. They are often intrigued by the random nature of chance, and this universal interest can be harnessed to teach statistics and probability.

For years, math resources have been introducing probability using illustrations such as flipping coins, spinning wheels, throwing dice, drawing marbles from a bag, and drawing/dealing playing cards. Although these situations lend themselves to teaching the concept of probability, and most students can relate to the items used, Aboriginal guessing games offer a fresh, entertaining, and culturally relevant means of teaching probability. At the same time they can offer a good opportunity to build connections between the mathematics class and the local Aboriginal communities.

Within First Peoples societies, guessing games have historically served many purposes – to entertain, to settle disputes, to pursue financial gain, and as part of ritual activities or family tradition. A quick online search can yield information on many First Peoples games, including the Coast Salish version of Lahal (alternatively Slahal or Bone Game), a guessing game that has been played for hundreds, if not thousands of years in many BC First Nations. This unit outlines an approach to using Lahal as a basis for teaching Grade 8 Statistics and Probability. It starts by introducing the game and teaching the general rules. Students then play the game and generate data (i.e., keeping track of both the guessing and the outcomes) for later analysis.

Learning outcomes addressed:

D1   critique ways in which data is presented
D2   solve problems involving the probability of independent events

Introduction to the Game of Lahal

The challenge of this unit is to introduce a potentially unfamiliar game. Yet the rules of play and the techniques are quite simple, and there are many resources online and in this unit. The optimum way to introduce this lesson is to have a local Elder or someone from the Aboriginal education department in your district demonstrate the game. Lahal can be taught in a single lesson and there may be some parents available to come in as volunteers to drum and sing. The power of the drumming and singing makes the game come to life for students. You can also consider bringing in other classrooms or even staff to play a game. The inclusion of Lahal in a school-wide assembly or cultural day would be invaluable to both Aboriginal s and non-Aboriginal learners. You may even consider recording the event for use in future classes when volunteers may be unavailable. Certainly, it is a wonderful way to start as it will provide context for the students and help them appreciate the significance of the game, as well as the wonderful songs, strategy, and traditional gesturing associated with Lahal.

If volunteers are not available, you could have students watch a short video of the game (http://wn.com/Lahal_A_Close_Look_at_the_Bone_Game) and research the game online using sources such as the following:

♦ www.aboriginaled.sd33.bc.ca/information/cultural-activities
♦ www.4directions.org/resources/features/si99/instituteprod/slahal/ .

Once they understand how the game works, students could work in groups to build their own game using sticks, and then spend time playing the game and recording both guesses and outcomes to build a database for analysis. Students can begin by playing the game and making observations about how frequently they guess the correct position of two, one, or none of the solid bones. They can follow this up by keeping tallies of their results to determine an experimental probability for each outcome (see the Tally Sheet handout provided). Another alternative is to have students play a simplified version online (at http://secwepemc.sd73.bc.ca/sec_village/Lahal_game.html), and use the results for data, though this loses a lot of the cultural context. Similarly, there exist other First Peoples games of chance that can be used as a basis for teaching probability, including the Stick game described further on under the heading, "The Stick Game Alternative."

Finding the Probability in Lahal

Finding the mathematics within the game of Lahal is fun and challenging for the students. Activities for stimulating discovery and enhancing understanding include having students

♦ work in groups to practice guessing with the bones (listing possible outcomes), collecting data (using the Tally Sheet), and generating summaries of the results
♦ create tree diagrams (Because Lahal is a guessing game, the students can begin by listing all possible guesses and bone locations. Breaking down the possibilities in this way allows them to analyze the concept of probability in a way that will make sense to them.)
♦ calculate the probability of events happening using the probability formula and an understanding of independent events.

Definitions and Probability Formula

To help students connect their Lahal playing (and data gathering) to the mathematical concepts involved, review the "Probability Terminology" handout with them, and encourage them to use the appropriate probability terminology in discussing their results. In addition, you may find it helpful to introduce the following formula, which can be found in most textbooks and is valuable in explaining how mathematicians find the probability of an event.

Probability of an Event
$P(A) = \dfrac{number\ of\ ways\ event\ A\ can\ occur}{total\ number\ of\ possible\ outcomes}$

Independent Events

Independent events: Two events, A and B, are independent if the fact that A occurs does not affect the probability of B occurring.

Some examples of independent events are: the probability of rolling a six on a die and then drawing a heart from a deck of cards. These events are independent, where one does not influence the other, and the probability can easily be calculated. Although this unit deals with Lahal, other examples include:

♦ Landing on heads after tossing a coin **AND** rolling a 5 on a single 6-sided die.
♦ Choosing a marble from a jar **AND** landing on heads after tossing a coin.

♦ Choosing a 3 from a deck of cards, replacing it, **AND** then choosing an ace as the second card.
♦ Rolling a 4 on a single 6-sided die, **AND** then rolling a 1 on a second roll of the die.

To find the probability of two independent events that occur in sequence, find the probability of each event occurring separately, and then multiply the probabilities (fractions). This multiplication rule is defined symbolically below.

Multiplication Rule 1	When two events, A and B, are independent, the probability of both occurring is:
	P(A and B) = P(A) × P(B)

Now we can apply this rule to find the probability for particular Lahal outcomes. Students can be challenged to work in groups to work on calculations in groups.

In this ancient guessing game there are two sets of bones with one person holding one set and a second person holding the other. There is one solid coloured bone (white bone) and one with markings on it. Remember, the guesser is attempting to guess which hand the white bone is in, but for both people. The possible outcomes are as follows:

♦ Person one has the white bone in either the left hand or the right so this results in a ½ probability or a .5 (50%) chance of getting it correct.
♦ For person two, the probability of guessing where the second set of bones is hidden is the same as for the first person; they are independent events and the probability is also ½, .5 or 50%.

The multiplication rule is used to calculate the probability of guessing the locations of both sets of bones:

$$P(A \text{ and } B) = P(A) \times P(B)$$

$$\tfrac{1}{2} \times \tfrac{1}{2} = \tfrac{1}{4}$$

You can explain to your students that the probability of them guessing the location of both white bones in one guess is 1/4, .25, or 25% of the time.

Class Discussions

As students present their results from playing multiple rounds of Lahal, class discussions will help reinforce the math concepts involved. These discussions should also cover the difference between experimental and theoretical probability and the various factors that make the game of Lahal somewhat more than an exercise in pure, theoretical probability. For example, students might be able to recognize the impact of human factors such as the following on their success in the game:
♦ good observation skills
♦ skill in hiding the bones
♦ ability to control one's body language
♦ ability to interpret the body language of others
♦ ability to apply psychology in game situations
♦ other contextual factors such as singing and drumming.

Collecting and Displaying Data

Statistics lie in the collecting and organizing of data. The information gathered can then be interpreted and used to make predictions. Accordingly, once students have gathered and recorded their game-playing data on a tally sheet (see handout), you can have them work in groups to decide how they would like to display the data in graph form (e.g., circle graphs, line graphs, bar graphs,

double bar graphs, pie graphs, pictographs). Students can then determine the strengths and limitations of each graph as they work on displaying their data in different ways.

Students should be encouraged to design and create graphs using online resources (e.g., www.nces.ed.gov/nceskids/createagraph/) or spreadsheet programs such as Excel. Discuss with them the advantages and disadvantages of each form of data graphing for the data they have gathered.

Getting Creative with the Data

Although Lahal seems like a very simplistic game, there can be much more to it than mere guessing. Once students have mastered the initial concept, they could be challenged to get creative and come up with more data that will help them analyze the game on a deeper level. The following are some examples students can try.

Influence of gesturing

Students may find it interesting to try and quantify the effect of gesturing on an individual's ability to guess correctly, or how the guesser can influence the person hiding the bones to provide hints or "tells" as to where the solid bone is located. Challenge them to come up with a way to collect data that would help determine who is the most talented at gesturing and reading "tells." This may involve a number of experiments where players are allowed to close their eyes and not be influenced by gesturing. This could be a fun way to play the game and determine if different factors, such as losing the sense of sight, will change the results.

Gender

Some Elders and experienced players believe that gender may influence ability in the game. Students could create tally sheets that track the guesses of male vs. female players.

Age

It is possible that age and experience could affect the results. Students can tally and organize data based on this criterion as well.

Time taken to guess

The time needed by a guesser to read the situation and make a guess could affect success. Students could compile and analyse result records that note whether guesses take less than five seconds, five to ten seconds, etc.

The Stick Game Alternative

Although games of chance that are played in local First Peoples communities (e.g., Lahal) provide the best opportunity to establish a First Peoples context for learning about statistics and probability, there are several games of chance associated with a wide range of aboriginal societies throughout North America that can be used to teach probability. Online descriptions of some of these can be found at www.mathcentral.uregina.ca/RR/database/RR.09.00/treptau1/index.html . Simpler in many ways than Lahal, the stick game described there can provide a valid alternative to Lahal for this unit. Activities involving the stick game could include
♦ having each student create a set of sticks (put designs on popsicle sticks) as explained online at www.mathcentral.uregina.ca/RR/database/RR.09.00/treptau1/game7.html (depending on the time available and your other instructional plans, you could cover some Grade 8-9 Shape and

Space learning outcomes as well by having students learn more about design traditions within a local First Nation and use tessellations and symmetry in their stick designs)

♦ forming groups of three and having each group play the game, record their outcomes, and calculate scores using the supplied handout, "Playing the Stick Game"
♦ reviewing the "Probability Terminology" handout with them, and explaining Independent Events and the probability calculation formulae, as suggested earlier in relation to Lahal
♦ covering the difference between theoretical and experimental probability by having students independently complete the instructions on the "Theoretical Probability" and the "Stick Game Tally Sheet" handouts and then discussing the concepts, as suggested earlier in relation to Lahal
♦ challenging students to draw conclusions from their sticks game activities by responding to the supplied handout, "What's Fair?"

Other Probability Situations with First Peoples Relevance

To reinforce students' understanding of probability calculations (or conduct assessment of their learning), challenge them to apply their understanding to other probability situations such as

♦ the likelihood of catching a specific species of salmon in a river that supports multiple species (You could provide students with a ratio or percentage of each species in a river and ask students to determine probability of not only catching a Coho for example, but the probability of catching five Coho in a row – independent events).
♦ the birth of baby animals in the wild (You could come up with challenges such as having students determine the probability of a moose having a female calf or having a female calf two years in a row.)
♦ scoring in a lacrosse game (You could provide questions such as "If Kevin scored 12 times out of his last 50 shots on goal, what is the probability that he will score on his next shot? Answer: $12/50 = .24$ or 24% so the probability of scoring on his next shot is .24").

Lahal Tally Sheet

What is it?   A tally sheet is a simple data collection form for observing how frequently something occurs.

Who uses it?   Researchers, statisticians

Why use it?   To easily and efficiently collect and organize data

When to use it?   To collect data on the frequency of certain events, such as a student's guesses, in the game of Lahal.

How to use it for Lahal

1. Review the steps of the game.
2. Make a list of events and possible outcomes. Only information you intend to use should be included.
3. Decide on the number of events (guesses) you would like to observe.
4. Record your observation of every event (guess) by a check in the corresponding cell of the sheet each time that the event occurs.
5. Total the results at the end, and use the data to create graphs such as circle graphs, line graphs, bar graphs, double bar graphs, and pictographs.

Events (guess results)

Team members (names)	Both solid bones correct	One solid bone correct	None correct
1.			
2.			
3.			
4.			

Probability Terminology

	Definition	Example
Experiment	An experiment is a situation involving chance or probability that leads to results called outcomes.	In Lahal, the experiment is the guess (trying to find the white bone).
Outcome	An outcome is the result of a single trial of an experiment.	The possible outcomes are guessing both correctly, one correctly, or none.
Event	An event is one or more outcomes of an experiment.	One event is taking one guess.
Independent Events	Two events, A and B, are independent if the fact that A occurs does not affect the probability of B occurring.	In the stick game, a play of 4 sticks up followed by a play of 4 sticks down.
Probability	Probability is the measure of how likely an event is.	The probability of guessing where both bones are is 1 in 4 (1/4); guessing one right is 1 in 2 (1/2)

Playing the Stick Game

You will need a set of 4 sticks (e.g., popsicle sticks), coloured or patterned on one side and plain on the other. The patterned side is the "up" side when you are playing the game.

Hold the sticks in one hand, and let them fall to the table. In taking turns play continues until the first person reaches a tally of 50 points. Keep track of the score in the table provided. The first person to reach 50 points wins.

Scoring

♦ All 4 up	5 points
♦ 3 up and 1 down	2 points
♦ 2 up and 2 down	1 point
♦ 1 up and 3 down	2 points
♦ All 4 down	5 points

Search and Discuss: *Combinations vs. Arrangements*

Just from experience playing the game, about how many different *arrangements* of the sticks did you see? Describe some of the *combinations*.

Player 1	Player 2	Player 3

Theoretical Probability

Fill out the table on the right with all the possible results from four sticks. The first three results have been done for you. Every line must be filled in.

Note: Make your work easier by using a pattern. Some mathematicians use a "Tree Diagram" to make sure all the possibilities are found. If time allows, work on a separate sheet and draw the tree.

Find the frequency of the combinations:

All 4 up: _____

3 up and 1 down: _____

2 up and 2 down: _____

1 up and 3 down: _____

All 4 down: _____

Now find the theoretical probability of each combination:

All 4 up: _____

3 up and 1 down: _____

2 up and 2 down: _____

1 up and 3 down: _____

All 4 down: _____

Stick #1	Stick #2	Stick #3	Stick #4
Up	Up	Up	Up
Down	Up	Up	Up
U	D	U	U

Stick Game Tally Sheet

Now "throw" (or drop) your set of sticks 50 times, and use the blank column in the table below to keep a tally of all the outcomes occurring.

Outcome	# of Occurrences
All 4 up	
3 up 1 down	
2 up and 2 down	
1 up and 3 down	
All 4 down	

Based on your 50 "throws," what is the experimental probability of each outcome?

All 4 up: _____

3 up and 1 down: _____

2 up and 2 down: _____

1 up and 3 down: _____

All 4 down: _____

What's Fair?

1. Based on what you have learned about the sticks game (especially the scoring system) and about theoretical and experimental probabilities, is the sticks game fair? Why or why not?

2. Create your own fair system of scoring:

    All 4 up: _____ points

    3 up and 1 down: _____ points

    2 up and 2 down: _____ points

    1 up and 3 down: _____ points

    All 4 down: _____ points

3. Justify the fairness of your scoring method for the game of sticks. (Be ready to defend and demonstrate your answer.)

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 ≥ _____

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 ≥ 17.2 – 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'emla̱xamit*. 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 *Sdik̠yoodena̱x* (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 *Sdik̠yoodena̱x* and gave him back to the mountain.

Meanwhile, the mountain goats on *Sdik̠yoodena̱x* 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'emla̱xamit.*

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 *Sdikyoodenax*, 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)
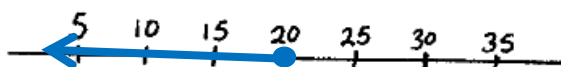
$$m \leq 20$$

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)
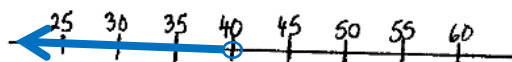
$$f < 40$$

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).

The Shape and Space component of the Grade 9 Mathematics curriculum, with its emphasis on circles, polygons, and surface area offers rich possibilities for integrating a First Peoples perspective. For the circle has functional importance as well as spiritual significance within many First Peoples cultures. The Inuit *igloo,* for example, is an example of a traditional structure whose design and construction is based on the circle. Likewise, pit houses laid out on a circular floor plan are a type of traditional dwelling built by many of the First Nations in the Interior of British Columbia for winter housing or, in some cases, for defence in times of upheaval.

This unit gives students a chance to take a closer look at traditional circle dwellings and complete a project wherein they apply an understanding of circles, polygons, and surface area to complete a diagram and scale model of a traditional circle dwelling.

Depending on your circumstances, this unit could include a visit to see a circle dwelling structure. Public access structures can be found in Lillooet, Kamloops, Enderby, and Mission, as well as several in the Kootenay, Chilcotin, and Southern Interior areas of BC. Both the Kelowna Museum and Royal BC Museum in Victoria have pit houses to visit. When visiting a pit house, be aware of, and observe, the local customs associated with them.

> ## A Variety of Names
> Although pit houses built in the Interior of BC had many features in common, the names used to refer to them are quite varied. For example,
> - among the Esketemc people (Secwepemc nation) in the Cariboo region, south of present-day Williams Lake the term for a pit-house-type circle dwelling is *kiglee*
> - among others in the Secwepemc nation, in the Shuswap region near present-day Salmon Arm, the term for a pit-house-type circle dwelling is *kekuli*
> - among the Okanagan and Similkameen people (in the Interior regions of the same name) the term for a pit-house-type circle dwelling is *Keekwillie* or *Kickwillie*
> - among the St'at'imc people in the areas around Lillooet and west along Lillooet Lake, the term for a pit-house-type circle dwelling is *s7istken* (pronounced *Sheesh'kan*)

Suggested Resources

Even if you can't arrange a field trip to see a circle dwelling structure, photos and descriptions of First Peoples circle dwellings can be found online at many sites. In addition, a YouTube video is available (www.youtube.com/watch?v=THxvqceF-Sg) that presents a description of the traditional means of building a pit house and shows how a group of Sinixt students from School District #20-Kootenay Columbia built one. Other helpful online resources that can be referred to when completing particular unit activities include the following:

- www.mathopenref.com – this site provides helpful definitions and illustrations of circle geometry terms and concepts
- www.learnalberta.ca/content/mejhm/html/object_interactives/circles/tangent/index.html — this site is useful in describing and visualizing tangents
- www.members.shaw.ca/ron.blond/Circle.Geom1.APPLET/index.html — inscribed and central angles
- www.youtube.com/watch?v=1bZhvjY9qBk — a time lapse of the construction of the pit house roof at Thompson Rivers University, showing how paired beams work together to create a circular roof.

Prescribed Learning Outcomes

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

C1   solve problems and justify the solution strategy using circle properties, including
  – the perpendicular from the centre of a circle to a chord bisects the chord
  – the measure of the central angle is equal to twice the measure of the inscribed angle subtended by the same arc
  – the inscribed angles subtended by the same arc are congruent
  – a tangent to a circle is perpendicular to the radius at the point of tangency

C2   determine the surface area of composite 3-D objects to solve problems

C4   draw and interpret scale diagrams of 2-D shapes

C5   demonstrate an understanding of line and rotation symmetry

Review of Circle Terms, Pythagorean Theorem, and Angle Sum Property

Before starting this unit, students should understand the vocabulary associated with circle geometry, and know the basic triangle rules for similar triangles (side/angle/side, angle/side/angle, side/side/side). For a review of the terminology associated with circle geometry you could have students use an online resource such as www.mathopenref.com and then play a game of Circle Terms Dominos, for which Domino "tiles" and instructions have been provided in a handout included with this unit (students will have to invest a bit of time in preparing these for use). Students should also be able to work with Pythagorean theorem and angle sum property.

In order to be successful at circle geometry, given the level of math the students are capable of at this point, students must grasp (and memorize) a set of theorems. The Circle Dwelling Project allows them to see the connections among these concepts and apply them in a meaningful way. By giving them the "Circle Dwelling Project Instructions" and "Geometry Theorems" handouts early in the process of teaching the unit, you provide an engaging context for "unpacking" and teaching them about each of the key processes associated with circle geometry at this level. Plan on spending the following amounts of time (at minimum) on each of the main sections of this unit:

♦ review of circle terms, Pythagorean theorem, and angle sum property: 1.5 h
♦ tangents: 2 h
♦ inscribed/central angle theorem: 2 h
♦ chords: 2 h
♦ plan/diagram creation and project building: 2 h (creation of diagrams could also be done incrementally as you cover each of the preceding three sections)

To help standardize students' diagrams (and thus facilitate your assessment of this part of their work), consider having them use the templates provided with this unit as a starting point for their design work. Note that if you print this from the PDF file, when opening the print dialogue box you will need to select "None" rather than "Fit to Printable Area" where it says, "Page Scaling." Otherwise, your PDF reader may shrink the templates (thus altering the scale).

Introducing Tangents

What is a tangent? A tangent is a line that just touches the curve of a circle or sphere. The point where it touches is at 90 degrees to the radius that touches that same point. One method to show this concept is to lay a ruler against a ball. Regardless of where on the ball, the ruler is placed, there is one spot where the ruler contacts the ball at 90 degrees to the centre of the ball. This is the tangent. If the shadows of the ball and ruler can be used, the visual is more dramatic.

Using a Tangent to Find an Unknown Length

Demonstrate for students how the fact that a tangent is at right angles to the radius of a circle allows them to calculate the distance between a point on the tangent and the centre of the circle. For example:

> "On a circle with a 3m radius, draw the tangent that touches the perimeter at the same point as the radius it and extend that tangent 4m away from that point to a new point P. Consider the radius and the 4m segment of the tangent as 2 sides of a right triangle. This allows you to use the Pythagorean theorem to determine the length of the final side (hypotenuse).
> Draw another tangent from the same point outside the circle, but going in the opposite direction.
> You know the length of the hypotenuse of the first triangle, and the radius of the circle. Using Pythagorean theorem, determine the length of the new tangent. Compare the two tangents. What do you notice? (They are the same length.)"
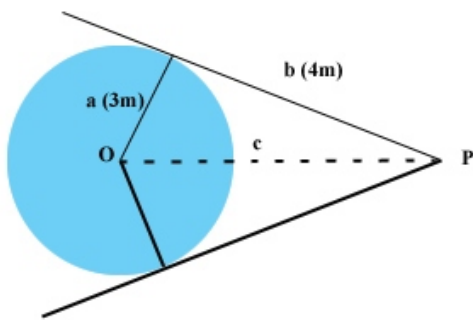
$$a^2 + b^2 = c^2$$
$$(4m)^2 + (3m)^2 = c^2$$
$$16m^2 + 9m^2 = c^2$$
$$25m^2 = c^2$$
$$5m = c$$

$$a^2 + b^2 = c^2$$
$$a^2 + (3m)^2 = (5m)^2$$
$$a^2 + 9m^2 = 25m^2$$
$$a^2 = 16m^2$$
$$a = 4m$$

www.learnalberta.ca/content/mejhm/html/object_interactives/circles/tangent/index.html, or another similar site, can be used to help explain and visualize the process.

> "Find a second radius that is at a symmetrical angle to your first radius (at equal degrees away from the newly created triangle). Create another triangle that uses a tangent to the second radius as one side and whose third side (hypotenuse) is the same as the third side (hypotenuse) of the first triangle. This creates a quadrilateral with a common point outside circle, P."

The students will need to use the quadrilateral in order to determine the length and width of their doorways. This also ensures that the doorways are centred in between the two posts, and that the entrance is smaller than a door placed on the wall of the structure would be. This creates extra room for storage, less heat loss in the winter or gain in the summer, and makes a Bernoulli funnel that draws the smoke up and out of the smoke hole. A door on the wall would actually draw the smoke downward, and out the doorway.

Using Tangents to Make an Entrance to a Circle Dwelling

Help students pursue the process of designing an entrance to their circle dwelling:

> "Pick a point P outside the circle that is 7 m from the centre, O. Draw 2 tangents from P to the circle. Measure the length of the tangents (hint: they should be the same length). If you go toward P and make a mark, then, starting at P, go 1.68m back along one tangent to make a right-angle triangle, how wide would the entrance be if you made the opening at that point? Based on these measurements, how long is the radius of your circle dwelling (use similar triangle ratios)? Is this a feasible number?"
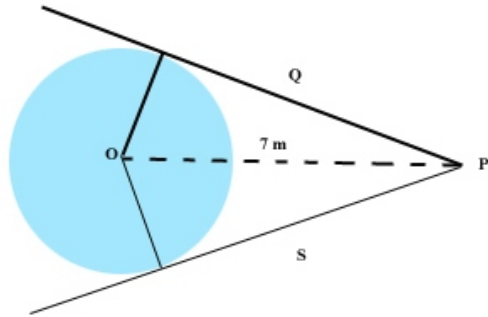
$$a^2 + b^2 = c^2$$
$$Q^2 + (3m)^2 = (7m)^2$$
$$Q^2 + 9m^2 = 49m^2$$
$$Q^2 = 40m^2$$
$$Q = 6.325m$$

$$a^2 + b^2 = c^2$$
$$S^2 + (3m)^2 = (7m)^2$$
$$S^2 + 9m^2 = 49m^2$$
$$S^2 = 40m^2$$
$$S = 6.325m$$

When students carry out the calculations they will find that given the radius of 3m, if they measure 1.68m back along tangent Q or tangent S they will end up creating a new right-angle triangle (90° where it meets OP) with a base that is 0.75m. By doubling that to 1.5m (using both tangent-based triangles) they should end up with an opening of realistic dimensions, using manageable mathematics. If students need help visualizing how the entrance to their circle dwelling will look, show them a video such as this one: www.youtube.com/watch?v=k1WrOc9vRR8

Inscribed Angle Theorem

Students will need to understand the **Inscribed Angle Theorem** (#3 on the accompanying Geometry Theorems student handout) to figure out where on the outer arc to place the beams that support the roof of their circle dwelling. To explain to students how paired beams are arranged to support a circular roof, use the time-lapse video showing the construction of a pit house roof at Thompson Rivers University: www.youtube.com/watch?v=1bZhvjY9qBk

To then explain and illustrate the theorem, (the central angle is always twice the inscribed angle, as long as both angles share the same arc), consider using a website such as www.mathopenref.com or www.members.shaw.ca/ron.blond/Circle.Geom1.APPLET/index.html. You will then need to follow up with specific examples such as the following to verify students' understanding:
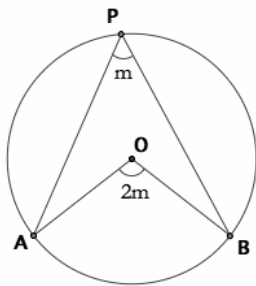
If $\angle APB = 42°$ Then
$\angle AOB = 2 \times 42°$
$\angle AOB = 84°$

If 2 arcs on the circle are the same length, then you can use the Inscribed Angle Theorem, because the central angle will be the same for both.
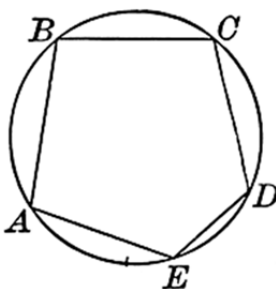
If AE and CD are the same length, then the arc between them is also the same length. Therefore, if we create a central angle, $\angle COD$ and $\angle AOE$ are equal.

To use this in the project, students need to understand that the centre of the dwelling floor and the entrance supports (A and B) are used to create a central angle, and determine where support beams

on the outer arc should be placed. Pairs of beams are used to optimize the support of the ceiling, and ease the construction process. Provided that the radius remains constant (that the circle is true), the inscribed angle will always be the same, when using the entrance beams, and is also half the central angle. The central angle formed, will always be twice the inscribed angle created by the supports.

As students begin work on their projects, circulate and observe how well they are able to apply the theorem to the task of placing the beams. Probe as needed with questions such as the following:
♦ If using 12 beams, the central angle is 30°. What is the inscribed angle?
♦ If using 16 beams, the inscribed angle is 11.25°. What would the central angle be?

If students are having trouble understanding, or need a hands-on activity, use GeoBoards to show the relationship between angles, chord length, and arc length.

Chords

Students will need to understand the properties of chords and be able to combine this understanding with their knowledge of Pythagorean theorem to figure out
♦ how tall their central supports will need to be, in order to support the opening and allow a person who is 1.82 meters tall to stand comfortably, 2 meters from the central point (i.e., using the radius length they determined previously by using tangents)
♦ the length and depth of the seating/sleeping benches situated inside the outer wall of the circle dwelling.

Show them how to apply the **Chord Perpendicular Bisector Theorem** (#1 on the Geometry Theorems student handout) to determine the length of a chord or segment and/or its distance from the circumference (or from the centre), using examples such as the following.

Example 1:

Determine the length of a chord that is inside a circle with radius 5cm, and bisected by a segment 3cm long. (Encourage them to always draw the diagram first, when dealing with this sort of challenge!)
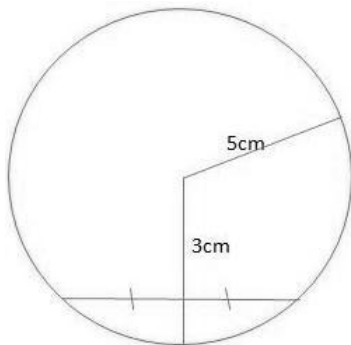
Demonstrate how to draw in the missing side to form a right triangle and use Pythagoras to determine the missing side. From there, simply multiply by 2 to determine the length of the chord. Therefore the length of the missing side is 4cm, and the entire chord length must be:
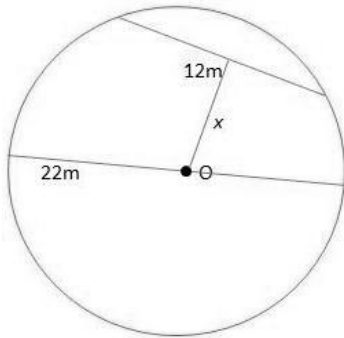
4cm + 4cm = 8cm
OR   4cm x 2 = 8cm

Example 2

Determine how far away the 12 m chord is from the origin of the circle. First recognize that the 22 m chord is actually a diameter.

From there, the radius is $22\ m \div 2 = 11\ m$.

Because the radius is 11 m and you can place another radius at 90° to the 12 m chord (therefore splitting it in half, or 6 m long), you know 2 sides to the right triangle created.

$$a^2 + b^2 = c^2$$
$$6m^2 + x^2 = 11\ m^2$$
$$36m^2 + x^2 = 121\ m^2$$
$$x^2 = 85\ m^2$$
$$x = 9.220\ m$$

They may also need to practise the computational procedure involved in order to apply it to their projects. As they ponder how to apply it to their projects, they may need hints such as the following:

♦ If your smoke hole is 2/3 the diameter of your fire circle, you can use this to determine the distance from the floor. This is how tall your central supports will need to be, in order to support the opening.

♦ To determine the depth of the seating/sleeping benches, start at beam A (entrance) and connect a chord to the 4th beam (3 beams away). Move to the next beam, and connect a chord to the 5th beam (3 beams away). Continue in this way, connecting every beam to the one 3 beams away in a clockwise manner. Stop when you connect to beam B (entrance). Connect all the inner lines. Determine the depth of the benches (using Chord Theory and assuming the benches are 1m away from the wall).

Project Completion and Assessment

Depending on your preferences and on factors such as the amount of time available and the capacities of your students, you could use any of the following approaches to have them complete the project assignment:

♦ ask each student to complete all aspects of the project individually, using a minimum amount of class time supplemented by homework

♦ have students work in pairs or groups of 3-4 to complete all aspects of the project

♦ have students work individually on the planning and calculating stages of the project, then collaborate with one or more fellow students to build the actual scale model.

The approach used to complete the project will of course affect the approach you use to assess it. To facilitate assessment of students' planning work (which includes the calculation-intensive portion of the assignment), consider having students use copies of the templates provided to draw their scaled plans. This will allow you to quickly verify that their work is correct by comparing it with the plans provided here as the "Circle Dwelling Plan – Assessment Masters." (Note that the first assessment master, the top view, relates to a 12 post design only.) These assessment masters are sized like the student template handout & blank on the reverse side to allow you to use a "lightbox" method for marking, whereby you simply align the student's work and the master and hold them up to the light to quickly see where discrepancies might exist.

If your students are reasonably well versed in generating and helping decide on assessment criteria, you may find it worthwhile to spend the necessary time on that process. As an alternative, you could use criteria such as the following (arranged in a four-level rubric), and simply share them with students as they begin work. Criteria have been identified here for each aspect of the project, so you can apply them to individual or to group work, as appropriate, and relate them to a weighted marking scheme compatible with what you use for the rest of your Grade 8-9 Math program.
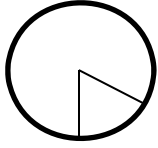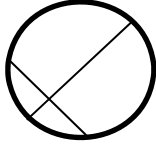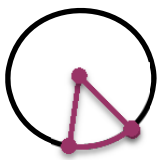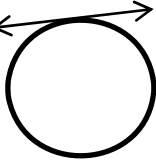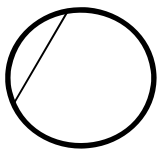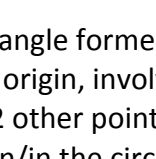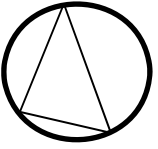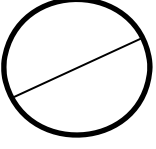
Sample Criteria for Assessing Circle Dwelling Project Tasks				
CATEGORY	**1** Does not meet expectations	**2** Minimally meets expectations (not very well)	**3** Meets expectations, with only minor deficiencies	**4** Meets to a high standard or exceeds expectations
Plan	Plan does not show measurements clearly or is otherwise inadequately labeled.	Plan provides clear measurements and labeling for some components.	Plan is neat with clear measurements and labeling for most components.	Plan is neat with clear measurements and labeling for all components.
Circle Geometry Concepts	Student's work indicates little or no knowledge of circle geometry concepts.	Student's work indicates limited knowledge of circle geometry concepts and/or capacity to correctly select and apply them for given purposes.	Student's work indicates reasonably complete and accurate knowledge of circle geometry concepts and an ability to apply them, albeit with some errors.	Student's work indicates clear knowledge of circle geometry concepts and an ability to correctly select and apply them to solve all project-related problems.
Related Math Concepts (linear geometry, properties of triangles, Pythagorean theorem, etc.)	Response shows a complete inability to select and apply relevant mathematical concepts	Response shows some understanding of the problems and ability to select and apply relevant mathematical concepts	Response shows substantial understanding of the problem, ideas, and processes.	Response shows complete understanding of the questions, mathematical ideas, and processes.
Calculations	Measurements are not transferred to the template accurately or at all. Essential project calculations are not attempted, work is not shown, and/or serious errors reflect a careless attitude.	Measurements are mostly transferred to the template. All calculations are attempted, but work is not always shown and/or several errors (including rounding errors) are evident.	Measurements are transferred to the template, and all calculations are performed, with work shown in full. Isolated and/or minor errors (including rounding errors) can be identified, however.	Measurements are transferred to the template accurately. All calculations are shown in full and are correctly performed.
Construction – Materials	Inappropriate materials have been selected and contribute to a product that performs poorly.	Appropriate materials have been selected.	Appropriate materials have been selected and there has been an attempt at creative modification to make them even better.	Appropriate materials have been selected and creatively modified in ways that make them even better.
Construction – Care Taken	Construction appears careless, rushed, or haphazard. Many aspects need refinement.	Construction generally follows the plans, but 3-4 details could have been refined for a more attractive product.	Construction is careful and accurate for the most part, but 1-2 details could have been refined for a more sturdy or attractive product.	Great care is taken in construction process, and plans are accurately followed. The structure is neat, attractive, and sturdy.
Project Requirements	Key project requirements are ignored and work is not complete.	Most project requirements are met, though some only barely.	Project requirements are fully met to an acceptable standard.	All work is completed to high standards, and there is evidence of a comprehensive commitment to care and quality.

Circle Terms Dominos

Play circle dominos to review the terminology associated with circle geometry. The rules are the same as those for regular dominos:

- Place all dominos face down in either a pool or a stack.
- Each of the 2 players is to select 4 tiles.
- The first player places a domino face up on the playing field.
- The second player can play on either end of the tile, as long as they match either a diagram, a definition, or a term to the correct side. Tiles can be strung end to end, or at a right angle to each other.
- If players cannot match a term, diagram, or definition with the tiles in their hand, they must draw a tile from the pool, and pass their turn.
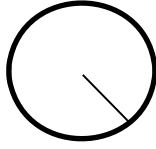- The winner is the player who uses all her or his tiles first.
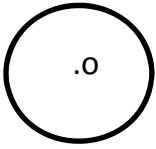
This game can be used as an individual review as well.

	A line that runs from the centre of the circle to the outer edge
	A portion of the perimeter of the circle
	A line segment that joins two points on a circle
	The centre of the circle
	A line which cuts a line segment into two equal parts at 90°
An angle formed at the origin, involving 2 other points on/in the circle	Origin
	Tangent
	Perpendicular Bisector

An angle formed on the perimeter using 2 points found elsewhere on/in the circle	Diameter

	Radius

A portion of a circle bounded by two radii and the included arc	Chord

	Central Angle

.o	Sector

A line that touches the perimeter of a circle at a 90° angle, contacting at only one point	Inscribed Angle

A chord that bisects the circle, passing through the centre.	Arc

Circle Dwelling Project Instructions

This project involves two related tasks:
♦ designing a circle dwelling that will allow a person who is 1.82 meters tall to stand comfortably, 2 meters from the central point; the design work is to consist of two diagrams that
• follow the specifications provided below
• demonstrate the use of circle geometry concepts
• use a scale of **1 m: 2.5 cm**
♦ building a scale model of the circle dwelling you have designed, using a scale of **1 m: 4 cm** (or another scale that you have agreed upon with your teacher)

Diagram 1 – Top View:

Draw a top view of your circle dwelling. Include
♦ an entrance 4.5 m from the centre, that is consistent with a common outside point
♦ a fire circle, a smoke hole that is 2/3 the diameter of your fire circle, and surrounding central support beams (use either 12 or 16 support beams for the ceiling. Remember that the more beams used, the more curve your roof will have. The first pair of beams should be placed exactly opposite the entrance beams (A and B). The second and third pairs of beams should be at a right angle to these beams. Remaining beams are placed halfway between these pairs.
♦ positions of all outer posts on the circle
♦ seating/sleeping benches that encompass the rest of the circumference (i.e., other than the entrance)

Also include measurements/calculations for
♦ the radius of the dwelling's "footprint"
♦ the length of the entrance
♦ the width of the entrance
♦ the depth of the sitting/sleeping benches
♦ the radius of the fire circle

♦ the central angle using the entrance beams
♦ the inscribed angle using the entrance, centre, and 2 outer posts.

Diagram 2 – Side View:

Draw a side view of your circle dwelling. Include
♦ the radius
♦ an entrance
♦ seating/sleeping benches that encompass the rest of the circumference
♦ a fire circle with dimensions and surrounding central support beams
♦ a smoke hole with dimensions for height and width.

Also include measurements/calculations for
♦ the height of the ceiling outside the fire circle and calculations for the central support beams,
♦ the height of the ceiling 2 m from the centre
♦ the height of the entrance

Model

Build a model of the circle dwelling you have designed, using willow twigs (they are flexible enough), pipe cleaners, wikisticks/bendaroos, wire, or other suitable material, affixing it to a base of cardboard or sandpaper. You can use a glue gun, sticky tack, or modelling clay to affix the material in place. Include other features of the inside of a circle dwelling in your model and cover half your model in moss, willow leaves, popsicle sticks, clay, or paper maché. Be sure to work as close to scale as possible.

Geometry Theorems

1. **Chord Perpendicular Bisector Theorem**

   A line through the centre of a circle bisects a chord *iff* (if and only if) it is perpendicular to that chord. This means that

   a)   the perpendicular bisector of a chord passes through the centre of the circle

   b)   the line joining the midpoint of a chord to the centre is perpendicular to the chord

   c)   the line through the centre and perpendicular (at 90°) to a chord bisects the chord (i.e., splits the chord into two segments of equal length)
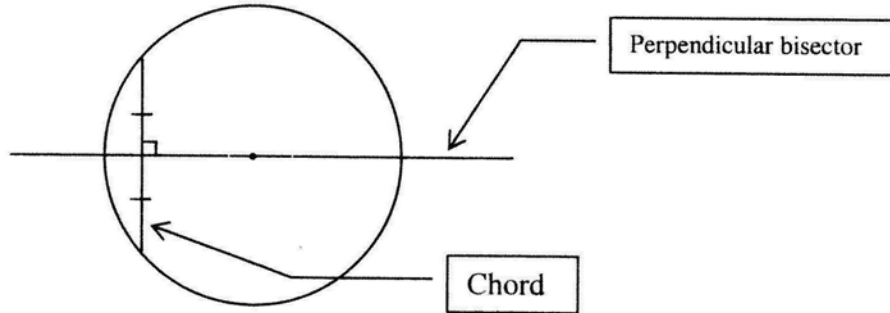
   Note: there is ALWAYS a radius that will be at a right angle to the chord. Otherwise, the Chord is really a diameter!

2. **Equal Chords Theorem**

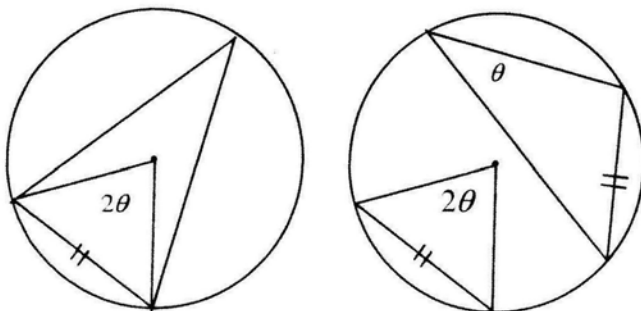   Inscribed angles or central angles containing equal chords are equal.
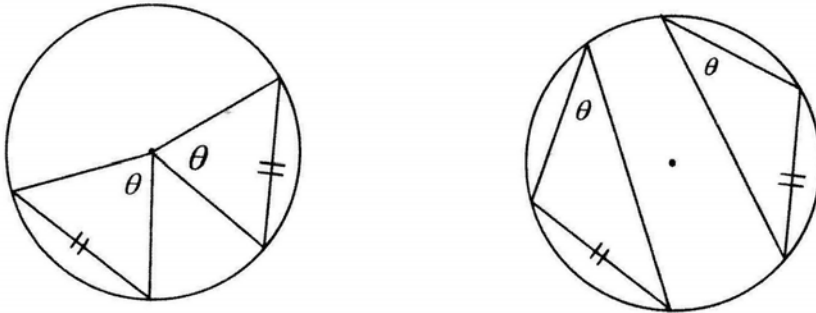
   Since the chords are equal, the angles are equal ($\theta = \theta$) and vice versa.
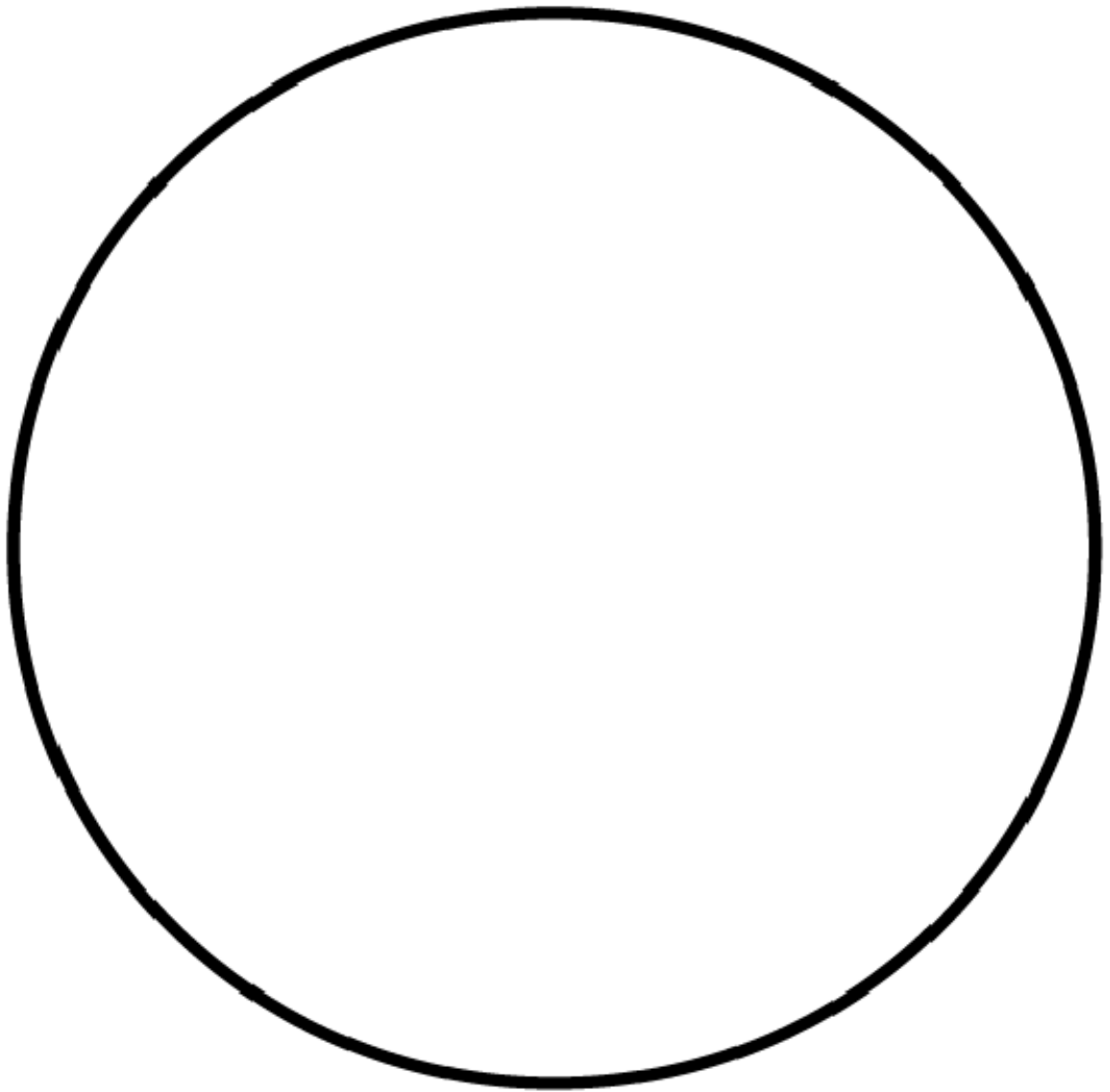
3. **Inscribed Angle Theorem**

   The central angle is twice the inscribed angle *iff* (if and only if)

   •   both angles share the same arc
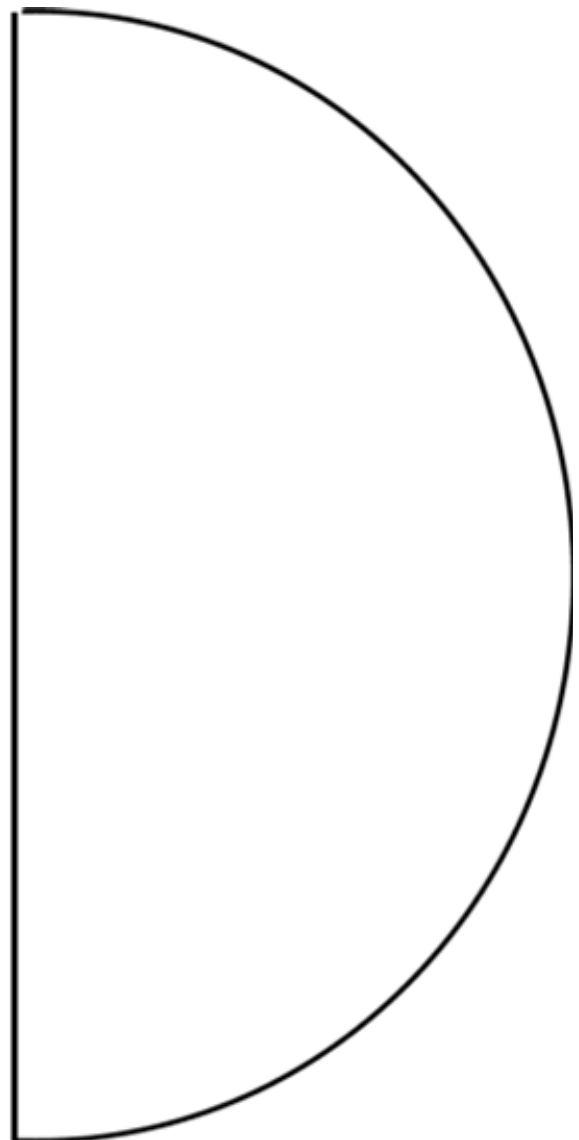
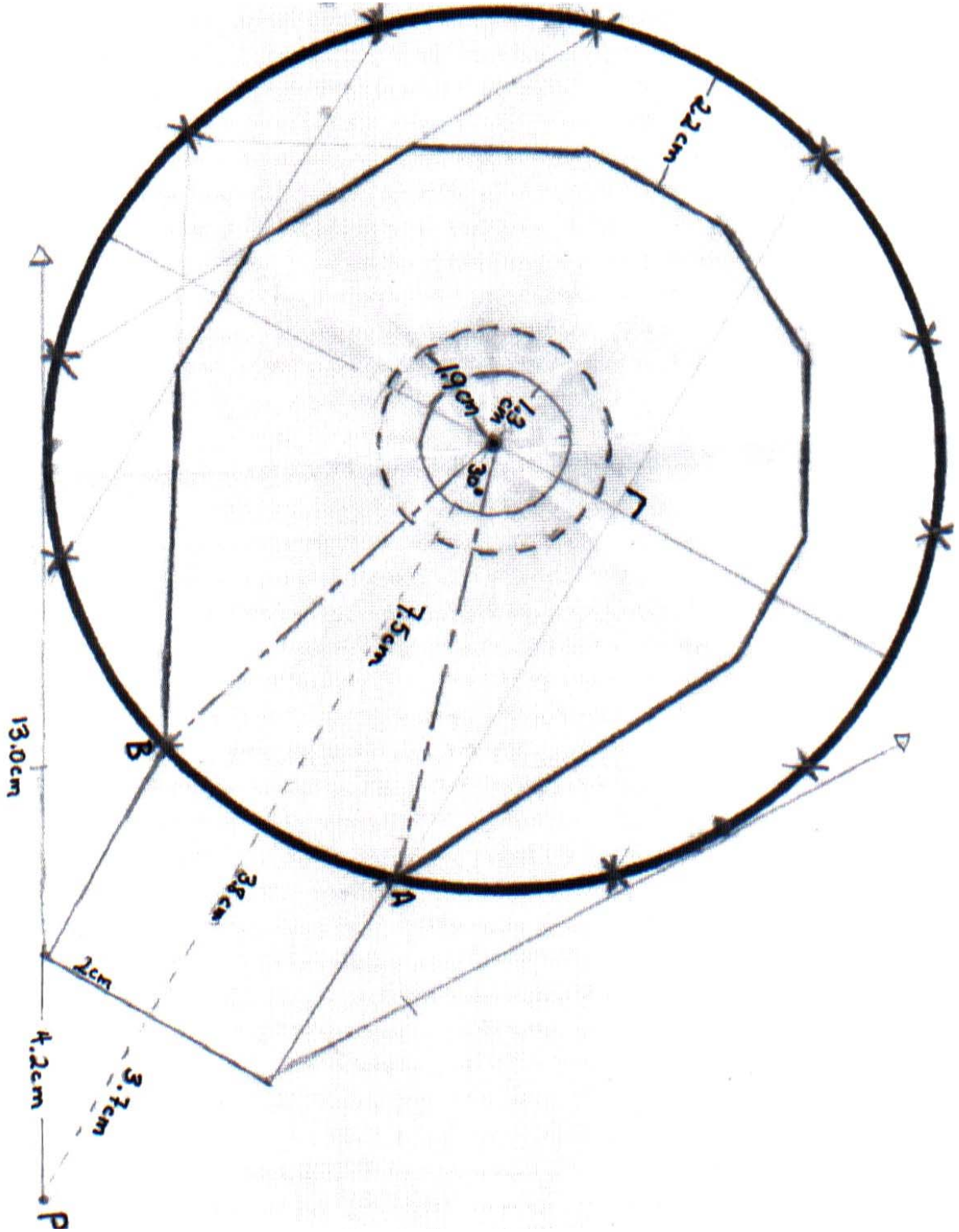   •   the angles contain equal chords.

Name: _____

Template for Top View

Name: _____

Template for Side View
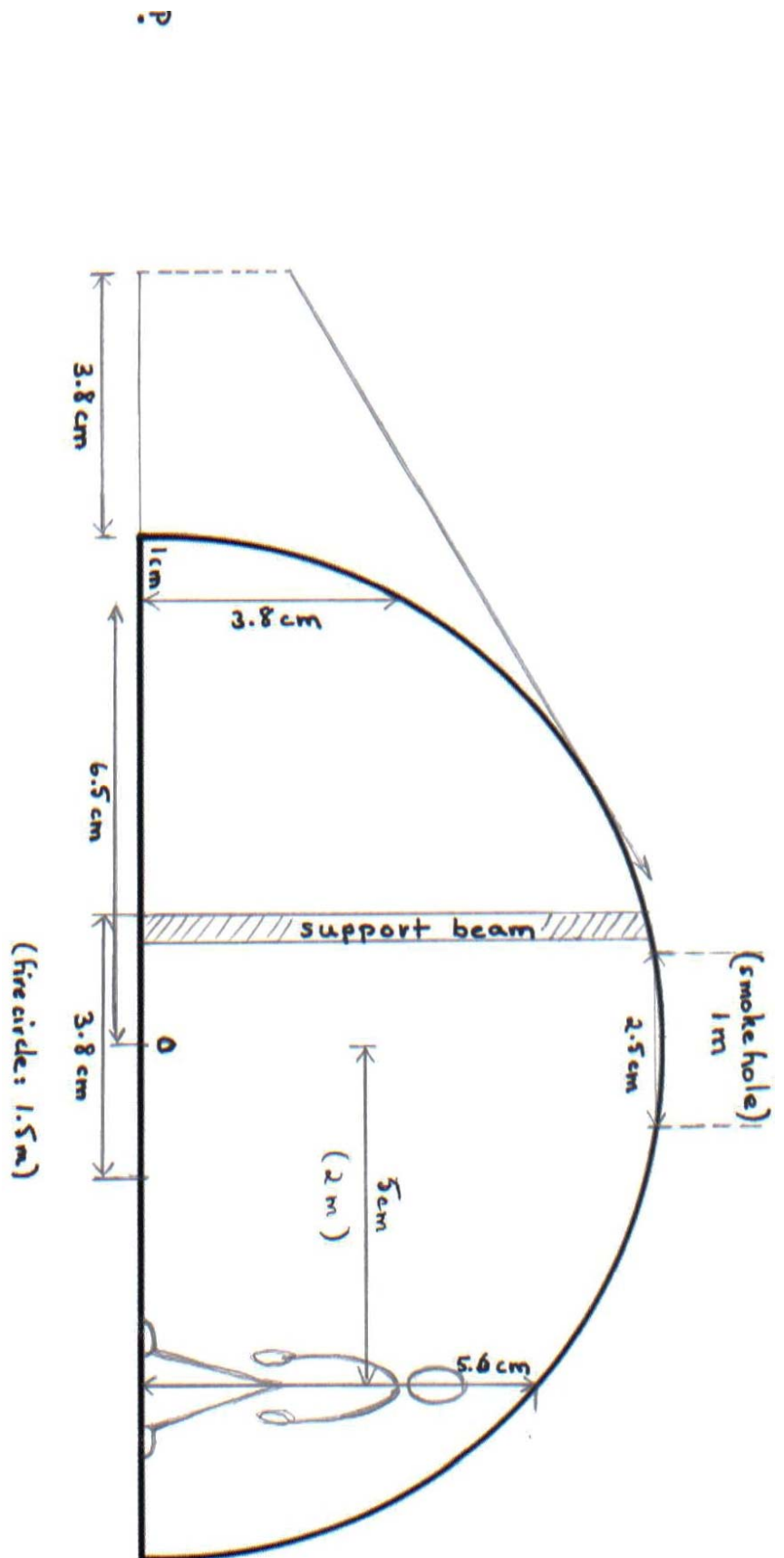
P.

3.8 cm

1 cm

3.8 cm

6.5 cm

///////// support beam ///////

(fire circle: 1.5 m)

3.8 cm

0

(smoke hole) 1 m

2.5 cm

5 cm

(2 m)

5.6 cm

Context

The button blanket is post-European contact regalia and is worn for ceremonies, such as feasts, naming ceremonies, memorials, totem pole raisings, weddings, and given as gifts within the Haida, Tsimshian, Tlingit, Nuxalk, Kwakuitl, and Nisga'a nations. A widely used term for the blankets is "Feast Wear."

Dancing in the firelight, the blanket wearer will come alive portraying a particular figure or event. Although the red, black and white colors have spiritual meanings, the button blanket was really designed for temporal reasons rather than spiritual — in other words, they represent family crests, proclaim rank, and the social status of the wearer. That status was and is reinforced by the robe's acclamation of cosmic support — power — the history of which has been validated properly and perpetuated through time."

Prescribed Learning Outcomes

This unit can be used to help students achieve the following Prescribed Learning Outcomes for Mathematics 9:
C3   demonstrate an understanding of similarity of polygons
C4   draw and interpret scale diagrams of 2-D shapes
C5   demonstrate and understanding of line and rotation symmetry

Suggested Resources

The following resources are not required but are useful for enriching this unit:
♦   *Learning by Designing: Pacific Northwest Coast Native Indian Art,* by Jim Gilbert and Karin Clark (see the Resources section at the end of this document for more information) — an excellent teacher resource for First Peoples design projects
♦   any text illustrating examples of First People button blankets and other textiles (consult with your school visual arts department)

Unit Introduction

Tell the students what the upcoming lessons will be about and the final project involved. Explain how similar polygons are also represented in First Peoples art. Show students an example of an Aboriginal blanket (e.g., Button, Star, Chikat), either by inviting someone who possesses one to bring it to the class and discuss it or by finding some examples online. Let the students know that after all of the lessons have been done, they will be using this knowledge to design and make their own Aboriginal-style blanket. There will be a couple of smaller student projects prior to the quilt making: logo design, print making activity, and mini blanket. Have examples of each project so the students know what the lessons will be leading to.

After all the lessons have been taught and the students have a grasp on the required outcomes, they will be able to design their own personal button blanket. The lesson can be extended to have the students produce a "full-size, wall quilt." This would be a good opportunity to invite Elders/community members, who have knowledge in quilt making, into the classroom to help with the designing and making of the final project.

Lesson: Similarity

The study of similarity will eventually lead to students designing a personal logo. Show a variety of logo and crest examples, such as

♦ FNESC: www.fnesc.ca/assets/home_logo.gif
♦ Four Host First Nations: www.fourhostfirstnations.com/
♦ local First Nations band associations
♦ local municipality and school

Point out logos that demonstrate similar polygons. There are many logos that use a letter to represent the company. The logo, later on, can be shrunk and used with the print-making activity.

The study of similarity should include looking at similar figures, corresponding sides, and scale factors. Also look at angles in similar triangles that are congruent. Students should learn how to measure and calculate the scale factors of similar triangles and use this information to find the measurements of missing sides in a figure. Students will also have the opportunity to practice measuring angles with a protractor and measuring lengths with a ruler. Use your preferred Grade 9 text to provide students with extra practice working on similar polygons, corresponding sides, and scale factor.

Introduce similar polygons: (Def: *Similar polygons* = 2 or more polygons that are identical or where each polygon looks like an enlargement or reduction of the other.)

Look at similar polygons, enlarging and reducing, and scale.

Distribute the Similar Polygons worksheet provided as a handout at the end of this unit, and help students as they work through the questions in pairs or small groups.

As an extension, students can create their own logos. Distribute the Personal Logo worksheet to assist in this project.
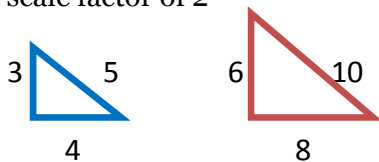
Lesson: Scale

Definition of **Scale Factor**: the factor one dimension of a polygon is multiplied by to calculate the corresponding dimension of a similar polygon.
Scale factor can be shown as a percent, a ratio, or as a whole number, decimal, or fraction.
If the scale factor is **less than 1** (ex: .25, .5) the shape is being **reduced.**
If the scale factor is **larger than 1** (ex: 2, 5, etc.) the shape is being **enlarged**.

Example: scale factor of 2

3   5   6   10

4   8

Distribute the Scale worksheet provided as a handout at the end of this unit, and help students as they work through the questions in pairs or small groups.

Lesson 3: Line and Rotational Symmetry

Bring a variety of examples that show symmetry: First Peoples designs, objects from nature that display symmetry (flowers, etc.), Escher designs, etc. Ask students if they see the symmetry. Explain symmetry and reflections:

♦ **Symmetry** is when one shape becomes exactly like another if you flip, slide or turn it.
♦ The **Line of Symmetry** is the line that divides a 2-D shape in half.
♦ **Rotational Symmetry** is when a rotating shape, when turned less that 360 degrees, fits exactly over its original position.
♦ **Reflection** results from the flip of an object.
♦ A **translation** is a slide along a straight line: left or right, up or down.
♦ **Transformations** include translations, reflections and rotations.

Using a flat mirror, demonstrate a reflection and the symmetry of an object. Students can draw a variety of shapes (on graph paper) and then draw the reflection using a flat mirror. The flat mirror can also be used on the Cartesian plane to demonstrate reflections and what the reflected coordinates are.

Distribute the Symmetry worksheet provided as a handout at the end of this unit, and help students as they work through the questions in pairs or small groups.

Final Project: Button Blanket

Introduce the button blanket by showing examples (collected from the community, or illustrated in books or online). The following site includes a series of video clip depicting the making of a button blanket:
www.lttacollection.ca/content/lesson-plan.asp?SessionId=747741&ItemId=379&ProvinceId=5

Distribute the Button Blanket handout provided at the end of this unit, and assist students as they create their blankets.

As a time-saving alternative, students can create their "blankets" using art paper.

Extension: School Quilt

Have students work as a group to combine their individual button blanket patches into a quilt. Many quilt patterns are available online (for example, www.quilterscache.com/QuiltBlocksGalore.html), or consult with your school home economics department for assistance.
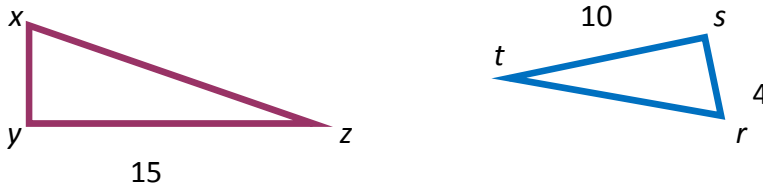
Similar Polygons

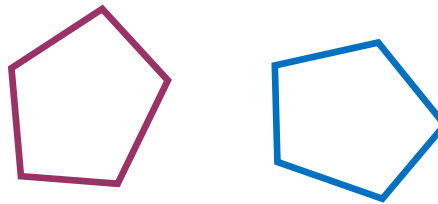1. 3 rectangles measure 5 cm x 3 cm, 10 cm x 6 cm, and 15 cm x 9 cm. Are they similar? Explain.

2.

Which shapes are similar?

3. These triangles are similar. What is the length of side *xy*?
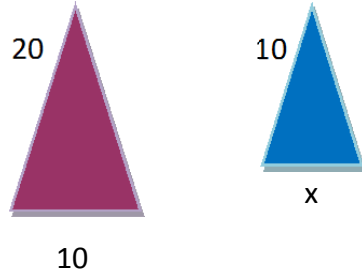
4. Measure the sides of the polygons. Are they similar? Explain.

Scale

1. Jim is designing a pattern to paint on his paddle. This is one of the shapes he will be using. Jim needs to reduce the pattern t fit on the handle. How long does the bottom of the triangle need to be?

   20 ▲ 10 ▲

   10   x

2. Measure the rectangle. Draw similar rectangles for each scale factor.
   Reduce by a scale factor of 40%.
   Enlarge by a scale factor of 1.5.
   Reduce by a scale factor of 1/3.

3. Draw a polygon, on graph paper, which you would use for a border around the bottom of a quilt. Draw to 2 polygons that are similar – one enlargement and one reduction.

4. On graph paper draw your initial in block letters. Now reduce it by 50% and then enlarge it 2.5 times.

5. You and your family are heading to a feast 75 km away. On the map you are following, 1 cm equals 10 km. How long is the line on your map between home and the feast?

6. You are standing by a cedar tree and wondering how tall it is. Your shadow is 4.6 m long and you are 1.5 m tall. The shadow cast from the cedar tree is 70 m long. How tall is the tree?
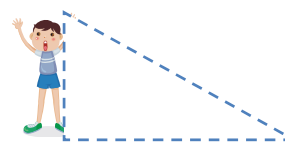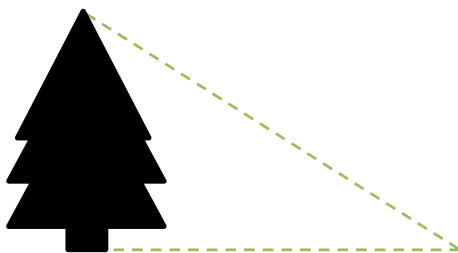
Symmetry

Definitions

- **Symmetry** is when one shape becomes exactly like another if you flip, slide or turn it.
- The **line of symmetry** is the line that divides a 2-D shape in half.
- **Rotational symmetry** is when a rotating shape, when turned less that 360 degrees, fits exactly over its original position.
- **Reflection** results from the flip of an object.
- A **translation** is a slide along a straight line: left or right, up or down.
- **Transformations** include translations, reflections, and rotations.

Questions

1. Look at the block letter initial you drew for the previous lesson. How many lines of symmetry does it have? Share with a partner.

2. Draw and cut out this shape; the internal angle at C is 60 degrees. Rotate the shape (and trace) on the vertex to make a shape with rotational symmetry. What is the order of rotation symmetry?

   C = the centre of rotation

   C

3. Determine the order of rotation symmetry and the angle of rotation for each polygon:

4. Identify the line of symmetry and the order of rotation symmetry:

5. a. Which triangle is a translation of triangle ABC?
   b. Which triangle is the image of triangle ABC after a reflection in the x-axis?
   c. Which triangle is an enlargement of triangle ABC?
   d. What is the scale factor of the enlargement?
   e. Rotate triangle ABC ¼ turn clockwise around the origin. Label the new triangle A'B'C'. What are the co-ordinates for point 'C'?
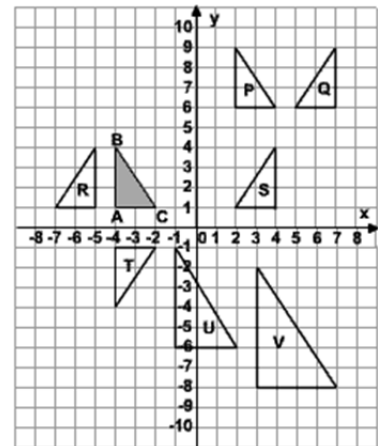
Personal Logo

The Vancouver 2010 games were held on the shared traditional territories of the Lil'Wat, Musqueam, Squamish, and Tsleil-Waututh First Nations. The Host First Nations wanted the cultures, protocols, and traditions of its peoples represented and respected before, during, and after the Olympics.

The Vancouver 2010 Aboriginal Licensing and Merchandising Program was created as part of the partnership. It was another first in Olympic history. The program showcased excellence in Aboriginal arts, culture, and enterprise. As part of the licensing and merchandising program, a Four Host First Nations logo was developed.

Materials needed: graph paper, pencil, felt pens (pencil crayons).

Using 8 ½ x 11 graph paper design a personal logo. In the centre draw your initial in block letters. Around the outer edge of the paper you are going to make a repeated pattern of at least 3 different polygons. Once you have come up with your personal logo you will enlarge your drawing to fit on poster paper.

Extension

Reduce your personal logo by 50%. Now you can make a "patch" that can be sewn onto your book bag or on your jacket.

Materials needed: logo design, craft felt (plain and self-adhesive type in a variety of colors), scissors (craft knife), small white buttons, embellishments (optional), needle and thread.

Procedure:
1. Transfer design onto self-adhesive felt.
2. Cut out design.
3. Iron cut-out pieces onto plain felt.
4. Place buttons and/or embellishments.
5. Hand or machine sew patch onto bag or jacket.

Final Project: Button Blanket

Your final project will combine what you have learned about scale, similar polygons, and symmetry to make a mini button blanket.

The centre of your blanket will be a First Peoples themed design. Buttons are sewn on wherever you want to accent the blanket. The outer edges of the blanket will consist of polygons that have been reduced, enlarged, and rotated.

Materials needed:
♦ graph paper
♦ felt squares (variety of colors)
♦ iron-on sticky glue
♦ small white buttons
♦ craft knives
♦ wooden dowels — length of finished banner (to make hanger)
♦ ribbon/cord (to make hanger)

Steps

1. Find or make a design that will fit in the felt square.

2. Iron on the "sticky glue" to the felt square. You can also buy felt squares that are pre-glued.

3. Trace your design onto the felt square.

4. Cut out the design and iron on to another felt square (a different color)

5. Cut out a variety of polygons and shapes that have been rotated, flipped, enlarged, etc.

6. These shapes also receive the iron-on glue.

7. Place the shapes on the outer edge of the quilt.

8. Add buttons where desired.

9. Roll down top edge, with dowel inside, glue closed.

10. Add ribbon or string to act as a hanger.

Context

Salmon has been chosen as an underlying theme because it has been a vital resource for so many of British Columbia's First Peoples for time immemorial; and continues to be to this day. There are many different applications of math that relate both directly and indirectly to salmon, thus enriching the curriculum and appealing to the many different learning styles and backgrounds found in most BC classrooms.

Prescribed Learning Outcomes

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

D1   describe the effect of
–   bias
–   use of language
–   ethics
–   cost
–   time and timing
–   privacy
–   cultural sensitivity
on the collection of data

D2   select and defend the choice of using either a population or a sample of a population to answer a question

D3   develop and implement a project plan for the collection, display, and analysis of data by
–   formulating a question for investigation
–   choosing a data collection method that includes social considerations
–   selecting a population or a sample
–   collecting the data
–   displaying the collected data in an appropriate manner
–   drawing conclusions to answer the question

D4   demonstrate an understanding of the role of probability in society

Instructional Time: 8 to 10 hours (for planning purposes, each lesson in this unit is designed to take approximately 1 hour)

Materials needed:

♦   coloured marbles, tokens, or other manipulatives, at least 3 colours, and at least 25 of each colour for each group of student
♦   lidded containers or boxes, 1 per group of students

Suggested Instruction and Assessment Approach

Lesson 1: Introduction to the Salmon Unit

The approaches for introducing the unit could include a story, video or a guest speaker (e.g., local Elder, conservation officer, local fisher). Most districts have an Aboriginal education department that could assist in organizing an Elder to come in. (For an example from the Saanich peoples, visit www.racerocks.com/racerock/firstnations/13moons/moons/centeki.html.)

Depending on how you decide to introduce this unit, students will need to be guided to start asking questions so the teacher can begin introducing the relevant concepts of bias, cultural sensitivity, privacy, time and timing, etc. in a non-threatening way.

Examples (relating to information from the Centeki — Salmon Moon web site):
♦ Why did the Saanich People like the taste of Sockeye salmon?
♦ Why do all Aboriginal people believe they are related to salmon?
♦ Why were Sockeye the only species of Salmon that the Saanich people caught?
♦ Why do you think Aboriginal peoples eat so much salmon?

Students should share their questions with a group or with the class.

Discuss how the questions could be rewritten to avoid potential problems with cultural sensitivity or bias etc. This is a great way to make the topic meaningful to students, relevant to math and applicable to the unit at hand.

Lessons 2 and 3: Salmon Surveys

PLO: D1

Research requires asking questions so that you can collect information. This information can then be used to draw conclusions. First Peoples and conservation officers can use research to predict the health of the salmon runs and the size of fish populations.

Introduce the lesson with these three problem questions:
♦ How many times a week does your family eat salmon?
♦ What is your favourite type of salmon? Choose from Spring, Chum, or Coho.
♦ Do you think people eat less salmon because it is too expensive?

Have students share their answers in groups. Can they identify problems with the questions? How might a question that is poorly written create problems with data collection?

For example: Asking someone their favourite type of salmon and only giving three choices is very limiting and assumes that they do have a favourite. A better question may ask if they indeed have a favourite and more options should be given for choices.

Distribute the handout, Factors That May Influence Data, and discuss the information and examples given. Then have students work in small groups to rewrite the above questions.

Lessons 4 and 5: Samples and Populations

PLO: D2

In this section of the unit students will need to be able to defend the choice of a sample or a population when collecting data. Students must be careful to consider appropriate sizes when sampling a population, time constraints, costs, and validity.

Distribute the handout, Jennifer's Salmon Stand. Use this handout to guide a discussion about the difficulties of collecting useful and valid data. In this scenario Jennifer is posed with a simple

problem but may realize that many challenges can arise. The questions at the end of the handout can be used for group work or teacher led-discussion.

Distribute the Samples and Populations handout. Use the activity in this handout to illustrate how the size of a sample affects the ability to make reliable predictions based on data collection. For example, using as small sample may not be accurate but a big sample may not be effective due to time and cost.

Lessons 6 and 7: Salmon Statistics Project

PLO: D3

This lesson is an opportunity for students to do some field work. Students will have an opportunity to utilize some of the work from previous lessons that could satisfy the requirements for their project.

The challenge is to find projects that are meaningful to students. Students could use the research they did early in the unit or they can explore other creative options. The internet will be a great resource for data collection as well as using the student body of the school for surveys, questionnaires or interviews.

Possible **project ideas** could include:
♦   Survey people about salmon preferences, uses, knowledge of/familiarity with etc.
♦   Collect data about salmon habitats, species, characteristics etc. Potential resources:
   •   BC Salmon Market Database www.bcsalmon.ca/market-database/index.html
   •   Statistics Canada www.statcan.gc.ca/start-debut-eng.html
   •   Dept. of Fisheries and Oceans www.dfo-mpo.gc.ca/science/publications/uww-msm/articles/pacificsalmon-saumonpacifique-eng.htm
♦   Use data from Statistics Canada about salmon exports, industry value, production value, etc.

To prepare their statistics project, students should:
♦   Prepare an appropriate **question** that can be answered with a survey or data collection. Students need to avoid bias and make sure they consider cultural sensitivity. Remind them of the information in Factors That May Influence Data handout.
♦   Choose a method for **data collection** and include a choice of sample or population. Students must consider cost and time involved
♦   Analyze and display the data and make appropriate conclusions.

As a class, discuss criteria for assessing students' work.

Lesson 8: Probability

PLO: D4

Use the following examples to illustrate the application of probability.

Example 1
Probability is most commonly used in weather forecasts. When planning a fishing trip it is important to know the probability of things like rain or a storm. An accurate forecast is important

because the safety of the crew members could depend on it. Students may be able to talk about how some Elders are able to predict weather and the clues they use to hone this skill.

Modern forecasters use probability to express the degree of certainty that a weather event may occur. For example, a 70% chance of rain means there is 7 chances out of every 10 that it could rain.

Example 2
First Peoples in British Columbia have been fishing in the rivers for thousands of years. Even today they fish with gaffs every fall and are part of these river ecosystems just as much as the plants, eagles, sea gulls and bears. Every year excitement grows as the people prepare gaffs, nets, supplies and even their smoke shacks in anticipation of catching fish for their families.

Last year the Edwards family went gaffing two times and took 20 fish from the river. They caught 8 Coho salmon, 6 Spring salmon, and 6 Chum salmon. What is the probability that the Edwards family will catch any Coho this year?

8/20 = 40%

This is an example of **Experimental Probability** because it is based on the past experience of the Edwards fishing experiences.

If Jimmy Edwards had gaffed five female salmon in a row he might say he thinks his next salmon will be a male. He bases this on **Theoretical Probability** because it is based on the fact that he has a 50% chance or a .5 probability of gaffing a male.

Probability Game

Divide the class into groups of 4, and distribute the Salmon Probability Game handout. Have students work through the game in their groups, then bring the class back together to discuss the results.

Factors that May Influence Data

Bias

♦ Likely to influence a person to respond in a certain way.
  Example of biased or leading question: "Do you think salmon tastes too fishy?" This person obviously has a bias against the taste of salmon and this can affect the question. A more appropriately phrased question would ask what they think salmon tastes like, and offer potential choices.

Use of Language

♦ Language can affect people's answers by influencing them.
  Example of language leading question: "Do you agree that the price of salmon is way too high?" People may be led to say yes because of the language used. If the question asked if you thought the cost of salmon was fair, inexpensive or too high it would significantly improve the question.

Ethics

♦ The data collected must only be used for the purpose of study that respondents agree to.
  Example: A study asks an Aboriginal community the best methods for catching salmon with the intent to send a salesperson to that community to try to sell products that support those methods. The data collector needs to inform all participants of the exact purpose of the data collection and how it will be used.

Costs/Method

♦ When conducting research, all costs must be considered to ensure that the study is worth the work.
  Example: Studying a small salmon stream may cost thousands of dollars and hours but it may not be worth it if the purpose is purely common interest. It would be worth it if the overall result is to improve the stream for future use.

♦ The data collection method must also be considered. An electronic survey may be more cost-effective, but it may eliminate people without access to a computer. A door-to-door survey may include only a certain segment of the population in your results.

Time and Timing

♦ When the data is collected can influence results.
  Example: Conducting a salmon count in a river in June will be a lot different than doing the count in November. It is essential that the reason for the data collection be assessed and then the timing of the study be decided.

Privacy:

♦ People need to have the right to refuse to participate if the topic is too personal or makes them uncomfortable.
  Example: People who are pressured into participating in a study may just tell you any answer to get you to leave or they may refuse if you say you will use their name. A better option is to offer the choice of participating and disclose the purpose of the study and details regarding publication of results to ensure they have all the information and can then make an informed choice.

Cultural Sensitivity:

♦ You must take care not to offend people from different cultural groups.

Example of a culturally insensitive question: asking a First Peoples Elder why all Aboriginal people love eating salmon. It may offend the Elder because you have made a generalization that all Aboriginal people love salmon, and it assumes that the Elder is able to answer for all First Peoples everywhere. A less offensive option would be to ask if salmon is popular within the Elder's own community, or why salmon has played such an integral part in First Peoples history.

Remember: when designing a survey:

❑ Are your questions appropriate?

❑ Do your questions ask what is necessary to gather the data you require?

❑ Do your questions take into consideration bias and sensitivity?

❑ Does your method for data collection seem practical?

❑ Have you considered cost and the time it will take?

❑ Did you choose a sample or a population?

❑ How will you display the data?

❑ Can you interpret your data and draw a conclusion?

Jennifer's Salmon Stand

Jennifer was planning to raise money for a school ski trip. She had an opportunity to set up a bake sale at a school track and field event. Her grandfather, a very good fisherman in her First Nations community, suggested that she should offer traditional types of salmon at her table. He even promised to give her the fish and help her prepare it in a variety of ways.

Jennifer had a problem: Would the kids like her salmon? How much should she ask her grandpa to catch? How should it be prepared?

What other problems could she potentially foresee with this business idea?

Jennifer talked to her math teacher about it and due to the fact that her school had a lot of students (**the population: the whole group you are interested in**) and had many grades. She decided to do a survey in her own classroom (**a sample: part of the population**) to help her answer her questions. A census **(a census: counts the whole population)** did not make sense because it would include everyone in the school (**population**) and would take a lot of time and effort.

Steps and Questions for discussion:

♦ Ask everyone in your class to mark down their favourite preparation of salmon. Let them choose from only three options: a) salmon jerky b) smoked salmon c) baked salmon.
♦ Write the results down on a tally sheet.
♦ Use the results to predict the how many people at the track and field event will choose each flavour.
♦ Engage the students in the class about the kinds of people that will be at the track and field event.
♦ Discuss as a class or in groups whether or not your class is a good sample for Jennifer to study.
♦ Could she survey a different sample of students in her school to get a result that will be closer to the population that will be attending the track and field event?
♦ Does it make sense for Jennifer to use a sample instead of asking the population of the school?
♦ Is a large sample more likely to be better than a small one?

Using Samples to Collect Data

Name: _____   Date: _____

Each group will need 50 marbles to represent a population of fish. One color of marbles will represent male salmon and the other color marbles will represent female salmon. You will not know the ratio of male to female in your population.

Without peeking, choose a sample of 10 fish from your population. Record the numbers of male and female fish in the table and use this to estimate the percent of male and female fish in the population.

Repeat step 1 but use a sample of 20 fish.

Repeat step 1 but use a sample of 40 fish.

	# of Males	# of Females	Male %	Female %
10-fish sample				
20-fish sample				
40-fish sample				

Which estimate of the percent of male and female fish in the population do you think is most reliable, the 10, 20, or 40-fish sample? Why?

Count the actual number of male and female fish in the whole population and calculate the actual percent of male and female fish.

	# of Males	# of Females	Male %	Female %
Whole population				

Does this agree with your prediction that the greatest sample is the most reliable?

_____

How could you check that the greatest sample size is usually the most reliable?

Salmon Probability Game

Goal: |To use experimental probability to estimate the numbers of species of salmon in a "fish tank."

Materials: you will need a box or lidded bin, as well as at least 30 marbles or tokens with three colours (each colour to represent a type of salmon)
> Red: Sockeye
> Green: Chum
> Black: Spring

Number of Players: 4

Rules of Play:

1) Choose one player to be the fisher. The fisher selects any 30 marbles from a selection of marbles in three different colors. A possible example: the fisher could choose 5 red (Sockeye) marbles, 12 green (Chum) marbles, and 13 black (Spring) marbles. No other player should know how many marbles of each color are selected. The dealer places the 30 "fish" in a **covered** "fish tank" (e.g., box or lidded bin container) from which samples will be drawn.

2) Each player records a guess of how many fish of each species are in the container. Players should not share their guesses.

3) The players take turns selecting one salmon from the fish tank, then **returning** the salmon. (The fisherman must make sure the players cannot see what is in the container). Players note which species was selected each time. Stop after 10 fish have been selected and returned.

4) Players now adjust their initial guesses by considering the colours of the cubes selected.

5) Repeat Steps 3 and 4 two more times.

6) Players compare their final estimates with the actual numbers of salmon to calculate their points. The player with the fewest points wins.

For example, one player's data might look like this:

	Initial Guess (before the draw)	**Actual number of salmon in the tank**	**Player's final estimate**	**points (difference between actual # and estimate)**
Sockeye	10	5	4	1
Chum	12	12	11	1
Spring	8	13	15	2

Total points: 4

7) Repeat the game until everyone has had the opportunity to be the fisher.

8) Share your strategies with the other players. Whose strategy worked best?

Supplemental Unit

Context

The ready availability of safe, clean drinking water in our homes is something that many of us take for granted. But recently publicized cases of deficient infrastructure and water contamination, particularly within First Peoples communities in various parts of Canada, have highlighted the need for greater awareness of the issue at all levels — including among members of the public. For although specialized knowledge and expertise are needed to ensure that community water collection and distribution systems are properly designed and built, understanding what is involved in managing the water system for a small (and likely isolated) community on a day-to-day basis is well within the capacities of an attentive high school student.

This unit takes this premise to heart. Using a compilation of self-paced interactive learning materials (originally designed to train on-site community water system personnel), it allows students to explore the application of Grades 8-9 mathematics concepts in
♦ calculating community needs and consumption
♦ treating water to ensure it is free of pathogens
♦ monitoring flows within a stand-alone water system to be sure the water remains safe for people to drink.

Because this unit uses self-paced electronic media incorporating HTML and Flash (a mixture of graphics, text, animation, and interactive Q&A screens, all available on a single CD that can be copied or loaded onto several computers as needed), it can be readily used to support individualized learning for students. Much of the student work in the unit can be completed independently on computer, and because the instructional content deals with the full range of mathematical processes involved in completing set challenges, students who need to review precursor math skills (i.e., skills covered at earlier grade levels, such as working with fractions and calculating percentages) will be able to do so on their own. Further, the Excel worksheet files included on the CD allow students to produce and submit an electronic file for assessment.

At the same time, the teacher support material provided here suggests ways in which you can create opportunities for having students "return" periodically from their computer explorations to
♦ report on their success in meeting interim challenges you have set for them
♦ participate in group activities that will support their learning.

Resources

The primary resource for these units is the computer disc supplied with this printed resource. This disc contains the following electronic materials:
♦ The Water Keepers — an interactive program exploring the various aspects of small community water systems, and the mathematical operations required to work such a system
♦ The Safe Water Challenge — a simulation that introduces learners to drinking water safety issues in First Nations communities, particularly sampling and testing processes
♦ two Excel files (one for grade 8 and one for grade 9) for students to use as part of the unit procedure

The materials on this disc are **copyright free,** and you are encouraged to make as many copies as you need for your students (e.g., copy the materials onto multiple school computers, copy for students to take home to use on their own computers).

Prescribed Learning Outcomes

The **grade 8 portion** of this unit can be used to help students achieve the following Prescribed Learning Outcomes for Mathematics 8:

A1   demonstrate an understanding of perfect squares and square roots, concretely, pictorially, and symbolically (limited to whole numbers)

A2   determine the approximate square root of numbers that are not perfect squares (limited to whole numbers)

A3   demonstrate an understanding of percents greater than or equal to 0%

A4   demonstrate an understanding of ratio and rate

A5   solve problems that involve rates, ratios, and proportional reasoning

A6   demonstrate an understanding of multiplying and dividing positive fractions and mixed numbers

B1   graph and analyse two-variable linear relations

B2   model and solve problems using linear equations of the form:
  – $ax = b$
  – $\frac{x}{a} = b, a \neq 0$
  – $ax + b = c$
  – $a(x + b) = c$
  concretely, pictorially, and symbolically, where *a*, *b*, and *c* are integers

C3   determine the surface area of
  –   right rectangular prisms
  –   right triangular prisms
  –   right cylinders
  to solve problems

C4   develop and apply formulas for determining the volume of right prisms and right cylinders

D1   critique ways in which data is presented

The **grade 9 portion** of this unit can be used to help students achieve the following Prescribed Learning Outcomes for Mathematics 9:

A4   explain and apply the order of operations, including exponents, with and without technology

B1   generalize a pattern arising from a problem-solving context using linear equations and verify by substitution

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

D1   describe the effect of
  –   bias
  –   use of language
  –   ethics
  –   cost
  –   time and timing
  –   privacy
  –   cultural sensitivity
  on the collection of data

D2   select and defend the choice of using either a population or a sample of a population to answer a question

D3   develop and implement a project plan for the collection, display, and analysis of data by
  –   formulating a question for investigation
  –   choosing a data collection method that includes social considerations
  –   selecting a population or a sample
  –   collecting the data
  –   displaying the collected data in an appropriate manner
  –   drawing conclusions to answer the question

Grade 8 Unit

Introduction to the Water Keepers

If possible, begin the unit with a presentation by a local Elder or community member, talking about
♦ the traditional importance of water
♦ ways in which water resources were managed in the past
♦ how water is managed today.

Alternatively, begin by having students work in small groups to create a mind map around the term "water." Provide time for groups to share their responses with the rest of the class.

Demonstrate the first part of the media resource, Water Keepers Part 1, until it's clear that students understand the format and what's expected of them. (Access this resource by running the "Start_CD" file from the main directory of the disc.)

Have students complete Part 1 of the Water Keepers resource on their own or in pairs. Depending on the computers you have available, you can accomplish this by
♦ having students work in the school computer lab
♦ having students take the resource home to use on their own computers, or to a library or community centre computer
♦ completing the resource as a whole class using a projector or smart board.

Advise students that you will be reviewing the various math concepts as a class in subsequent lessons, but if they have any particular questions they should make note of them.

After all students have completed the resource, debrief as a whole class. Questions for debrief could include
♦ What was the most surprising thing you learned?
♦ Did this activity change your views about water, water use, and water stewardship?
♦ What do you know about how water is managed in the local community?

Math Concepts

PLOs: A1 to A6

Explain to students the concept behind a square and square root. Show students using grid paper or an online grid table, how to draw a square that is 3 x 3. Expand this grid to 7 x 7, and another grid to 12 x 12. Have students compare the three squares. Using area (L x W) show how the answer is the same as squaring the one side. Have students predict using a table of values other squares.

Distribute the 100 Grids handout (provided at the end of this unit), or have students create their own in a 10 x 10 square on graph paper. Have students colour 37 squares in the first grid. Explain how this represents 37/100 or 37%. Have students colour 2 other numbers and show them as percentages. Show students how fractions and percentages add up to a whole, using the coloured and uncoloured squares.

Remind students that, in order to convert a fraction into percent, the numerator must be divided by the denominator then multiplied by 100. Show some examples on the board. Demonstrate how to

return to a fraction from a percentage. Then provide students with additional fractions to convert to percentages, and show them representationally on the grids.

Use the Ratios handout provided with this unit to review ratios and equivalent amounts.

Extensions

Students can go to www.arcademicskillbuilders.com/ to practice ratios, equivalent fractions and proportions in individual and team games.

Students can go to www.funbrain.com/tictactoe/index.html and using the links, play tic tac toe against the computer to practise squares and square roots.

Students can go to www.mathplayground.com/percent_shopping.html (level 1 and level 2) to practise using percentages.

Water Keepers Part 2

Have students complete the Water Keepers Part 2 (as per Part 1). Again, ask them to keep track of any questions they have about the math concepts raised.

Provide an opportunity for class debrief before moving on to the next lesson.

Math Concepts

PLOs: B1, B2

As Canada's population grows, access to fresh water declines. This relationship is evident in both arid and wet climates. This activity will introduce students to the relationship between population growth and water availability for community use.

Have students access the Statistics Canada data for "population served by drinking water plants, by source water type and drainage region — surface water" (www40.statcan.gc.ca/l01/cst01/envi33b-eng.htm). This page contains a table of data on the number of people served by surface water sources in different areas of Canada. Look at the 4 regions of British Columbia listed:

British Columbia Regions	2005	2006	2007
Pacific Coastal and Yukon[2]	2,315,837	2,345,382	2,371,455
Fraser-Lower Mainland[3]	801,593	817,507	825,720
Okanagan-Similkameen	188,894	194,989	201,328
Columbia	106,501	107,191	106,860

Have students create line graphs to display the data. Be sure to point out the need for scale, and proper labeling of axis. Use the graphs to answer the following questions:

1. What does your graph show?
2. What are the trends in population relying on surface water over time?

3. Is the difference between the regions consistent over time, or is one growing more than others?

4. What might be some reasons for the gap between regions?

5. Using the data given, and the trends shown, what would be a good prediction of population using surface water for each region in 2015?

Now have students access the data for "population served by drinking water plants, by source water type and drainage region — ground water" (www40.statcan.gc.ca/l01/cst01/envi33c-eng.htm). Have students recreate the graphs using the same regions and years, but with the groundwater data. Advise students whether they should show both data sets on the same graph per region, or other variations to show relationships.

Discuss as a class: How are the graphs different? The same? Why is there no data for the one region? How do the predictions for 2015 change?

Key:
1. Graphs show a general upwards movement.
2. There is an annual increase in the number of people who use surface water as their main water source.
3. The Columbia region remains static, with little to no change. The Pacific Coastal/Yukon area increased by the greatest number of people, but showed the same approximate percentage increase as the remaining regions.
4. Reasons could include (but are not limited to) increased population growth due to job increases (oil and gas industry), urbanization, and immigration to province.
5. Approximate figures could be:
   - Pacific Coastal/Yukon: 2 580 000
   - Fraser Valley: 935 000
   - Okanagan-Similkameen: 251 000
   - Columbia : 108 500

Safe Water Challenge

Have students complete the Safe Water challenge, as per the Water Keepers media resources (access by running the "Start_CD" file from the Safe Water directory on the disc).

Math Concepts — Data Analysis

PLO: D1

Review with the class how to read a co-ordinate point graph, and how to create and plot a table of values.

Pose the hypothetical situation attached to the class. Explain that in any community, the water supply is regularly tested to monitor levels of dangerous organisms and parasites. Two of these organisms are fecal coliforms and e-coli.

In a simulated water quality situation, a water quality technician sampled the water supply and determined the levels found in the Excel worksheet (provided in the root directory of the disc accompanying this resource guide). Have students use the Excel sheet, chart the data, and answer the questions associated. Distribute the Graphing Tutorial Using Excel handout to help guide them through this process.

Water Keepers Part 3

Have students complete the Water Keepers Part 3 (as per Parts 1 and 2). Again, ask them to keep track of any questions they have about the math concepts raised.

Provide an opportunity for class debrief before moving on to the next lesson.

Math Concepts — Cylinders

PLOs: C3 C4

Have students brainstorm cylindrical items and their uses. Tell students that the class will be calculating the size of the objects based on surface area and volume.

Review volume and surface area formulas with examples.

Provide students with a number of cylindrical objects (various food & drink cans, water bottle, film canister, Dutch oven, cookie tin, etc.). Have students measure the items and record their measurements in a chart with the following headings:
- Description
- Diagram
- Radius
- Height
- Circumference
- Surface Area
- Volume

In addition, provide students with measurements from a number of larger real-world cylindrical objects to include in their calculations (e.g., grain silo radius 8 m, culvert radius 1.2 m, propane bottle radius 45 cm, railway tunnel radius 3.75 m).

Students can then do the calculations for volume and surface area of the items. Remind students that they need to use the same unit of measurement for all items (metres or centimetres) to ensure proper scale on their graphs.

Together as a class, plot the items measured and the large examples on a graph. Use volume on the Y axis, and radius on the X axis. What trend can the students see? Explain and draw the line of best fit as an exponential growth curve.

Grade 9 Unit

Introduction to the Water Keepers

If possible, begin the unit with a presentation by a local Elder or community member, talking about
♦ the traditional importance of water
♦ ways in which water resources were managed in the past
♦ how water is managed today.

Alternatively, begin by having students work in small groups to create a mind map around the term "water." Provide time for groups to share their responses with the rest of the class.

Demonstrate the first part of the media resource, Water Keepers Part 1, until it's clear that students understand the format and what's expected of them. (Access this resource by running the "Start_CD" file from the main directory of the disc.)

Have students complete Part 1 of the media resource on their own or in pairs. Depending on the computers you have available, you can accomplish this by
♦ having students work in the school computer lab
♦ having students take the resource home to use on their own computers, or to a library or community centre computer
♦ completing the resource as a whole class using a projector or smart board.

Advise students that you will be reviewing the various math concepts as a class in subsequent lessons, but if they have any particular questions they should make note of them.

After all students have completed the resource, debrief as a whole class. Questions for debrief could include
♦ What was the most surprising thing you learned?
♦ Did this activity change your views about water, water use, and water stewardship?
♦ What do you know about how water is managed in the local community?

Math Concepts – Order of Operations

PLO: A4

Review the Water Keepers content that dealt with order of operations. Explain that the order of operations rule is "just one of those things" in mathematics — it seems arbitrary and without reason, but not following the rule can result in some very incorrect calculation.

Review "BEDMAS" as a way of remembering the order of operations:
B = **B**rackets
E = **E**xponents
D, M = **D**ivide, **M**ultiply (these two can be reversed)
A, S = **A**dd, **S**ubtract (these two can be reversed)

To illustrate how different results will be achieved using the correct vs. the incorrect order of operations, demonstrate the following example:

$$3^2 - 3 \times (8 - 6) = ?$$

Using BEDMAS, we do the brackets first, then the exponent, then the multiplication, then the subtraction:

$$3^2 - 3 \times (8 - 6) \text{ (perform within brackets or parenthesis)}$$
$$= 3^2 - 3 \times 2 \text{ (evaluate the exponent)}$$
$$= 9 - 3 \times 2 \text{ (perform multiplication)}$$
$$= 9 - 6 \text{ (perform subtraction)}$$
$$= \mathbf{3}$$

If however we do the problem from left to right, ignoring the order of operations rules, we'd end up with this:

$$3^2 - 3 \text{ x } (8 - 6) = ?$$
$$= 9 - 3 \text{ x } (8 - 6)$$
$$= 6 \text{ x } (8 - 6)$$
$$= 48 - 6$$
$$= \mathbf{42}$$

That's quite a difference!

Even if you remember to do the brackets first, if you don't do the rest of the operations in order, you'll still get an incorrect result:

$$3^2 - 3 \text{ x } (8 - 6) = ?$$
$$= 9 - 3 \text{ x } (2)$$
$$6 \text{ x } (2)$$
$$= \mathbf{12}$$

Remind students that a calculator will perform operations in the order they are given, and will not factor in BEDMAS. That's another reason to "know the math" rather than relying on a calculator to provide the answer. They can still use calculators to solve a problem like this one, so long as they enter the operations in the correct order.

Provide additional exercises for practice:

$12 + (6 \div 2)$

$12 \div 2 \times (8 \div 2)$

$4 + 4^2$

$(3 - 2)^2 \times 9 \times 10$

$(3^2 - 3) \text{ x } (5 + 10)$

As an extension, challenge students to create their own order of operations problems for each other.

Water Keepers Part 2

Have students complete the Water Keepers Part 2 (as per Part 1). Again, ask them to keep track of any questions they have about the math concepts raised.

Provide an opportunity for class debrief before moving on to the next lesson.

Math Concepts – Linear Equations and Linear Inequalities

PLOs: B1, B2, B3

There are several ways to show how people's behaviour can affect the amount of water that is used. Something as simple as turning off the water during brushing one's teeth can make a significant difference. On larger scales, the conversion of regular toilets to low flush options in a mall, office building or school can make even more dramatic differences.

Have students research average household water usage for the local community. Alternatively, provide them with the handout, Average Water Usage, provided at the end of this unit. Ask students to develop the formula to determine the amount of water used in a day by a regular toilet flushed 6 times (30 L x 6=180 L). Have students determine the formula and amount of water used in one week given the same amounts (180L x 7=1260 L). Now change the toilet to a low flush toilet (6 L x 6=36 L). To be sure the students understand which variable represents the amount of water used per flush, ask which number would change if the toilet was only flushed 4 times (6 L x 4=24 L), clarifying as needed. Determine the formula and amount of a weekly value (36 L x 7=252 L).

Because there is a range of values, have students brainstorm ideas as to why the differences are so wide in range. Ask students if they know of any ways to reduce the amount of water used and record the answers. Some suggestions that were given out in water seminars and municipal pamphlets in the past have included the use of water displacement items in the holding tanks of toilets.

For example, placing a filled 1 L plastic milk jug or 1.5 L water bottle into the tank would save that amount of water each time. Or, if those don't fit, placing large rocks would do the same thing. If a large rock displaced 1.13 L of water, how would that affect a regular toilet that normally would use 19.5 L of water? (No displacement (19.5 L x 6 = 117 L) (117 L x 7 = 819 L) With displacement (19.5 L-1.13 L) x 6=110.22L) then (110.22 L x 7 = 771.54 L). What would the difference be using the same parameters over a given week? (819 L – 771.54 L = 47.46 L) Over a given year? (47.46 L x 52 = 2467.92 L)

Have students determine how much water would be saved if all toilets in your school used water displacement, or were converted to low flush options, using the Excel spreadsheet provided in the main directory of the disc.

Safe Water Challenge

Have students complete the Safe Water challenge, as per the Water Keepers media resources (access by running the "Start_CD" file from the Safe Water directory on the disc).

Data Collection Project

PLOs: D1, D2, D3

Review the questions had about water and water management at the beginning of the unit. Ask: What questions are still outstanding? What else would they like to find out? What can be tested mathematically? How would they design a survey to find out?

Allow time for students to share their ideas, and then divide the class into small groups based on similar topics of interest. Explain that their task is design and implement a data collection plan on their chosen water-related topic chosen by the student. Advise students whether they will be conducting their survey "in real life" or in a simulated context (e.g., with other groups in the class, with other grade 9 math classes).

For example, students might choose to investigate
♦ community members' confidence in the safety of their water
♦ community members' attitudes toward management of the water system
♦ water usage by type of household or business
♦ numbers of people who have gotten sick from water-borne viruses & bacteria

Discuss the steps for a data collection plan:
♦ formulating a question for investigation (What do they want to find out?)
♦ choosing a data collection method that includes social considerations (What is the best method to use for their question? An online or text-in survey may be more appealing for younger respondents but may alienate older residents; vice versa for a door-to-door survey. Do they need to provide translation of the survey in other languages? Are the survey questions sensitive, requiring some way of protecting the respondents' privacy? etc.)
♦ selecting a population or a sample (Review the terminology, and discuss the advantages and disadvantages of each. A population will gather more accurate data than a sample, but it is often difficult or impossible to target the entire population.)
♦ collecting the data
♦ displaying the collected data in an appropriate manner (What is the best method for their question? A bar graph? Line graph? Circle chart? What types of graph are best for what types of information? etc.)
♦ drawing conclusions to answer the question (What do the survey results say about the question asked? How might this information be used to better the community?)

Assist students as they prepare their survey questions, ensuring they have worded them in a way that will result in clear and usable data.

Provide time for students to conduct their surveys, tabulate the results, and present them to the rest of the class. The handout, Using Excel to Create Graphs (provided at the end of this unit) may assist students if they choose to use Excel to tabulate and then present their survey results.

As an extension, students can present their findings to a wider audience via a (real or simulated) town hall meeting, band council meeting, letter to the local newspaper, etc.

100 Grids
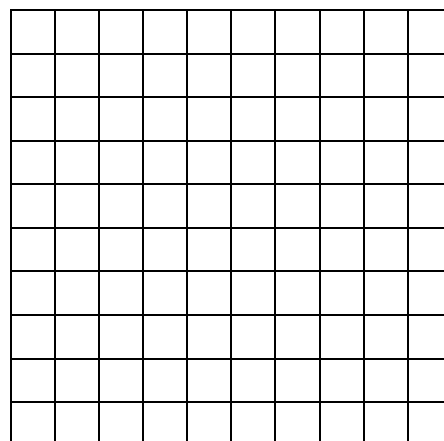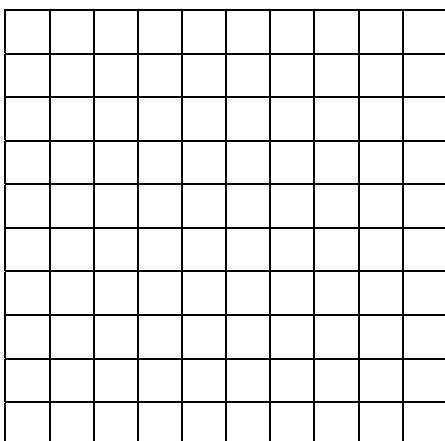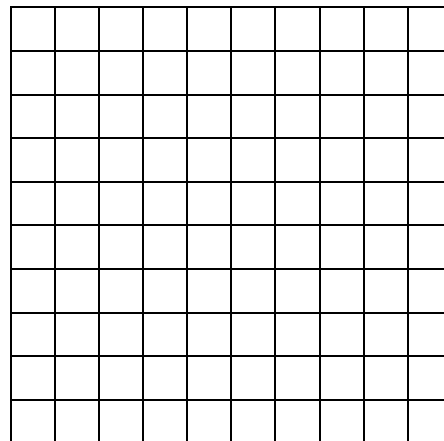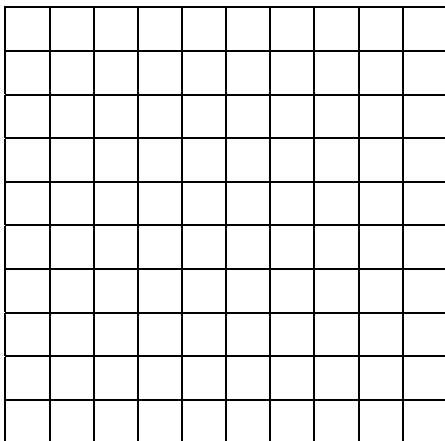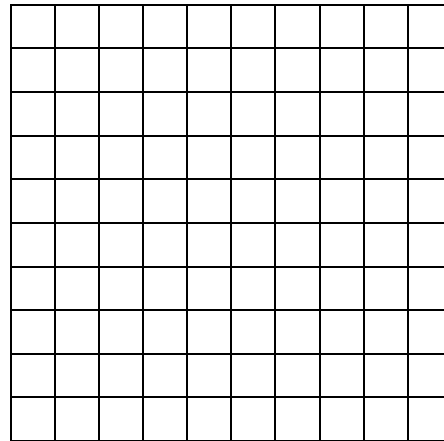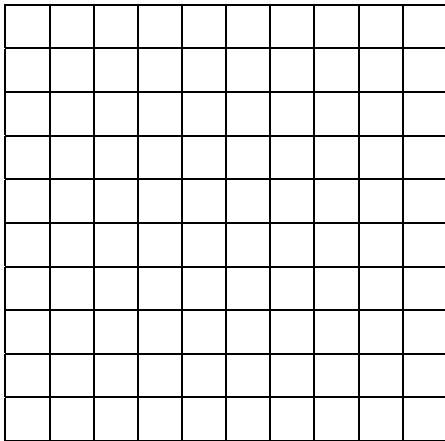
What is Ratio?

Ratio is a way of comparing amounts of something. It shows how much bigger one thing is than another.

Ratio is the number of **parts** to a mix. For example, a 2-stroke boat motor uses mixed gas. This mix is 51 parts, with 50 parts gas and 1 part oil.

The order in which a ratio is stated is important. For example, if the ratio of gas to oil is 50:1, this means for every 50 measures of gas there is 1 measure of oil or 50 + 1 = 51 parts in all.

The amount of gas and oil we need increase in direct proportion to each other. This means you must multiply both amounts by the same value. Create a table of values to show how much gas and oil is needed for a series of amounts.

Gas (L)	Oil (L)
100	2
75	
	6

Simplifying ratios

We can often make the numbers in ratios smaller so that they are easier to compare. You do this by dividing each side of the ratio by the same number, the highest common factor. This is called **simplifying.**

Example: In a class the ratio of female to male members is 12:18. Both 12 and 18 can be divided by 2.

12 ÷ 2 = 6
18 ÷ 2 = 9

So a simpler way of saying 12:18 is 6:9.

To make the ratio simpler again, we can divide both 6 and 9 by 3

6 ÷ 3 = 2
9 ÷ 3 = 3

So a simplest way of saying 12:18 is **2:3**. These are all **equivalent ratios**, they are in the same proportion. All these ratios mean that for every 2 female members in the class there are 3 males:

12:18 ➜ 6:9 ➜ 2:3

2:3 is easier to understand than 12:18!

Be careful! When working with ratios **keep both the words and the numbers in the same order** as they are given.

Grades 8 and 9

Using Excel to Create Graphs

Step 1 – Start Excel & then Insert your data into columns A & B.

Make sure you leave row 1 blank.

Step 2 – Highlight all your data in both columns by left clicking in the top right hand corner of cell A1 and dragging to the bottom right hand corner.
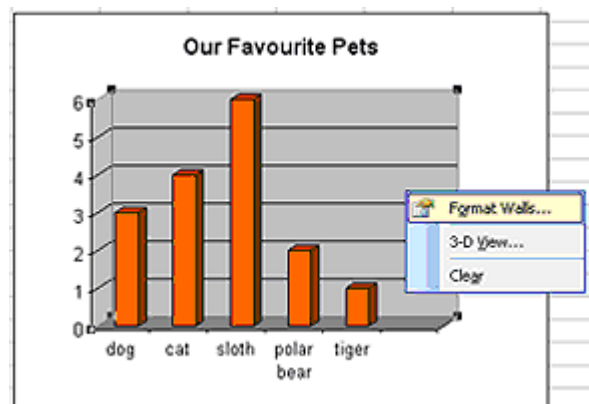
Step 3 – Press the Chart Wizard button to convert the data into a graph.

Step 4 – Choose a graph that will communicate the meaning of the data effectively.

Step 5 – Press Next

Step 6 – Write in the title of your graph and press "Next"

Step 7 – Right click on any column and choose "Format Data Series' then choose the colours of the graph.

Average Water Usage

Typical home water use in Metro Vancouver

Fixture/Appliance	Range of Litres Used
Drips	
Fast drips	750 litres per week
Steady stream	3785 litres per week
Indoors	
Toilet flush	6 to 30 litres per flush
Fraction of leaking toilets	up to 30%
Showering	5.7 to 18.9 litres per minute
Bathtub	115 to 190 litres per full tub
Washing machine	170 to 190 litres per cycle
Dishwasher	40 to 55 litres per cycle
Kitchen faucet	7.6 to 11.3 litres per minute
Bathroom faucet	7.6 to 11.3 litres per minute
Slow & steady drips	280 litres per week
Outdoors	
Car washing	approximately 400 litres per car
Lawn watering	10 to 35 litres per minute

from www.metrovancouver.org/services/water/conservation/Pages/residential.aspx

Resource
Suggestions

Although there are many academic resources dealing with ethnomathematics and related education theory, the number of classroom support learning resources related to teaching Grade 8-9 mathematics from an aboriginal perspective is relatively limited. This brief list includes only resources providing practical advice that can be immediately applied in a mathematics teaching situation (e.g., lesson planning ideas or math-related content accessible to a Grade 8-9 student). This list is neither exhaustive nor authoritative, but it is hoped that the sources cited here will prove useful. Where possible, annotations have been provided.

Online Resources

"Fish Trap" — Cowichan Valley School District
www.sd79.bc.ca/programs/abed/acip/grade7/math7_Lessons/ktunaxa_fish_trap7.html
www.sd79.bc.ca/programs/abed/acip/grade8/math8_lessons/ktunaxa_fish_trap8.html
www.sd79.bc.ca/programs/abed/acip/grade9/math9_lessons/ktunaxa_fish_trap9.html

> These are three district-developed online lessons that deal with circle mathematics and the Pythagorean theorem. The three sites include links to sketches of fish traps and videos showing models of different types of trap. The instruction is focused on finding the height of a conical fish trap. There are examples using Pythagorean theorem, and trigonometry to find the height of the trap. Students can then use the same formulas and strategies to generate their own word problems in relation to fish traps as well as other examples in their communities. You could take the information presented and create many extensions including having students build their own model fish trap.

Seminole Patchwork
www.austincc.edu/hannigan/Presentations/NSFMar1398/MathofSP.html

> From Austin Community College, this site features strip pattern designs along with the native stories that explain the pattern. The section "Symmetries of Culture" gives the background of strip patterns and how they can be manipulated through different combinations of reflection, rotation, translation, and glide. There is a well laid out and easy to use activity hidden at the very bottom of the homepage on how to make a bookmark.

Virtual Bead Loom — www.csdt.rpi.edu/na/loom/index.html

> An interactive website where students choose a basket design, then replicate it using coordinate geometry. They can choose the coordinates of points, lines, and shapes on the grid, and choose fill colors. Easy to use, yet challenging enough to be engaging. There are many references to the cultural background through information and photographs. The tutorial can be used by teachers and students to find all the parts of the website. The "Beginners Software" link uses one quadrant of the grid, whereas the "Software" link uses all 4 quadrants (more suitable for Gr 8, and it's actually easier to keep track of the points). In the "Teaching Materials" link there are many well done lesson plans for using the virtual bead loom.

Pacific Northwest Basketry — www.csdt.rpi.edu/na/pnwb/weavework.html

> This is an interactive website where students choose a basket design, then replicate it using coordinate geometry. They can choose the coordinates of points, lines, and shapes on the grid, and choose fill colors. It is easy to use, yet challenging enough to be engaging. The site includes good cultural background information and photographs.

Show Me Your Math — contest information and samples of submitted student work (This resource, made available on the web by Atlantic Canada's First Nation — http://firstnationhelp.com/ — was originally hosted at http://schools.fnhelp.com/math/showmeyourmath/index.html, but has migrated to a new web address, as of August 2011. Search "Show Me Your Math" to locate.)

This web site provides an example of a multi-grade "Find the Math" project, in which First Nations students were challenged to seek out connections between the thinking covered in their school mathematics curriculum and the local community (both the Indigenous Knowledge base and the day-to-day activities that community members engage in). The project was run as a contest, which provided added motivation for students to participate.

Possible uses with students include showing the video and challenging students to
♦ come up with ideas about math in their communities and produce a poster that highlights the math and the connection to their lives. These could then be displayed at a math evening, parent-teacher night, or student showcase to bring the math full circle back to the communities.
♦ use their own cameras to take pictures around the community. These photos can be printed and posted around the class. Over the ensuing week or month students are then asked to create and post under each photo lists of questions that bring out the math in the photos. For example, a photo of fish drying on racks could elicit a list of questions such as
  • How many fish pieces are on each stringer? How many stringers of fish pieces are there? So how many fish pieces are there altogether?
  • How long will the fish have to dry?
  • How much money could you charge for a bag of dried fish?

As an extension to this project, a book could be produced using the photos and questions and used in the elementary schools.

PAVE Math 9 (Peace Wapiti School Division, Alberta)
http://ecommunity.pwsd76.ab.ca/mod/tab/view.php?id=27592

This school district-designed site has some good aboriginal content – looks at Four Host Logo (rotation symmetry, similar polygons, etc.), Medicine Wheel (circle geometry). Registration is required for full access, but there is still considerable content available to guests.

Native Access (Faculty of Engineering and Applied Science, Queen's University)
www.nativeaccess.com/teachers/curriculum.html

This award-winning webs site offers over engaging 25 lessons on a variety of math and science subjects, most containing First Nations content or information relevant to First Nations communities. Each topic and ready-to-use lesson plan comes with a newsletter, student worksheets, and teacher's guide with answer key.

Village Math (University of Alaska – Fairbanks)
www.ankn.uaf.edu/publications/VillageMath/

This website contains situational and real life examples mixed with traditional history, mostly relating to northern or isolated living, often on-reserve. All materials are easily accessible and free to use. Many of the 25 chapters contained at the site are suited for teacher-lead activities and examples, while others can be used as student assignments. Students with below grade level reading abilities should not find the exercises, instructions, or questions difficult to understand.

Print Resources

Adams, B.L., Lipka, J. (2003). *Building a Fish Rack (Grade 6/7).* Calgary: Detselig Enterprises Ltd.

> Contains: Building a Fish Rack Text, 1 CD (Yup'ik Glossary, 3 posters (Fish Racks, Salmon Life Cycle, The Five Salmon Species. Kit: 978-1-55059-258-0, $34.95

Adams, B.L., Lipka, J., Rickard, A., & Gilliand, K. (2005). *Salmon Fishing : Investigations into Probability – A curriculum module for Grades 6 and 7.* Alaska: The University of Alaska Fairbanks.

> Contains: Salmon Fishing Text, 2 CDs (Yup'ik Glossary, Excel Template), 2 posters (Salmon Life Cycle, The Five Salmon Species Kit: 978-1-55059-305-1, $32.95

BC Ministry of Education. (2006) *Shared Learnings* (see www.bced.gov.bc.ca/abed/documents.htm for further information and a downloadable version)

> This resource was designed to promote understanding of BC Aboriginal peoples and their cultures, values, beliefs, traditions, history, and languages. It includes curriculum-specific information for incorporating Aboriginal content in the full range of K-10 subject areas.

Gilbert, Jim and Clark, Karin. (2001) *Learning by Designing: Pacific Northwest Coast Native Indian Art* — Volume 1. Union Bay: Raven Publishing.

> Although its primary focus is on visual arts and design, this teacher guide also contains ideas for applications in a mathematics context (e.g., 2-D shapes, tesselations).

Lumpkin, Beatrice and Strong, Dorothy. (1995) *Multicultural Science and Math Connections: Middle School Projects and Activities.* Maine: J. Weston Walch

> The focus of this resource is middle school years. It provides projects and activities from Africa to the Arctic. Seventeen underrepresented cultures are included in this resource. This resource leans more towards science but still has many valuable math lessons that can be used as they are modified easily. It is very practical and contains material that can be reproduced. An example of a lesson title is "American Indian Games and Laws of Probability: Group Project."

Zaslavsky, Claudia. (1998) *Math Games and Activities from Around the World.* Chicago Review Press, Inc.

> This book is written for use with students aged nine and up. It offers information on math-related games of chance and strategy games that go back 3300 years. Cultures represented include Africa, Asia, Europe, North America and Polynesia. The book also includes activities. Many games require two kinds of counters or markers but all are designed to be simple for teachers or students to set up.

Print Resources Related to the Mathematics of Local Mapping

Aberley, D. (1993). *Boundaries of Home: Mapping Local Empowerment.* Gabriola Island, BC: New Society Publishers.

Barrett, K. (1992). *Mapping Animal Movements.* Berkeley, Calif.: Lawrence Hall of Science.

Cobden, D., Mosley, S., and Sutherland, E. (1998). *Maps and Plans (Starting from mathematical ideas).* London: Beam Publishers.

Fanelli, S. (1995). *My Map Book.* USA: HarperCollins Publisher.

Gonzales, N.A., Mitchell, M. & Stone, A.P. (2001). *Mathematical history* (2nd ed.). Reston, VA: National Council of Teachers of Mathematics, Inc.

Harrington, S. (1999). *Giving the Land a Voice: Mapping Our Home Places.* Salt Spring Island BC: Land Trust Alliance of BC, Salt Spring Island Community Services.

Harrington, S., Stevenson, J. (2005). *Islands in the Salish Sea; A community atlas.* Salt Spring Island: TouchWood Editions.

Hoffman, J. & Jones, K. (2001). *Barefoot Mapping.* Canada: The Sierra Club of BC.

Mock, J. & Johnson, J. (2000). *Math trails: One path for making connections.* Bellingham, WA: Hold That Thought Publishing Co.

Neel, K., Wood, M. (2004). *For Langley BC Numeracy Walk.* Fort Langley, BC.

Rawlins, N., Wheatley, N. (1992). *My Place.* New York: Kane/Miller Book Publishers.

Sobel, D. (2004). *Place-Based Education: Connecting Classrooms & Communities.* USA: The Orion Society.

Stetcher (1983). *Mapping Small Places: Teachers.* Hampshire: Thompson Publishing Services.

Szeta, S. & Little, C. (2001). *Take a mathwalk: To learn about mathematics in your community.* Toronto, Canada: Trifolium Books Inc. [available at www.triboliumbooks.com]