MATH FIRST PEOPLES

TEACHER RESOURCE GUIDE

ELEMENTARY & SECONDARY

Acknowledgments

2011 Acknowledgments

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The K-12 Mathematics curriculum is available online at www.curriculum.gov.bc.ca/curriculum/mathematics. See also www.fnesc.ca/learningfirstpeoples/ for a range of First Peoples classroom resources.

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Introduction

Goals and Rationale for this Guide

This document is designed for teachers of Mathematics in British Columbia (BC). It has been developed by the First Nations Education Steering Committee (FNESC), supported by the BC Ministry of Education. It is grounded in the view that increased student success can be achieved through adjustments in pedagogy and approach that make mathematics feel more inclusive and engaging. Development of this resource has been guided by the recognition that

- teaching and learning with respect to First Peoples in British Columbia's school systems should be based on authentic knowledge and understanding, as articulated by Elders, educators, and other content experts from within British Columbia's First Nations and Métis communities
- decisions affecting teaching and learning with respect to First Peoples in British Columbia's school systems should take appropriate account of the advice of community leaders from within the province's First Nations and Métis communities
- while commonalities exist, First Peoples' cultures within BC are extraordinarily diverse.

The 2020 revision of this document also supports implementation of the Calls to Action of the Truth and Reconciliation Commission, specifically the call to "integrate Indigenous knowledge and teaching methods into classrooms" (clause 62) and "build student capacity for intercultural understanding, empathy, and mutual respect" (clause 63).

Accordingly, the goals of this guide are:

- to contribute to reconciliation for all by building greater understanding of the skills, knowledge, and perspectives of First Peoples for all students
- to ensure the inclusion of First Peoples knowledge and perspectives is done respectfully and without appropriating First Peoples knowledge
- to encourage and support the respectful development of local teaching and learning resources
- to provide support for the implementation of the BC mathematics provincially prescribed curriculum

Supporting Teacher Professional Learning and Reflection

Many non-Indigenous teachers are aware

- of limitations in their own knowledge of First Peoples' cultures, communities, histories, and knowledge
- that there exists considerable diversity among First Peoples in BC (making it inappropriate to base teaching on broad generalizations).

This resource guide cannot fulfill all the learning needs of educators new to including First Peoples knowledge/perspectives in classrooms. Teachers are encouraged to undertake their own professional learning alongside the learning of their students. This learning can take the form of formal learning experiences such as professional development opportunities or courses focussed on First Peoples' cultures, or other learning experiences such as engaging in professional discussions with colleagues or connecting with local First Nations communities or Indigenous organizations.

Teachers are often anxious about perpetuating misconceptions, making mistakes, or giving offence when approaching First Peoples topics. That is why this guide has been developed. By following the suggestions provided here and remaining open to respectful dialogue and consultation with members of the local First Nation communities and other Indigenous organizations, teachers will be able to create engaging, rich learning experiences for their students, and expand their own comfort with this material. While mistakes will inevitably occur (as in any learning undertaking), no mistake arising from application of the suggestions provided here will prove as serious as the mistake of failing to work toward a more accurate portrayal of First People in the classroom or a pedagogy that is more inclusive of First Nation, Métis, and Inuit learners.

Teachers are also encouraged to think about their connection to the students, the content of the lesson, and students' development of the curricular and core competencies. The following are among the questions a teacher may ask:

- How am I creating learning experiences that honour the First Peoples Principles of Learning?
- How is this unit working for me and my students?
- How has my own personality and place within society affected my approach to what I am teaching?
- Am I treating all students inclusively?
- If I encounter any challenges, how am I responding to them?
- Do I need any support, and if so, where can I find that support?

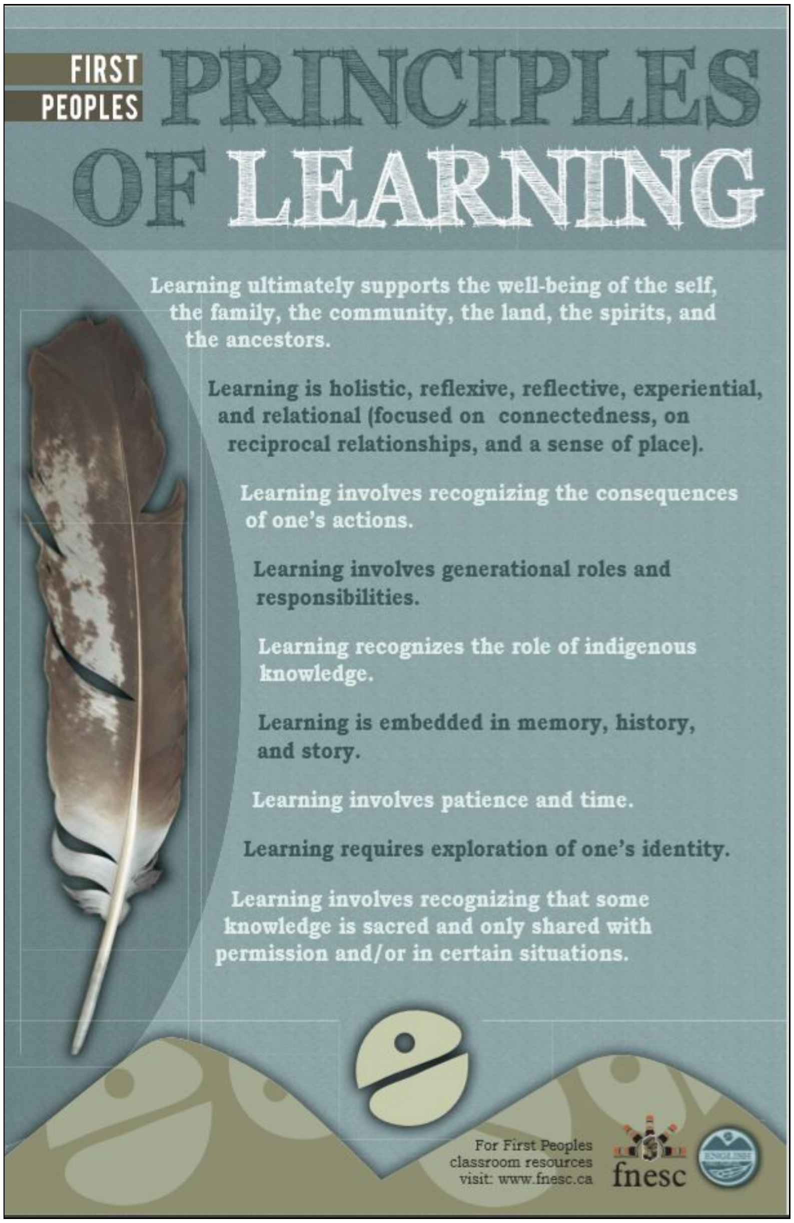
Find out if your school or school district has any support documents to assist teachers (e.g., a district Aboriginal Education Enhancement Agreement, instructional guides with First-Nations content, locally developed First Nations materials suitable for classroom use, district lists of First Nations community contacts, district-area maps that show topography, land use patterns, or resources).

Foundations

Key Principles and Concepts

Math First Peoples is an initiative of First Nations Education Steering Committee to make the wisdom and knowledge of Indigenous Knowledge-keepers and educators within British Columbia's First Nations and other Indigenous communities a part of mathematics teaching and learning around the province.

A succinct expression of the shared wisdom of Indigenous Knowledge-keepers, scholars, and educators within British Columbia's First Peoples communities is captured within the **"First Peoples Principles of Learning."**



These First Peoples Principles of Learning are thoroughly compatible with approaches to teaching and learning that emphasize

- building on what students are already familiar with (both abstract knowledge and concrete knowledge)
- exploring and building on students' interests (e.g., asking learners about what is important to them as a way to identify what context will prove meaningful to them as a basis for learning mathematics)
- presenting mathematics problems of various sorts in varied ways (e.g., visual, oral, role-play, and experiential problems as well as word and symbol problems)
- stimulating students' innate curiosity and desire to explore

- communicating a positive and enthusiastic attitude toward mathematics (e.g., being willing to take risks and make mistakes and encouraging students to do the same)
- promoting and rewarding perseverance (e.g., giving necessary time for difficult problems and revisiting them on multiple occasions)
- encouraging students to reflect on and be explicit about their own thinking processes and the transformations in their own understanding.

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 practised 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-Indigenous 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 to 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

Aspects of Indigenous Knowledge

Indigenous Knowledge is the knowledge of Indigenous peoples, including scientific and evidence-based knowledge, that has been built up over thousands of years of interaction with the environment. It is holistic knowledge rooted in place and contained in language.

from *Science First Peoples Teacher Resource Guide: Grades 5 to 9*. (West Vancouver: FNESC, 2016), p. 6

Indigenous Knowledge (IK) can be broadly defined as the knowledge that an [I]ndigenous (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/

One of the most effective ways to begin teaching Mathematics First Peoples 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. The tokenism of periodically introducing one-off, trivial examples or contrived problem situations that promote simplistic, stereotypical aspects of First Peoples traditions will be obvious to most students and will likely 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 math class.

Interconnectedness

First Peoples are diverse, and the unique knowledge each group holds is part of its distinct worldview. However, many First Peoples share a common belief that we are all connected to nature and to each other. This notion that we are all connected with everything in the world is expressed by many First Peoples in the phrase "All my relations." Inherent in this view of the world are the understandings that everything in the universe has a place there and deserves respect, and that all things are connected. A change to one part of a system affects all other parts of a system. From this vantage point, people appreciate that what affects one person affects others as well.

Connection to Place and Land

Connection with place, with the land, is foundational to Indigenous perspectives. Each Indigenous group holds unique worldviews, knowledge, and stories related to its environment and territories. The concept of Place goes far beyond the physical space. It includes a crucial Sense of Place – the memories, emotions, histories, and spiritualities that bind the people to the land.

Five concepts of place have been identified, common to most First Peoples:

- Place is multidimensional. More than the geographical space, it also holds cultural, emotional, and spiritual spaces which cannot be divided into parts.
- Place is a relationship. Relationship encompasses both human relationships and the relationships between people and the land.
- Place is experiential. Experiences a person has on the land give it meaning.
- Place is local. While there are commonalities, each First Nation has a unique, local understanding of Place. Stories are connected to Place.
- Place is land-based. Land is interconnected and essential to all aspects of culture. Making connections with place in English First Peoples courses is an integral part of bringing Indigenous perspectives into the

classroom. Peoples' perspectives are influenced by the land they are connected to. That means including experiential learning in local natural and cultural situations.

Adapted for EFP from Michell et al.,
Learning Indigenous Science from Place, p. 27-28.

First Peoples' Languages

Language is the vessel that contains Indigenous Knowledge. Understanding is embedded in language, and knowledge is structured and transmitted through language. Learning through oral language is part of its experiential nature. Through the processes of colonization, First Nations languages have undergone significant assault. Most communities suffered significant language loss, and one of the results of the loss of language is the loss of knowledge. As well, learning has moved from the oral to the written. Some languages face extinction, but others are experiencing renewal.

People are working to revitalize languages, which in turn will serve to keep traditional knowledge alive. Like most languages, strong Indigenous languages continue to grow, and sometimes new words have been added to the language for contemporary objects. For example, in the Ts'msyen language Sm'algyax, the word *flashlight* is *laawksm ts'amti* (light lightning or lightning from a light). In Tsilhqot'in, the word for *helicopter* is *betŝit'ay naghedalt'ex* (something that has something spinning on top of it).

Incorporating traditional languages into classrooms can enhance courses. Some Indigenous stories in English contains Indigenous words that have not been translated for specific reasons. The exploration of why this occurs can help students understand the connections between language and perspectives of the world. Support for the pronunciation of words from some First Nations languages can be found at www.firstvoices.com, which provides searchable vocabularies for many of BC's diverse First Nations languages.

The Power of Story

Story is one of the main methods of traditional Indigenous learning and teaching. First Peoples' stories also take many forms such as prose, song, dance, poetry, theatre, carvings, pictures, etc.

Different stories have different purposes. Traditional and contemporary First Peoples' stories are told for:

- teaching – life lessons, community responsibilities, rites of passage, etc.
- sharing creation stories
- recording personal, family, and community histories
- "mapping" the geography and resources of an area
- ensuring cultural continuity (e.g., knowledge of ancestors, language)
- healing
- entertainment.

Where appropriate, talk with students about the purposes of specific stories used in the classroom.
Because of the connotations often associated with the terms "legend" and "myth" (i.e., fiction), it is preferable to use the terms "story" or "traditional story" or "narrative."

Permissions, Protocols, and Respectful Practice

It is important to recognize that local protocols exist with respect to various aspects of every First Nations community's culture. Respectful pedagogy recognizes this and the fact that permission should be obtained from the relevant individuals, families, Elders, hereditary chiefs, Band Councils, or Tribal Councils for use of many unpublished First Peoples' cultural materials or practices – stories, songs, designs, crests, photographs, audiovisual materials, and dances.

It is also important to note that there are cultural practices and activities that are not appropriate to re-enact in the classroom or to have students participate in. It is, for example, inadvisable to engage students at any grade level in

- creating a replica "totem" pole
- designing and/or making a button blanket
- creating personal "logos" using First Nations-style crests

For First Nations artists, such objects represent significant aspects of their cultures and are integrally linked to identity, family, ancestors, and history. They are considered tangible representations of intangible property. This means that they are used as legal documentation of a families' stories, histories, property, and territories. There are thousands of years of history and knowledge associated with these objects and the ceremonies that surround them. There are protocols involved in the making of, the use of, and the storage of the different items. As the First Peoples Principles of Learning state, "…some knowledge is sacred and only shared with permission and/or in certain situations." It is up to the various nations themselves to decide what knowledge this applies to and what protocols are appropriate.

Thus, while student-centred learning and hands-on activities that engage all of students' faculties are a valuable part of any good pedagogical approach, it is important to prioritize the development of awareness about First Peoples cultures and what is significant to them as well as respect for all of the knowledge and history that various nations hold. This learning intent always needs to be considered. To acquire awareness and respect, students should learn about certain customs, practices, and objects without attempting to re-create them in the classroom. Such out-of-context "re-creation" is generally meaningless and trivializes their history. As an alternative, consider activities that do not simply mimic a culture. Instead, use authentic resources (see the examples provided throughout this guide, including the "Additional Resources" section at the back) and/or bring in guest speakers who can explain, display examples, discuss, and demonstrate, as appropriate.

If you are unsure whether an activity appropriates or inappropriately represents aspects of a culture it would be good to contact band councils, tribal councils or your local Aboriginal/Indigenous education department. They would have a good idea of what is appropriate and what is not. This guide is designed to highlight aspects of First Peoples' cultures as a way to illuminate the implicit mathematics and provide context for mathematical learning. The activities provided use cultural knowledge that is available to all and does not include significant sacred elements that should be protected and respected.

Culturally Inclusive Mathematics and Indigenous Knowledge

To improve academic success of students within mathematics, researchers and educators in the field of culturally relevant mathematics pedagogy have identified the need for the following:

- creating equitable conditions in mathematics education
- connecting school mathematics to the experiences of culturally diverse students
- developing mathematics curriculum that is culturally relevant, temporally relevant (i.e., applicable to students' present-day experiences), and academically rigorous
- inspiring students to appreciate the mathematical accomplishments of their rich cultural pasts, while simultaneously preparing them to meet the mathematical challenges of the present and future.

In addition, creating culturally relevant mathematics will

- contribute to reconciliation for all by building greater understanding of the skills, knowledge, and perspectives of First Peoples for all students
- implement strategies to enhance Indigenous students' participation in mathematics, which will in turn improve Indigenous student enrolment and graduation rates within post-secondary fields that involve mathematics.

It is easy to imagine how a teacher's personal relationships with community members can create opportunities for students to interact directly with Elders and other members of the local Indigenous 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 the definition at the beginning of "Aspects of Indigenous Knowledge")
- features of the community that might only be known by long-time inhabitants of the land.

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 information about culturally relevant mathematics can be obtained from the publication *Living Culturally Responsive Mathematics Education with/in Indigenous Communities* and the academic literature created by the following scholars and researchers (to name a few): Julie Kaomea, Jerry Lipka and colleagues, William Tate, Gloria Ladson-Billings, and A.J. Bishop.

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 Nations community that involve the use of mathematical thinking. Exploring the connections between Mathematics and Indigenous Knowledge or day-to-day community activities or practices can occur informally, in the course of your day-to-day interactions with community members in a range of situations.

Finding and Using Story/Narratives for Teaching Mathematics

Using traditional stories in mathematics units is a way of connecting with Indigenous knowledge and acknowledges the First Peoples Principal of Learning: "Learning is embedded in memory, history, and story." When using or discussing a traditional First Nations story, it is most appropriate to refer to it as a "story," "traditional story," or "narrative" and avoid the terms "legend" and "myth," because of their connotations (i.e., that they are fiction/untrue).

What to look for in finding stories for mathematics classes.

- The story should be authentic. Criteria for what constitutes authentic First Peoples text can be found in the *FNESC/FNSA Authentic First Peoples Resources for Use in K-9 Classrooms* annotated bibliography (www.fnesc.ca/authenticresources/). Alternately, a story may be endorsed by an Indigenous group or body, either published directly by them or with an indication that the story or publication has their stamp of approval.
- While there may not be a story that relates to specific curriculum content, you may be able to find a local story that speaks to a holistic approach to the content.

Story sources

- Ideally, a local First Nations storyteller would visit your class to share a story that relates to your unit. Work with your school and district's Aboriginal/Indigenous Education staff to help you to find a storyteller.
- There are video sources of First Nations storytellers sharing stories on the internet. These can be relied on to be authentic. However, beware of videos that illustrate or act out a traditional story unless you are sure that it is authentic and produced by or with Indigenous peoples.
- Children's books
- Published sources

Things to know about stories

- Traditional stories that are printed may have different structures than students may be used to. Many Indigenous stories are complex intertwined stories that can take hours or days to tell fully. Often when an Elder has shared a story that has been printed, it may be just one part of a much longer story.
- The stories are out of context. As traditional stories were told many times, people would have known the cultural references and the context of a character or an event; readers or listeners who encounter this story for the first time in a school setting probably will lack this context and may consequently need help to appreciate the story's significance.

What can students look for in a traditional story or narrative?

- Often examples of situations or activities involving the application of mathematical understanding are embedded in a story. Sometimes they may be explicit, other times they may be implied.
- What lessons does the story teach about human relationship(s) with the land?
- How is an Indigenous perspective or worldview embedded in the story?

Choosing & Developing Local Indigenous Teaching & Learning Resources

This guide provides sample units which incorporate Indigenous perspectives into math activities. Teachers are encouraged to develop local units that speak to the local sense of place and non-appropriated knowledge of local First Nations, in collaboration with knowledgeable community members.

Framework for Designing Indigenous Resources

On the following pages is a rubric illustrating a framework for designing Indigenous resources. Although the considerations and criteria cited in the framework are written to apply to science resources, they can be readily adapted and applied to mathematics resources. The rubric was developed by Dr. Judy Thompson and is reprinted here with permission. The rubric identifies the following considerations for involving Indigenous perspective when developing and implementing Indigenous resources:

- **Indigenous Voice** – What cultural experts can contribute to the unit development and implementation?
- **Indigenous Languages** – How can the local First Nations languages be included in the lessons?
- **Diversity of Indigenous Groups** – Do the lessons recognize the diversity of First Nations? Can the unit be shared and adapted to other groups?
- **Protocol** – What protocols need to be followed during the implementation of the unit?
- **Relationship with the Land –** How can the unit reinforce the importance of the land, plants and animals to Indigenous people?
- **Ways of Learning, Ways of Teaching** – Are traditional ways of learning included? Are activities student centered? Is evaluation formative?

Collaboratively Developing Indigenous Resources

	Gradations of Quality	
Criteria	**4**	**3**
Indigenous Voice	Cultural experts are a significant and critical part of unit implementation. Elders and community members are involved at all stages of the curriculum resource development process and an Indigenous person is directly involved in writing the material.	Cultural experts are involved. Elders and community members have been involved in many stages of the curriculum resource development process.
Indigenous Languages	Indigenous languages are recognized as an integral part of Indigenous ways of knowing and worldview. The language plays a significant part in the lessons and activities.	Indigenous languages are recognized as an integral part of Indigenous ways of knowing and worldview. While the language does not play a large part in the lessons, the importance of learning the language from Elders and other fluent speakers is stressed.
Diversity among Indigenous Peoples	The focus of the curriculum resource is on one particular Indigenous group. The material is flexible enough that it can be adapted to other Indigenous groups.	The focus of the curriculum resource is on one particular Indigenous group; however, there is limited flexibility in the lessons, and they cannot be easily adapted to other Indigenous groups.
Protocol	Developers have recognized that there are protocols to be followed when working with specific Indigenous communities and cultural experts. The protocols are explicitly articulated.	Developers have recognized that there are protocols to be followed when working with specific Indigenous communities and cultural experts. The protocols are not explicitly articulated, but consultation with appropriate individuals and/or bodies has occurred.
Relationship with the Land	Developers state the importance of the land, plants, and environment to Indigenous peoples. Lessons take place out of the classroom (e.g., at fish camps, seaweed camps) as well as in the classroom. Cultural experts are integral to the lessons.	Developers state the importance of the land, plants, and environment to Indigenous peoples. While some lessons may take place on the land and in the environment, most still take place within a classroom. Cultural experts are often involved.
Ways of Learning; Ways of Teaching	Traditional ways of learning and teaching are explained. Activities are numerous, varied, and student-centred. They often take place on the land with Elders (observation, practice, participation, active involvement, etc.). Learning and evaluation ideally take place at the same time and evaluation is a balance of formative and summative.	Traditional ways of learning and teaching are mentioned. There is variety in lesson approaches (e.g., videos, guest speakers, field trips, guided labs, non-directed labs). Lectures are limited and the teacher acts as a facilitator. Evaluation is a balance of formative and summative.

Adapted from Appendix F, pp. 136-140. Thompson, J.C. (Edōsdi), (2004). *Gitga'at Plant Project: The Intergenerational Transmission of Traditional Plant Knowledge Using School Science Curricula*. (Unpublished Master's Thesis). University of Victoria, Victoria, BC.

Gradations of Quality		
2	**1**	**Criteria**
Cultural experts have been involved; but their role is not clear.	Involvement of cultural experts is not mentioned	***Indigenous Voice***
Indigenous words are used here and there throughout the resource; but there is no mention of the importance of Indigenous language to Indigenous ways of knowing and worldview.	Indigenous languages are not part of the curriculum, and there is no mention of their importance to Indigenous ways of knowing and worldview.	***Indigenous Languages***
The curriculum resource does make reference to the diversity amongst Indigenous groups; but the content is very general and not specifically identified with any particular Indigenous group.	The curriculum resource is very general and is not focussed on any particular Indigenous group. It does not make reference to the diversity amongst Indigenous groups.	***Diversity among Indigenous Peoples***
The importance of following protocol is not highlighted, but individuals and/or organizations within the community are listed as contacts for general information.	There is no mention of the importance of following protocol.	***Protocol***
The curriculum resource does not state/acknowledge the importance of the land, plants, and animals to Indigenous peoples. Most lessons take place in the classroom; but cultural experts are brought in once in a while.	The curriculum resource does not recognize the importance of the land, plants, and animals to Indigenous peoples. Lessons take place entirely inside a classroom without the involvement of cultural experts.	***Relationship with the Land***
Traditional ways of learning and teaching are not mentioned. There is some variety in lesson activities (e.g., videos, guided labs). There is some formative evaluation as well as summative evaluation.	Traditional ways of learning and teaching are not recognized or acknowledged. Activities are teacher-centred and teacher directed. Evaluation is exclusively summative.	***Ways of Learning; Ways of Teaching***

Numeracy Enhancement and the Provincial Numeracy Assessment

Resources that aim to support students' learning in the area of mathematics are expected to take account of curriculum requirements. As part of a recent revision and redesign of BC's provincial K-12 curriculum (2016-2018), the BC Ministry of Education has specifically strengthened and clarified expectations with respect to **numeracy**, defined as "[…] the willingness and ability to interpret and apply mathematical understanding to solve problems in complex situations, and the perseverance to analyze and communicate these solutions in ways that are relevant to the given context" (https://curriculum.gov.bc.ca/sites/curriculum.gov.bc.ca/files/pdf/glossary.pdf).

As is explained in the BC Ministry of Education's *Graduation Numeracy Assessment Design Specifications – Sept 2017* (https://www2.gov.bc.ca/assets/gov/education/administration/kindergarten-to-grade-12/assessment/final_graduation_numeracy_design_specifications.pdf) there are five numeracy processes that learners engage with as they work through a numeracy task. A focus on these processes is critical in helping learners acquire strong numeracy. When developing a teaching approach that strengthens student capacities with respect to these processes, it is important to consider how these processes might be fostered in a way that takes account of a First Peoples' perspective. Certainly, a focus on these processes is fully compatible with the suggestions provided on previous pages for creating new and locally relevant Indigenous teaching and learning resources.

- **Interpreting:** Students are able to read and decode a range of complex situations in order to identify real-world problems that need to be solved [including problems that are relevant to the lived realities of First Peoples in BC].
- **Applying:** Students are able to identify and activate their mathematical understanding (mathematize) in order to translate real-world problems into mathematical problems.
- **Solving:** Students are able to use a variety of approaches and representations to solve mathematical problems.
- **Analyzing:** Students are able to interpret mathematical solutions in context, such that the solutions make sense within complex situations.
- **Communicating:** Students are able to clearly and precisely construct valid logical arguments to defend their decisions and assumptions, explain their tools and approaches used, and present their solutions in context.

Summary: Authentic Integration of Mathematical and Cultural Teaching

When taking on the responsibility of addressing mathematics teaching and learning through First Peoples knowledge and perspectives, the following are some questions to consider:

- Where does math live in cultural practices and knowledge?
- What opportunities do my students have to engage with mathematics that includes connection to place, story, and identity?
- How might local Indigenous languages be used to illuminate ways of knowing mathematics?
- How will the learning experiences I offer my students reflect the diversity in culture within our community, and within BC First Nations contexts?
- What mathematical experiences could be offered that would enhance students' relationships to the land?
- How might a more holistic, interconnected approach to the teaching and learning of mathematics provide access points for all students?

There are two BC's K-12 Mathematics Curricular Competencies that specifically focus on First Peoples perspectives and knowledge:

> Students are expected to be able to do the following:
> - ► Engage in problem-solving experiences that are connected to place, story, cultural practices, and perspectives relevant to local First Peoples communities, the local community and other cultures.
> - ► Incorporate First Peoples worldviews and perspectives to make connections to mathematical concepts.

As educators consider these learning standards in their planning and design of experiences for their students, questions often arise regarding their own knowledge and understanding, as well as how to access appropriate resources. Often, a tension arises in trying to find connections to mathematical content. The following are some suggestions to consider in planning and designing mathematical learning experiences with a focus on First Peoples cultural practices and perspectives.

1. Learn about local First Nations cultural practices to which the public may be welcome, such as
   - carving of poles or other objects
   - building of traditional structures
   - raising of poles or tipis
   - harvesting of plants for food or medicine
   - planning for sustainability
   - drum-making
   - preparation of traditional foods
   - creation of textiles (e.g., beading or weaving)
   - ceremonies
   - travel over land and water
   - performances
   - games and competitions.

   In public schools, information about these can be found through the district's Aboriginal/Indigenous Education department.
2. Reflect on the experience and think about what authentic mathematical thinking is involved and what skills and concepts are used and applied. In the context of our current curriculum framework, consider both competencies and content.
3. Record mathematical or numeracy connection points that you identified as embedded in the practice (e.g., estimating, visualizing, comparing quantities).
4. Share and reflect on your experience with someone who has experience and knowledge of the practice to see if your connections mirror their authentic engagement with the practice.
5. Look to the BC K-12 Mathematics curriculum framework to look for connections to your experience – core competencies, big ideas, curricular competencies and curricular content.
6. Consider other disciplines, such as science and social studies, and look for related big ideas, curricular competencies and curricular content.
7. Plan and design a holistic learning experience that may involve multiple learning standards woven together. Consider the ways students will show what they are able to do and what they know.
8. As part of the learning experience with your students, acknowledge who and where your teachings came from and that you are sharing your own learning with your students.

Ultimately it is important to remember that the curriculum framework (particularly the content standards) is based on a Western/Euro-centric mathematics perspective and that thoughtful, deliberate care should be taken to avoid overlaying what is held up as "mathematics" on a cultural practice. Most especially, in attempting to seek connections, it is important to not trivialize a cultural practice or create a contrived context.

Connecting with Community

The support and participation of Indigenous teachers, Elders, and other knowledgeable members of your local Indigenous 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 Nations and other Indigenous peoples and seeking their support for what is being taught — will allow you to provide active, participatory, experiential learning and to localize course content. And when incorporating suggestions provided as part of the Thematic Units in this guide, connecting with the local community before implementing activities will enable you to ensure that your approach acknowledges and/or aligns with their culture and beliefs.

In a non-First Nations school, prior to initiating contacts with chiefs, Elders, or other authorities in the local First Nation, you might wish to consult colleagues and local school district Aboriginal/Indigenous contacts who already have some experience working with the community. District Aboriginal/Indigenous contacts can prove extremely helpful in securing local community support (e.g., by ensuring that proper protocols are followed). A list of school district Aboriginal/Indigenous contacts is available online at www.bced.gov.bc.ca/apps/imcl/imclWeb/AB.do. In First Nations schools, other processes may apply.

Considerations for First Nations, Inuit, and Métis Guest Speakers

Bringing First Peoples perspectives of mathematics into the classroom means, in part, connecting with the local First Nations community. It is important to understand, respect, and practice the local protocols when

- inviting Elders and other knowledgeable community members into the classroom to speak
- interacting with the natural world when going out on field trips
- visiting First Nations lands and territories
- interviewing people
- holding special events such as celebratory feasts
- developing mathematics units.

When it comes to protocols for inviting a member of a First Nations community or Indigenous organization to a classroom or school, the remainder of this section provides some general considerations and guidelines that can be applied to help the process. These can also be adapted and applied when taking students out of the school or into field learning experiences that will be led by, or facilitated by, a member of a First Nations community or Indigenous organization.

Be aware that there are also often protocols specific to local communities (most communities have protocols in place to be followed when working with Elders and Knowledge-Keepers). Such protocols may include showing respect by offering a gift to the person, or perhaps to the land when participating in on-the-land learning. School district Aboriginal/Indigenous Education departments or First Nations community education contacts can usually provide guidance regarding those specific protocols.

Remember too that knowledge shared by local First Nations is inherently their intellectual property. Respect that right if your First Nations invitees or presenters indicate that some knowledge is private.

Before the Visit

- Determine the purpose of the visit – how it is connected to the curriculum or learning standards for the class or course. If it is not directly connected to the curriculum, be clear about the intended learning standards so that the guest visit is a meaningful experience for all involved.
- Determine whether it is appropriate protocol to offer the guest speaker(s) a gift and/or honorarium:
  - Consult with the school district's Aboriginal/Indigenous Education department or First Nations community to determine the appropriate amount or gift (if the speaker has not already indicated an honorarium amount).
  - Determine where funds will come from. Check to see if the school or PAC can contribute.

    - If the school and/or school district requires any paperwork to be completed before payment can be issued, ensure this is done well in advance of the visit so payment can be issued at the time of visit or very soon afterward.

- Talk with the speaker about the details of the visit:
    - date and time of the visit
    - the course and grade levels of the students
    - approximate number of students
    - what related content/learning the students have pursued prior to the visit.

- Ask the speaker about any specific needs:
    - Is there any specific information that students should know before the visit?
    - Are there any specific protocols that the students and adults need to follow during the visit?
    - Is there is anything else that will make the visit more comfortable for the speaker (especially for an Elder)?
    - Would it help to have the classroom/space organized in a specific way?
    - Ask for permission to take photos or videotape (if desired).

- Ask the speaker for some background information that can be used to compose your introduction to the students (e.g., where the speaker is from, role or occupation, noteworthy experiences or accomplishments).
- Arrange arrival details. If possible, include students in the greeting.
    - Ensure everyone knows where the speaker will be met.
    - Arrange to meet the speaker at a designated spot in or near the school.
    - In some situations, the speaker may need transportation from home.

- Ensure the students are prepared prior to the visit:
    - Connect speaker's visit to students' previous learning.
    - Review respectful behaviour with students, including non-verbal communication.
    - Model for students how to introduce themselves.
    - Brainstorm questions that students might ask.
    - Prepare students to provide a thank-you to the speaker.
    - Ensure office staff and administrators know that a guest is expected.

Day of the Visit

- Prepare physical space of classroom. Set up any necessary equipment.
- Introduce speaker(s) to students and if appropriate do acknowledgement of territory.
- If students will be introducing themselves to the speaker, consider a talking circle format in which they say their names and where they are from.
- Ensure there is time for questions/discussion at the end of the session.
- Have student(s) formally thank the speaker and present gift or honorarium.
- If possible, debrief the session with speaker. Walk the guest out.

It is important that you stay present for the session, as this models for the students a valuing of the speaker's knowledge and time. If any behavioural challenges occur, it is up to you to address them, not the speaker.

After the Visit

- Debrief the session with the students.
- Do follow-up activity with students.
- Have students follow up with thank-you letter.
- Touch base with speaker to ensure that honorarium was received (if not presented on day of session).

Learning from the Local First Nations Community

Connecting with local First Nations or Indigenous organizations can include opportunities for both educators and students to learn from local community members. The following questionnaire can be used as a tool to learn about local mathematical knowledge.

If using the Cultural Math-Interview Guide, it may also be helpful to consider that

- not all questions listed here will be necessarily appropriate for your particular interview
- there can be something to learn in all six categories
- although many community members (formal and informal leaders, Elders/Knowledge-Keepers) 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/Indigenous Education Coordinator may be able to help, if you have difficulty finding people to interview
- when completed it is important to add a short piece describing the insights you have gained, and how you might apply them

It is also important to remember that when asking for information or support from community members, it is considered respectful to offer something in reciprocity. This could be in the form of honoraria or in service to the community.

The cultural interview is something that can be used to enhance your practice while exploring the connections between mathematics and Indigenous Knowledge. In some situations, the mathematical cultural interview 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.

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?	

<table>
<tr><td>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?</td><td></td></tr>
<tr><td>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?</td><td></td></tr>
<tr><td>Explaining
Are specific values recorded in any way (e.g., graphs)?
How is wealth/prominence shown?
Other?</td><td></td></tr>
<tr><td>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?</td><td></td></tr>
<tr><td colspan="2">Comments/Insights of Interviewer:</td></tr>
</table>

Using the Multi-Grade Thematic Units

Organization, Features, & Curriculum Connections

This Teacher Resource Guide is intended to help facilitate the respectful and meaningful inclusion of Indigenous knowledge and perspectives into BC classrooms. As such, it reflects an approach to Indigenous knowledge that values a holistic, integrated approach to teaching and learning.

The body of the Guide consists of seven multi-grade thematic units that address varied aspects of the BC Mathematics curriculum at differing grade levels. Consistent with the Guide's holistic, integrated approach to teaching and learning, these units are theme-based and emphasize cultural connections rather than seeking to align solely with one course or the curriculum for a single grade. Thus, the units are not all necessarily complementary. Nor are they designed to be used sequentially – or as a basis for an entire year's instructional planning. Although each multi-grade thematic unit does provide guidance with respect to curriculum connections, you the teacher will need to explore and examine all parts of the guide to determine what to use and when (i.e., what makes the most sense given the contexts of who the students are, where the learning is taking place, the course and grade level, and your own background knowledge or comfort levels).

It is acknowledged that exploration of the thematic units to determine the best activities to use for specific courses, grades, and student contexts is likely to require thoughtful consideration and time; but it is also more consistent with an Indigenous approach to learning. It is expected that the additional time required to explore the guide will result in your feeling more comfortable working with Indigenous Knowledge and perspectives, and it is hoped that the material in this Guide will create opportunities for you to collaborate with educators of other courses and grades. And although this guide is focussed specifically on mathematical learning, there is considerable room for you and your students to make explicit links to other curricular areas.

In terms of organization, each of the seven multi-grade thematic units contains a number of more specifically focussed mini-units that provide a sequential instructional plan linked to a story, a theme, or a topic associated with traditional and/or contemporary First Peoples cultures. This cultural starting point will resonate readily with students from Indigenous families or communities. It will likewise help non-Indigenous students to learn about, respect, and appreciate the sophistication and relevance of Indigenous Knowledge (see the Foundations section of this resource). Upon examining the mini-units, you will find that

- 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, it is assumed 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
- the suggestions offered do not replace what you are presumed to already know about effective assessment practices (i.e., the guide does not endeavour to include these in detail); while some formative and summative assessment opportunities are suggested, you will need to draw upon your own expertise and build on these to assess or evaluate student learning.

The BC Graduation Numeracy Assessment

Recognizing that the BC Ministry of Education has recently (2017) introduced the BC Graduation Numeracy Assessment (GNA) as a new graduation requirement (i.e., not to replace a provincial mathematics exam, but to assess numeracy across disciplines) you may find it helpful to consult the BC Ministry of Education website for additional support (https://curriculum.gov.bc.ca/provincial-assessment). This contains current, updated information about design specifications for the assessment, sample assessment questions and information for teachers, students, and families.

More specifically, each mini-unit typically contains the following elements:

- an authentic "story" or a link to online resource material that helps establish a context for the ensuing instructional activities
- a listing of supplemental resources (generally available online) that you could use to enrich or expand on the unit material
- a collection of applicable Blackline Masters (BLM) situated at the end of the theme unit; they are designed to be used as student handouts for summarizing information (including mathematical concepts, procedures, etc.), guiding students' independent or group work, or conducting student assessment/self-assessment

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 strategies for teaching particular mathematics topics
- respond to local requirements
- incorporate additional relevant learning resources (e.g., as suggested in the Additional Resource section at the end of this Guide).

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.

The following table identifies several themes and topics that relate to the lived realities and perspectives of most First Peoples in BC. This is by no means a finite list of possibilities. Consider exploring these themes to establish connections with your mathematics instruction and to develop your own instructional units or activities:

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

CONTEMPORARY CULTURAL ARTEFACTS

Multi-Grade Thematic Unit

Around the world, people recognize and celebrate many types of cultural artefacts created by First Peoples in British Columbia. Poles, drums, bentwood boxes, masks, regalia, and jewellery are just some of the types of objects that incorporate traditional design approaches and production techniques. Such objects are still being created and used today. In virtually every case, the creation of these cultural artefacts involves the application of mathematical principles and the use of calculations to achieve desired results. This unit focuses on three types of artefacts still being created by First Peoples artists and artisans and on the mathematics involved.

For the purposes of this resource guide **contemporary cultural artefacts** are defined as distinctive objects that have been created by an individual or group, that recognize and draw upon traditional and contemporary processes, and that have functional, aesthetic, social, and sometimes spiritual significance within the traditions of one or more First Nations. They grow from the knowledge of the ancestors and often carry cultural knowledge forward. Contemporary cultural artefacts also reflect the inspirations of their present-day creators.

Bentwood boxes

Bentwood boxes are versatile containers, typically made from one piece of wood, cut in such a way that it can be bent when softened by steam and then given a tight fitting, over-hanging lid. Most often they were used for the storage and transportation of goods (including blankets, berries, oolichan grease, tobacco, or trade items). Also, as they are watertight they could be used for cooking food. When made from cedar, bentwood boxes are bug resistant and therefore make a good option for long-term storage of regalia and other textiles. Very large boxes were also used as drums.

Bentwood boxes come in a variety of sizes and were often rectangular in shape, although some were trapezoidal to fit in the bottom of a canoe. Some were made for daily use; others to be given as a gift. In many communities they were placed on top of memorial poles for high ranking members of a clan. Today they are still used for ceremonial or ornamental purposes and less often for everyday use. In the story, "Raven Steals the Light" (see the Thematic Unit "Space" and the Cosmos), the Old Man uses them to store the sun, moon, and stars.

The making of bentwood boxes involves specialized procedures. Cedar can be split into planks once a tree is cut down; but it can also sometimes be harvested from a living standing tree. Traditionally, chisels, wedges, and ropes were used to remove the single plank from a standing tree such that enough of the tree could be left intact to ensure it would not die.

Button blankets

Button blankets are ceremonial robes that developed after European contact. Prior to European contact, comparable blankets were made from other materials such as mountain goat wool cedar bark, animal skins and/or fur. Following European contact, and the introduction of manufactured cloth to the west coast in the 1700s, these items began being made from wool blankets.

Button blankets are worn for ceremonies, such as feasts, naming ceremonies, memorials, pole raisings, weddings. They are also given as gifts. Button blankets were originally made from wool blankets or dark blue duffel blankets. They used abalone or dentalium shells for the buttons and red flannel for the design and borders.

The blankets constitute traditional regalia for coastal First Peoples: Gitxsan, Haida, Haisla, Heiltsuk, Kwakwaka'wakw, Nisga'a, Nuu-chah-nulth, Tagish, Tahltan, and Tlingit Nations. Every nation has its own protocols in place for the making, use, and storage of the robes. The robes are a visual reminder of family and clan history, providing a clear statement of identity and of the power and prestige that go along with being member of a clan. For the individual wearer, they denote specific community rights and privileges that are affirmed through feasting and are acknowledged by the guests who witness the clan rights to the history and territory perpetuated through time.

Weaving

Weaving has been a practice for tens of thousands of years all the way from the Tlingit in Alaska to the Ktunaxa in Washington. It is used to create a variety of everyday and ceremonial materials including textiles, containers, and structures. The examples found up and down the coast use a variety of materials such as cedar, spruce root, and wool. Which materials a Nation uses will depend on availability within their territory or that of a trading partner. Protocols to be followed and harvesting method will depend on the Nation, territory, and time of year. Two materials that have been used extensively and that will be the focus of this unit are cedar bark and wool.

Curriculum Connections

Mini-Unit: Bentwood Boxes

Big Ideas

Math 4: Polygons are closed shapes with similar attributes that can be described, measured, and compared.
Math 5: Closed shapes have area and perimeter that can be described, measured, and compared.
Math 6: Properties of objects and shapes can be described, measured, and compared using volume, area, perimeter, and angles.

Grade	4	5	6
Curricular Competencies	• Model mathematics in contextualized experiences • Use reasoning and logic to explore, analyze, and apply mathematical ideas • Explain and justify mathematical ideas and decisions • Apply multiple strategies to solve problems in both abstract and contextualized situations • Use tools or technology to explore and create patterns and relationships, and test conjectures • Develop, demonstrate, and apply mathematical understanding through play, inquiry, and problem solving • Visualize to explore mathematical concepts • Use mathematical arguments to support personal choices		
Content	regular and irregular polygons perimeter of regular and irregular shapes line symmetry	area measurement of squares and rectangles relationships between area and perimeter	perimeter of complex shapes area of triangles, parallelograms, and trapezoids angle measurement and classification volume and capacity
Core Competencies	Social Awareness and Responsibility Creative Thinking		

Cross-Curricular Connections

- BC First Peoples 12
- Visual Arts; Studio Art 9-12
- ADST 8-9 Textiles

Mini-Unit: Button Blankets

Big Ideas

Math 6: Properties of objects and shapes can be described, measured, and compared using volume, area, perimeter, and angles.

Math 7: The constant ratio between the circumference and diameter of circles can be used to describe, measure, and compare spatial relationships.

Math 9: Similar shapes have proportional relationships that can be described, measured, and compared.

Grade	4	5	6
Curricular Competencies	• Use reasoning and logic to explore, analyze, and apply mathematics ideas • Use tools or technology to explore and create patterns and relationships, and test conjectures • Develop, demonstrate, and apply mathematical understanding through play, inquiry, and problem solving • Visualize to explore mathematical concepts • Use mathematical arguments to support personal choices		
Content	combinations of transformations (first quadrant)	combinations of transformations (four quadrants) Cartesian coordinates and graphing	spatial proportional reasoning
Core Competencies	Social Awareness and Responsibility Creative Thinking		

Cross-Curricular Connections

- BC First Peoples 12
- Visual Arts; Studio Art 9-12
- ADST 8-9 Textiles

Mini-Unit: Weaving

Big Ideas

Math 6: Linear relations can be identified and represented using expressions with variables and line graphs and can be used to form generalizations.

Math 7: Linear relations can be represented in many connected ways to identify regularities and make generalizations.

Math 8: Discrete linear relationships can be represented in many connected ways and used to identify and make generalizations.

Math 9: Continuous linear relationships can be identified and represented in many connected ways to identify regularities and make generalizations.

Grade	6	7	8	9
Curricular Competencies	• Use reasoning and logic to explore, analyze, and apply mathematics ideas • Use tools or technology to explore and create patterns and relationships, and test conjectures • Develop, demonstrate, and apply mathematical understanding through play, inquiry, and problem solving • Visualize to explore mathematical concepts			
Content	increasing and decreasing patterns, using expressions, tables, and graphs as functional relationships one-step equations with whole-number coefficients and solutions	discrete linear relations, using expressions, tables, and graphs two-step equations with whole-number coefficients, constants, and solutions Cartesian coordinates and graphing	two-step equations with integer coefficients, constants, and solutions expressions-writing and evaluating using substitution	2-variable continuous linear relations: includes rational coordinates graphing relation and analyzing interpolating and extrapolating approximate values
Core Competencies	Social Awareness and Responsibility Critical and Reflective Thinking Collaborating			

Cross-Curricular Connections

- BC First Peoples 12
- Visual Arts; Studio Art 9-12
- ADST 8-9 Textiles

Mini-Unit: Coast Salish Wool Weaving

This mini-unit addresses the same curricular elements as the Weaving mini-unit, but extends to also address linear functions, content that forms part of the **Foundations and Pre-Calculus of Math 10** curriculum.

Mini-Unit: Bentwood Boxes

Context-Setting Introductory Material for Students

(for teacher-facilitated sharing in a whole-class setting)

About Bentwood Boxes

(See also the overview introduction to this unit for general information about bentwood boxes)

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. Boxes could be made for daily use or given as a gift. The Old Man in "Raven Steals the Light" uses them to store the sun, moon, and stars.

Bentwood boxes can be made in a variety of sizes and often followed rectangular shapes, although some were trapezoidal. The boxes are made from one piece of cedar, cut in such a way that it could be bent when softened by steam, and then given a lid that was tight fitting and oversized. This reduced the chances of water entering the boxes.

Harvesting the Cedar Plank

Cedar can be split into planks once the tree is cut down and sometimes from a standing tree. Chisels, wedges, and ropes could be used to remove the plank from a standing tree. This would only be done if the tree would not die, making sure there was enough of the tree left intact.

Videos: Making a Bentwood Box Then and Now

- www.youtube.com/watch?v=astU3VQwWx0 (30:42 min) *Wooden Box: Made by Steaming and Bending*; a video describing the traditional process of making a bentwood box, featuring artist Mungo Martin (1963)
- www.youtube.com/watch?v=m0rwVHz2t1M (3:03 min) Joel Good, a contemporary Coast Salish artist, demonstrates bending a thick-walled box with V-shaped kerfs after steaming.
- www.youtube.com/watch?v=KhKpbyeeuqI (3:01 min) Gwaai and Jaalen Edenshaw, Haida artists, steam a bentwood box using contemporary technology to prepare for their trip to the Pitt Rivers Museum in Oxford, where they will carve it alongside an original Haida bentwood box that is 150 years old.

Images of Bentwood Boxes

- www.lattimergallery.com/products/eagle-and-raven-steals-the-light-bentwood-box Eagle and Raven Steals the Light - Bentwood Box; images and information about a contemporary bentwood box created by Joe Campbell
- www.lattimergallery.com/products/cedar-bentwood-box-by-phil-gray-5265 Txamsem sees the Light; images and information about a contemporary bentwood box created by Phil Gray
- www.lattimergallery.com/products/cedar-bentwood-box-by-aaron-nelson-moody-5255 MIYU7TS - XTSEM - Cedar Bentwood Box; images and information about a contemporary bentwood box created by Aaron Nelson Moody

Ceremonial Use and Importance of the Bentwood Box: the TRC

- www.canadiangeographic.ca/article/truth-and-reconciliation-and-sacred-bentwood-box TRC commission Bentwood Box
- www.cbc.ca/news/indigenous/residential-schools-promises-of-reconciliation-saved-in-bentwood-box-1.3092725 Promises of reconciliation saved in Bentwood Box

Preparatory Notes

In this unit students will be working with cardboard to explore properties of bentwood boxes. Activity 1 provides some important suggestions for ways to avoid having students approach this as merely a crafts session (for more on this, review the material on "Permissions, Protocols, and Respectful Practice" in the Foundations section of this guide). Depending on your students' prior mathematics knowledge, consider conducting a preliminary lesson on faces, perimeter, volume, and capacity to facilitate their understanding of the objects and vocabulary.

Guiding Questions

- How do people convert a flat plank into a folded box?
- How could visualizing the folding process help when harvesting cedar planks?
- How do people use mathematics to minimize waste when making bentwood boxes?
- Why is it useful to know how much a bentwood box can hold?
- Why is it useful to know how much space a bentwood box takes up?

Applicable Blackline Masters

BLM 1 – Bentwood Box Kerf Exploration
BLM 2 – Modeling a Bentwood Box with Corrugated Cardboard
BLM 3 – Canoe Box Angle Exploration
BLM 4 – Template for Bentwood Box Lid Prism

Activity 1: Setting the Context: Bentwood Boxes in Traditional Narratives

If possible, begin by inviting an Indigenous artist with knowledge of bentwood boxes to speak with students.

Among First Peoples in BC, there are many variants of the story about how "Raven Steals the Light." The story describes how the light is initially kept within a series of nested [bentwood] boxes, before Raven eventually releases it. One variant of the story has been provided in this resource in the Thematic Unit "Space" and Cosmos. You can share it with your students by reading it aloud. If a local variant of this story exists in your region, consider inviting an Indigenous Elder or storyteller to come and share it with your class.

Resources and Materials

- *Txamsm Brings Light to the World* (see the "Space" and the Cosmos Thematic Unit; Mini-Unit: Inside the Box)
- images and information about bentwood boxes (see Context-Setting Introductory Material for Students at the beginning of this mini-unit)

Extend your introduction by focussing specifically on bentwood boxes, using some or all of the resources suggested under Context-Setting Introductory Material for Students (at the beginning of this mini-unit).

Activity 2: Kerf Explorations

Resources and Materials

- examples of real bentwood boxes (1 for each small group if possible) and/or online examples that exhibit a variety of styles and include dimensions (https://www.lattimergallery.com/collections/bentwood-boxes-1 is one possible source)
- flexible tape measure (or string and ruler) for each small group
- scissors for each student
- BLM 1 – Bentwood Box Kerf Exploration

Bring physical examples of bentwood boxes to the class, if possible. Students can also view them online. Discuss with student the dimensions of the boxes and ask the question, *Are the interior dimensions of the box the same as the exterior dimensions of the box?*

Have students use a flexible measuring tape (or string and ruler) to measure around the exterior perimeter of the box without its lid and then measure again around the interior perimeter. Discuss the difference in the lengths. If there are multiple bentwood boxes being measured in the class, note which boxes have the greatest difference between interior and exterior perimeters.

Discuss with students:

- Why are the interior and exterior perimeters different? *(because the walls of the box have thickness)*
- What dictates this difference? *(the thickness of the wood – the thicker the wood, the larger the difference)*
- Where does this difference go? *(most of it must be carved out prior to bending)*

As a class, watch the three videos cited in the Context-Setting Introductory Material for Students (if you have not already done so). These show the traditional and contemporary processes for creating a bentwood box. Then use BLM 1 – Bentwood Box Kerf Exploration to have students investigate kerfs.

- Explain that each box is made from a plank of wood divided into 4 sections and that prior to bending the wood, a groove called a ***kerf*** must be cut to remove part of the wood on the side that will become the interior of the box.
- Show students some of the various different kerf styles used in bentwood box creation. Ask them to cut out the 5 different kerf profiles, both unbent and bent by cutting on the solid lines. Have students carefully bend or unbend the corners and find the matching unbent and bent corners. Just as carvers with actual wooden bentwood boxes may need to make adjustments and carve off additional material in order to achieve a 90° angle, you may also need to cut away small amounts to achieve 90°.
- As a variation, you can cut apart the 5 bent and 5 unbent 2D kerf models and hand out to 10 separate students. Students bend or unbend their kerf and then those with bent kerf profiles look for the partner with the same kerf profile design that is unbent.

If possible, examine the corners of actual bentwood boxes in the classroom and try to determine the type of kerf used. See an example of a bent kerf in the close-up corner photo of a bentwood box made by Kwakwaka´wakw artist Bruce Alfred. Advance to next image to see the whole box. www.flickr.com/photos/adavey/3842498533/ .

Formative Assessment

- Have students design their own kerf profiles in 3 places on a long strip of paper (modelling the profile of a plank of wood). Measure the length of the strip and estimate what the length of the interior and exterior perimeters will be based on the knowledge you gained from the kerf exploration.
- Try to bend your strip with kerfs into a rectangle and measure the interior and exterior perimeter of the rectangle to see how close your estimate was. If there is a significant difference, what caused it?
- Repeat process with a variety of strip widths to model various thicknesses of wood.

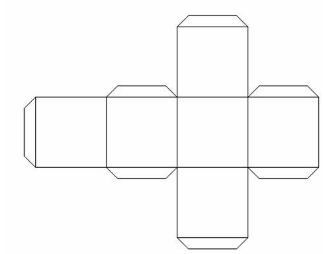
Activity 3: Modeling a Bentwood Box (3D nets)

In this activity, students will build a model of a bentwood box using cardboard and then investigate how much it can hold (capacity) and how much space it takes up (volume). If access to a woodshop is available, this activity may be adapted to work with real wood and make an actual bentwood box (with the guidance and support of a First Nations bentwood box maker. Bentwood box kits are also available for purchase. It is important to ensure that students understand the cultural significance of bentwood boxes before engaging in this activity.

Resources and Materials

- 2 pieces of corrugated cardboard for each student at least 10cm x 27cm
- white glue
- elastic band
- ruler (metal ruler is best)
- craft knife and cutting mat and/or strong scissors
- BLM 2 – Modeling a Bentwood Box with Corrugated Cardboard
- flexible measuring tape or string

Begin by showing students various nets of boxes like the one to the right. Discuss



- similarities and differences with how bentwood boxes are actually made. (tabs are not used with bentwood boxes; lid and base are not part of the same sheet of wood)
- why these differences might exist (planks of wood are long and rectangular; a T shape cut out of wood is impractical: too much waste)
- whether there are other variations of the net that will also yield the same end product

Explain to the students that they will use corrugated cardboard to model the process of making a bentwood box, using a net that is more closely related to the actual process than the net example above. See BLM 2 – Modeling a Bentwood Box with Corrugated Cardboard. Note that this BLM instructs students to measure by using the groove sections in the middle of the cardboard. As an alternative, students can also use a ruler to measure lengths and widths using standard units. If this method is chosen, it is important that the kerfs NOT run parallel to the grooves in the cardboard. They should cross against the grain or run perpendicular to the grooves so that the kerfs do not fall into the grooves. For standard double-ply corrugated cardboard, kerfs will be about 3 mm wide. This measurement is related to the thickness of the cardboard (i.e., for thicker cardboard, wider kerfs may be needed).

After completing the box and letting the glue dry, have students

- measure the dimensions of their box without the lid
- find the **surface area** of the base, each exterior wall face, and each interior wall face (length x width)
- compare the total interior surface area to the total exterior surface area
- find the **volume** (the amount of space taken up by the box) of the box and compare it to the **capacity** of the box (the amount of space the box can hold); note the difference in volume and capacity.

Discuss with the class when you would need to know the volume as opposed to the capacity. Discuss differences that might occur with cardboard of different thicknesses. Explain the use of bentwood boxes in historical and current times. What are some staples that can be housed in these boxes? Have students design a set of nesting boxes (with dimensions) and describe their purpose.

Formative Assessment

- What would be an appropriately sized box for blankets? …for oolichan grease? …for dried salmon? Why?
- How do we maximize the capacity (volume) of the box while minimizing surface area?

Further Adaptations and Extensions

- For differing instructions on building a bentwood box, a follow-up 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.
- Build boxes with the same external dimensions with cardboard of various thicknesses. (Different thicknesses can be achieved by gluing layers of cardboard together.) Measure the internal dimensions and discuss differences.

Activity 4: Design Challenges: Nested boxes and Canoe Tackle Boxes

This activity gets students to use their understanding of the bentwood-box-making process, problem solve, and work together to design boxes to meet a specific purpose.

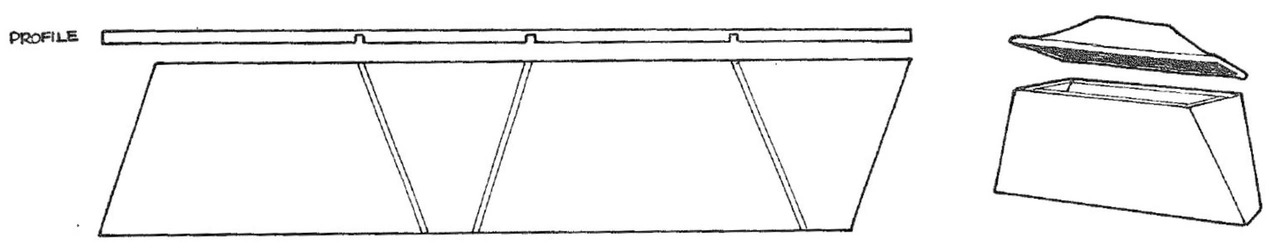
Resources and Materials

- *Txamsm Brings Light* ... (see "Space" and the Cosmos unit)
- corrugated cardboard of various lengths and sizes
- white glue
- elastic bands
- protractors
- rulers (metal ruler is best)
- craft knife and cutting mat and/or strong scissors
- BLM 3 – Canoe Box Angle Exploration

Option A: Nested Boxes Design Challenge
Have students work together as a team to build a set of nesting boxes like the one in the story *Txamsm Brings Light to the World*. They will use their knowledge from previous lessons to design model bentwood boxes out of cardboard with appropriate volume and capacity so that they nest within each other.

Option B: Canoe Tackle Boxes:
Display the image of a bentwood box by Kwakwaka´wakw artist Bruce Alfred, carefully designed to fit in the curve of a canoe. https://spiritsofthewestcoast.com/collections/bruce-alfred/products/bird-bentwood-box. Using paper strips have students experiment to create folds that would result in a box that is wider at the top and smaller at the bottom.

Use BLM #3 to do more in-depth study of the angles required for the kerfs. Show students the following drawing of the plank with kerfs, prior to bending of a fishing tacklebox designed to fit in the bow of a canoe. (from pg. 90 in *Cedar* by Hilary Stewart)



Laying your plank flat, use a protractor to measure the angles of each face created by the kerfs. What do you notice about the relationship of the angles?

- ends are cut at parallel angles along with middle kerf
- outer kerfs are parallel to each other
- middle kerf is a reflection of the outer kerfs
- all of the obtuse angles between edge and kerf are the same, all acute angles between edge and kerf are the same
- the obtuse angle and acute angle are supplementary

Note: Two angles are called ***supplementary*** angles if the sum of their degree measurements equals 180 degrees (straight line). One of the supplementary angles is said to be the supplement of the other. The two angles do not need to be together or adjacent. They just need to add up to 180 degrees.

Other discussion topics:

- How would you describe the shape of each face? (They are isosceles trapezoids.)
- What would be the shape of the base? What would be the shape of the top? (Both would be rectangles, with the top larger than the bottom.)

Using this knowledge, invite students to design and create a model of the bentwood box out of cardboard.

For further information on bentwood boxes, including other detailed drawings and diagrams, see pages 84 – 92 in *Cedar* by Hilary Stewart (Note, this resource is not an authentic Indigenous resource).

Activity 5: Exploring Nets of Regular Solids – A Bentwood Box Lid (OPTIONAL)

Explain that the lid of a bentwood box often has an interesting shape that is slightly different than a rectangular prism and that they are going to study it by building it from a net and drawing it from different perspectives.

- Cut out and build the lid prism (use tape to connect edges).
- Draw the lid in top, bottom, left-side, right-side, front-side, back views.
- Repeat the process with other shapes (e.g., triangular prism).

Resources and Materials

- BLM 4 – Template for Bentwood Box Lid Prism
- templates for triangular prism, right angle pyramid, cylinder, and cone, 1 copy per student (several sources online, including www.korthalsaltes.com/index.html)
- www.isotropic.org/polyhedra/ -- a site providing images and nets (templates) for building polyhedrons
- (optional) images illustrating top, corner, front, and right views of 3-D objects such as longhouses/bighouses and bentwood boxes (consult with the school visual arts department, which may have suitable texts to use)

Mini-Unit: Button Blankets

Context-Setting Introductory Material for Students

(for teacher-facilitated sharing in a whole-class setting)

Robes of Power

from Doreen Jenson and Polly Sargent. *Robes of Power: Totem Poles on Cloth*. 1986. pp. 6, …ii

Dempsey Bob

Our people say, when we wear our blankets, we show our face. We show who we are and where we come from. When we dance, we share part of our history with our people. It's more than just what you see when you look at a blanket. To us, it has so much meaning. The blankets become very personal.

Our people go to an artist and commission him to do a button blanket. They tell him a story, the artist draws a design, and if they approve of it, then they use it. The design becomes the property of the family and cannot be copied. Some blankets are passed down with names, our Indian names. To make the blanket have meaning, you have to know the history of the people and the crest designs.

…

As the masterpiece of human life is created by man and woman so are button blankets made. As thread links materials to create beautiful and useful objects so do button blankets link past and present to create living records. As the cycle of life is maintained by co-operation, nurturing, order, and respect so do button blankets maintain our way.

Preparatory Notes

Button Blankets hold a special significance for the coastal First Nations that use them. They are used as regalia and are given to an individual during a naming feast. They represent the house crest and the individual's personal, family, and community history (i.e., they are an outward representation of the individual's identity). They show the matrilineal connection to the house. They are like a legal document that is linked to story, ancestral knowledge, and family territory. When people see a button blanket, they are then aware of where the wearer is from and the history behind the wearer's people. "Your design tells where you come from and lets people know who you belong to [….] In identifying where you come from, it strengthens your own nation and reflects back on our houses. We come to understand that 'every blanket tells a story.'" (Trish Rosborough, *Kangextala Sewn-On-Top: Kwak'wala Revitalization and Being Indigenous*, p. 49)

For this reason, this mini-unit does not propose that students make a button blanket: its personal and cultural significance cannot be meaningfully replicated in the class. In addition, there are protocols around making a blanket (for more on this, review the material on "Permissions, Protocols, and Respectful Practice" in the Foundations section of this guide). Button blankets incorporate an intangible aspect of sacred culture that should never be trivialized. If you have someone in your community that makes button blankets, however, consider bringing that person in to talk about the creation of the blanket, recognizing that the intent is to learn about the process, not to have students create a button blanket together.

Guiding Question

What are the value and importance of balance in the design and construction of a button blanket?

Applicable Blackline Masters

BLM 5 – Similar Polygons
BLM 6 – Scale: Use of Basic Design Shapes
BLM 7 – Transformations

Additional 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 in the front matter of this document for more information) — an excellent teacher resource for First Peoples design projects.
- *Robes of Power* by Doreen Jensen and Polly Sargent.
- https://www.youtube.com/watch?v=cYt58pw_WnY (3:24 min) Haida community curators Nika Collison, Lucille Bell, and Jolene Edenshaw discuss the significance of a button blanket with a crest representing Killer Whale.
- https://www.youtube.com/watch?v=U6MDHIsUR3E (2 min) This APTN Digital Nations titled *footPrints: Aboriginal Expressions* highlights the meaning and significance of button blankets to First Peoples of the west coast.
- https://www.youtube.com/watch?v=0bdhPtqCXDs (2:03 min) Maxine Matilpi, an Indigenous artist from the Kwakwaka'wakw speaking people, discusses her button blanket that was showcased in an art gallery.
- *Salish Blankets: Robes of Protection and Transformation, Symbols of Wealth*, by Janice (Chepximiya Siyam) George, Leslie H. Tepper, and Willard (Skwetsimltexw) Joseph.
- *Strong Stories Kwakwaka'wakw: Button Blankets 6-Pack* (grade level: 4, 5, 6) by Sally Williams.

Activity 1: Looking Ahead

Tell the students what the upcoming lessons will be about, and the final project involved. Explain how similar polygons are represented in First Peoples art. Show students an example of a button blanket either by inviting someone who is knowledgeable about First Nations button blankets to bring one to class and discuss it, or by finding some examples online. Let students know that after all the lessons are completed, they will use this knowledge to create a design using the different shapes, transformations, and scale.

Students can look online or in books (such as *Robes of Power* by Doreen Jensen and Polly Sargent) or at a museum to find images of button blankets. Have students explain what math they see, how they know and why it is important. The students can get into small groups of 4 and each share their findings. This can be used as a formative assessment for the unit.

Possible math topics may include similar shapes, circles, symmetry, transformations, scale, area, perimeter, and patterning.

Activity 2: Similarity

> ***Resources and Materials***
> - BLM 5 – Similar Polygons

The study of similarity will eventually lead to students creating a personal design. Show a variety of design examples, such as

- FNESC: www.fnesc.ca/assets/home_logo.gif
- Four Host First Nations: http://canadiandesignresource.ca/graphics/logo/four-host-first-nations-logo/
- local First Nations band associations
- local municipality and school

Point out design images that demonstrate similar polygons. There are many designs that use one or more letters (often stylized) to represent an organization. Students' personal designs, 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. Provide students with extra practice working on similar polygons, corresponding sides, and scale factor.

Introduce similar polygons: (Definition: *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 copies of BLM 5 – Similar Polygons (provided at the end of this theme unit) and help students as they work through the questions in pairs or small groups.

Activity 3: Scale

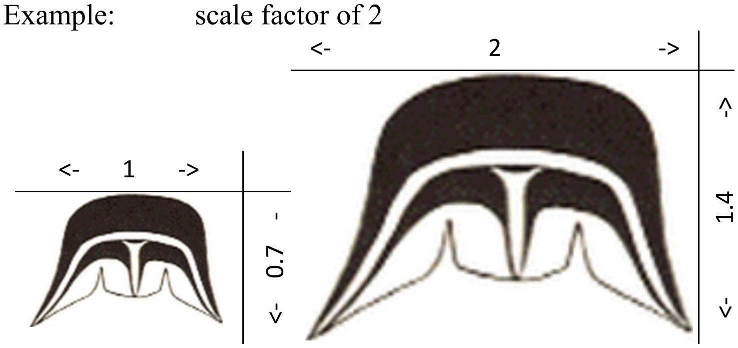
Resources and Materials

- BLM 6 – Scale: Use of Basic Design Shapes

Discuss with students the definition of ***scale factor***: the factor by which one dimension of a polygon is multiplied in order to calculate the corresponding dimension of a similar polygon. Explain/demonstrate how scale factor can be shown as a percentage, a ratio, a whole number, a decimal, or a 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



Distribute copies of BLM 6 – Scale: Use of Basic Design Shapes (provided at the end of this theme unit) and help students as they work through the questions in pairs or small groups.

Activity 4: Translations

Introduce students to the traditional Indigenous art shapes – circle, ovoid, u shape, t shape (trigon), and s shape. For more on these various shapes, see the resource *Northwest Coast Formline Design: Definitions and Student Activities: Art Kit Textbook Grade Level 5-8*, which explains Indigenous shapes in-depth: https://www.sealaskaheritage.org/sites/default/files/Sealaska%20Heritage%20Formline%20Art%20Kit%20ONLINE%20low%20res.pdf. Have students

- situate the pairs of shapes on a sheet of graph paper

- choose one of the images and a focal point on that image, then determine how each of the other shapes has moved from the starting image (i.e., right 4, up 1)
- repeat this process with the other images
- trade with a partner and repeat the process.

This activity can be completed on a cartesian plane.

Activity 5: Linear 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.

If possible, invite a First Nation artist to the class to share their knowledge about design and symmetry in First Nations art.

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 copies of BLM 7 – Transformations (provided at the end of this theme unit) and help students as they work through the questions in pairs or small groups.

Resources and Materials

- BLM 7 – Transformations

Activity 6: Finding Transformations in Artefacts

Have students go online or to a museum and find examples of button blankets. Students are to identify examples of transformations (symmetry, translations, scale, rotation and reflection) of the portions of the overall image. Have students pair up to share their examples with another student as a demonstration of their learning.

Activity 7: Button Blanket

Introduce (or reintroduce) the button blanket by showing examples collected from the community or illustrated in books or online. The following site includes a series of video clips describing the making of a button blanket: https://www.youtube.com/watch?v=0bdhPtqCXDs.

Have students develop a personal design using shapes, reflection, symmetry, and scale. Students' designs will naturally be inspired by what they have just learned about Button Blankets; be sure, however, that they understand the cultural significance and history of Button Blankets and recognize that their own designs are not expected to draw upon the same traditions or serve the same purposes. It is important that they understand these differences to avoid trivializing Indigenous knowledge.

If students decide to use First-Nations-inspired design ideas, ensure as well that they understand what they can use (i.e., designs they create) and what they cannot use (i.e., copying others' designs). Ideally students should learn about the protocols of using First Nations designs in art with the help of a First Nations artist.

Have students pick a partner to compare images with. Ask, "What similarities do you have mathematically? What differences do you have? How do your stories differ? Explain the strategy used to your partner. How would you change your process?"

Formative Assessment:

- Self and peer assessment: Did students use similar figures, linear symmetry, rotational symmetry, reflection, and/or translation of shapes in their personal design?
- Small groups or as a whole class: Have students share their designs and what it means to them. Classmates can look at other people's designs and identify similar figures, linear and rotational symmetry, reflection, and translation of shapes within each design and between each design.

Mini-Unit: Weaving

(Exploring Visual Patterns in Weaving)

Context-Setting Introductory Material for Students

(for teacher-facilitated sharing in a whole-class setting)

About Cedar Weaving

Cedar is considered the tree of life by the Ts'msyen people. In Sm'algya̱x, the Ts'msyen language, the name for cedar is smgan which means *real* or *true tree.* Traditionally, for the Ts'msyen and many other coastal First Nations peoples, it provided materials needed for everyday living such as clothing, shelter, transportation, storage and utensils. The inner bark of cedar was/is used to create clothing that meets many needs – soft and warm or tightly woven and waterproof when needed for the wet coastal climate. It was/is also used for spiritual and ceremonial purposes. Woven cedar is an essential component of regalia (ceremonial dress) and can take the form of hats, capes, bracelets and headbands. Woven cedar mats were also traditionally used to wrap loved ones after death before placing them in bentwood boxes.

There are two native species of cedar tree that grow in the temperate rainforests of coastal British Columbia: Yellow Cedar and Western Red Cedar. Yellow Cedar typically grows at subalpine elevations in damp coastal forests ranging from Vancouver Island to Alaska; but it is rarely found in inland regions. Red Cedar is common both on the coast and in moist slopes and valleys of the Interior. The inner bark of both types of cedar is used for weaving. Yellow cedar was usually used for clothing worn next to the skin because it is softer. Red cedar was used for outer clothing such as rain hats and capes. Red cedar was also most commonly used for baskets and mats.

In the late spring or early summer, when the sap is running and the bark is easier to peel off, people go out to collect cedar bark. They select a tall, straight tree with few branches at the base. They thank the tree for sharing its bark and only take enough bark to meet their needs without harming the tree.

After making a cut at the base of the tree using an axe or adze, the bark is peeled off the tree by grabbing the loosened part in both hands and pulling up in a rocking motion back and forth. Afterwards, the inner bark has to be carefully separated from the outer bark. This is done immediately, so it won't harden. The inner bark is later soaked in hot water to soften and split into three or more "thin-nesses." Skilled artists can split the bark so that it is paper-thin. The bark is then cut into the desired width for weaving and hung or rolled up to dry. When it is almost dry, the bark is bundled and tied until it is needed. Then, when it is time to use it, the bark is soaked in water until it is pliable. When it is used for clothing, the bark is separated, pounded, and shredded, to make it soft. The shreds are rolled together to the correct thickness for weaving into clothing. Bark used for weaving hats, baskets, and mats is split into thin strips.

Weaving-related Videos

- *Harvesting Cedar* https://vimeo.com/128505634 (3:59 min) Ts'msyen weaver Fanny Nelson harvesting cedar bark
- *Cedar Bark Weaving* https://www.youtube.com/watch?v=t7aunDwsy5M (3:11 min) Haida Weavers Delores Churchill and her daughter, Holly in South East Alaska
- *Lily Hope Chilkat Weaver* https://www.youtube.com/watch?v=YraJBuYfRgk (4:57 min) Video of Tlingit weaver Lilly Hope explaining the process and significance of Chilkat blanket weaving.
- *Weaving the Past in Whistler* https://www.youtube.com/watch?v=wT2E6UjCn44 (3:18 min). Alison Burns-Joseph (Squamish First Nation) talks about how she became a wool weaver has helped her connect to her culture and people.
- *MOA Shop Featured Artist: Rena Point Bolton* https://qrco.de/bbA4p6 (3:45 min) Xwelíqwiya (Rena Point Bolton), a Stó:lō Matriarch, describes how she learned to cedar weave and the importance of cedar weaving.

Preparatory Notes

In this unit, students will design a woven table mat using a collaborative process simulating the Master Artist – Apprentice Model. Avoiding a "trivializing," crafts-focussed approach to this activity is important. Please review the material on "Permissions, Protocols, and Respectful Practice" in the Foundations section of this guide.

Be sure to emphasize with your students the importance of Indigenous protocol and of the sustainable harvesting practices used when cedar is harvested for weaving.

Weaving has been a practice along the western coast of North America for tens of thousands of years, from the Tlingit in Alaska to the Ktunaxa in Washington. The examples found up and down the coast have used a variety of weaving materials including, but not limited to, cedar bark, spruce root, and wool. The materials chosen are dependant on access, seasonal changes, and protocols of access to traditional territories. Different protocols and harvesting are dependant on the Nation, territory, and time of year. In this mini-unit, the material that we will be focussing on will be cedar bark.

Applicable Blackline Masters

BLM 8 – Growing Chevron Pattern Fish
BLM 9 – Imitation Cedar Strips (Alternating)
BLM 10 – Imitation Cedar Strips (Yellow Cedar)
BLM 11 – Imitation Cedar Strips (Red Cedar)
BLM 12 – Cedar Mat Graphing Game
BLM 13 – Chevron Mat Game
BLM 14 – Blank Chart
BLM 16 – Keep or Toss Game Sheet A
BLM 16 – Keep or Toss Game Sheet B
BLM 17 – Cedar Mat Design Options (variety)
BLM 18 – Cedar Mat Design Options (using 2 alternating strip sheets)
BLM 19 – Cedar Mat Design Options (using solid yellow and red strips)
NOTE: Some of these Blackline Masters provide images (e.g., imitation cedar strips) for students to cut out and use in the absence of natural, real-world materials. If you opt to work with these, you and/or your students may find it helpful to refer directly to the on-line pdf version of this guide, which is in colour.

Other Suggested Resources (Optional)

- *Story of Cedar, Cedar Hat Weaving & Bark Pulling* Cowichan Coast Salish (29:16 min) https://www.youtube.com/watch?v=95rPwCDHOCE.
- https://cchauve.github.io/Callysto-Salish-Baskets/ A collaboration between the Department of Mathematics at Simon Fraser University and basket weavers from the Tla'amin Nation investigating how to mathematically replicate the motifs/patterns seen in in many Coast Salish woven baskets.
- http://www.authenticindigenous.com/artists/peter-thomas-mckay Peter Thomas McKay speaks about his work as a cedar weaver.
- Calder, Tannis. (2020) *From Patterns to Linear Relations in a Ts'msyen Context*. Aboriginal/Indigenous Education Dept. of SD52. https://sd52wap.wixsite.com/abed/resources.

Guiding Questions

- What features in a woven pattern can be described mathematically?
- What are the mathematical concepts inherent in the process of weaving?
- How can we use mathematical concepts to replicate patterns seen in cedar and other textile weaving?

Activity 1: Introduction to Weaving

Show students a variety of examples of cedar bark weaving and Coast Salish wool weaving and discuss the patterns that are visible. Are they growing patterns, shrinking patterns, repeating patterns? Are there examples of symmetry? Become familiar with the Context-Setting Introductory Material for Students and share it in an engaging way with your students (e.g., by means of a discussion, presentation or other meaningful sharing of information). If there are students in your class who have knowledge or experience of First Nations weaving practices, this is an opportunity for them to share with the class. From the supplied list of Weaving-related Videos, select videos to show the students. Ask them,

- What do you see?
- What questions do you have?
- How does cedar weaving relate to place and community?

Activity 2: Weaving Patterns with Imitation Cedar

In this activity, students will learn how to weave an increasing chevron pattern using imitation cedar strips like the example below. This activity involves using algorithmic thinking to solve a problem.

Resources and Materials

- video http://bit.ly/cedarfish
- one copy per student of BLM 8 – Growing Chevron Pattern Fish
- two copies per student of BLM 9 – Imitation Cedar Strips (Alternating)
- masking tape
- scissors

Show students the large mat woven by Rena Point Bolton (http://www.narrativethreads.ca/explorer-explore/tapis_en_cedre_tisse-cedar_mat.html). Explain that the pattern that they will be learning to weave is found within the large mat (it is a quarter of the nested boxes motif).

Show students a completed example of the woven mat trimmed to resemble a fish with the growing chevron pattern. Explain that they will learn how to use an algorithm to weave a fish that looks just like the example.

Algorithmic thinking is a way of getting to a solution through the clear definition of the steps needed. Usually, skilled cedar weavers learn how to weave patterns by watching and learning from master weavers. Many techniques and patterns have been passed down for generations. Some weavers may create new patterns using prior knowledge, experimentation, and creativity. An algorithm is a clearly defined set of instructions that, when closely followed, will result in replicating a desired result. A common type of algorithm you may have used before is a recipe. Computer programmers often use algorithms to tell computers how to do things because computers are very good at following directions; but they are not good at being creative. Sometimes algorithms have repeated steps for forming patterns.

Weavers can use algorithms to recreate patterns others have taught them or to help describe to others how they weave their designs and patterns. The algorithm to complete the chevron pattern is made up of rules, or instructions that repeat, making it easier to continue the design once you know the pattern.

- Demonstrate how to weave the chevron pattern using the algorithm. (See video or algorithm BLM 8 – Growing Chevron Pattern Fish for further guidance http://bit.ly/cedarfish.)

- Distribute two copies per student of BLM 9 – Imitation Cedar Strips (Alternating). Have students cut out 2 sets of imitation cedar strips with alternating colours and tape them down (one vertical, the other horizontal overlapping). If colour differentiation is a challenge, you and/or your students may find it helpful to refer directly to the on-line pdf version of this guide, which is in colour, and enhance the BLMs using highlighters or other colouring tools.
- Explain that you will be using a rule while weaving so that the pattern emerges. The rule is: If it is the same colour, fold the strip below it back before laying the new strip down. Or simplified: same colour, put it under.
- Invite students to cut them out as directed on the sheet and overlap and tape to the desk along the "Do Not Cut" strip to secure in place.
- Weave as demonstrated.

Guest Weaver

Invite a First Nations cedar weaver to the class. Due to the cost of cedar bark, you may want to consider making just one larger piece as a class by taking turns working in small groups with the role model.

While students are waiting for their turn, they can play the games from earlier lessons, or continue working on their imitation cedar weaving.

Activity 3: The Cedar Chevron Pattern Investigation

This activity pursues the investigation into visual decreasing patterns. Show the Chevron pattern that you created earlier and discuss the types of patterns you see (alternating, repeating, pattern moving from the corner outwards, growing from the corner outwards, etc.)

> ***Resources and Materials***
> - square tiles in two different colours (you will need approximately 30 tiles of each colour for each pair of students)
> - *Nested Boxes Cedar Weaving Mat* by Artist Rena Point Bolton
> - dry erase pockets and markers
> - graph paper

Distribute coloured tiles to the students and invite them to recreate the pattern starting with the mouth and working outwards using different coloured square tiles. As an alternative, students could colour squares on a sheet of graph paper.

Record the number of tiles used in each layer (chevron shape) before switching colours in a T Chart like the one below. Begin with only the left-hand column filled in. As a class, fill in the right-hand column together for the first 4 chevrons.

layer (chevron)	# of squares	
1	1	+2
2	3	+2
3	5	+2
4	7	
5	?	

At this point stop and ask the class if they can see a pattern in the number of tiles. (Are the numbers increasing or decreasing? How much is it incresing with each chevron?) Draw arrows and + 2 symbol to show that the numbers are increasing.

How many tiles do you predict will be needed for the the next chevron? Invite the class to use the tiles and complete the chart. Regroup as a class and check: Were their predictions correct?

Ask the class, if a weaver wanted to make a very large mat with 100 chevrons in the design, but first wanted to model the design on paper, how many squares will be needed to complete the 100th chevron (chevron)?

Ask them: ***What is the rule for <u>any</u> chevron number?***

Have students share their thinking. Tell them they are thinking like mathematicians when they express a pattern rule in the form of a generalization that works for <u>any</u> number.

	chevron	squares	
(1 x 2) -1	1	1	+2
(2 x 2) -1	2	3	+2
(3 x 2) -1	3	5	+2
(4 x 2) -1	4	7	
(5 x 2) -1	5	9	
	(chevron# x 2) - 1 = squares		

Steer them toward thinking about what **operations** (adding, subtracting, multiplying, or dividing) must be used. Ask if they can see the **relationship** between the # of terms and the number of squares. (multiply by 2, then subtract 1).

Write out each equation next to chart to help solidify the idea. (see diagram on the left).

If students are having difficulty finding this relationship it is useful to look at linear patterns that do not have constants. Use the following examples to bridge their understanding.

Show the relationship of the number it is increasing by and the number the term must be multiplied by to get the output.

See also *From Patterns to Linear Relations in a Ts'msyen Context* for a full lesson.

Term	Output	
1	2	+2
2	4	+2
3	6	+2
4	8	
5	?	

2 x term = output

Term	Output	
1	5	+5
2	10	+5
3	15	+5
4	20	
5	?	

5 x term = output

Rule: **chevron x 2 - 1**
or **c x 2 - 1**

Explain that t = the number of chevrons. This letter is called a ***variable.*** A variable is a symbol for a number we don't know yet. It stands for ***any*** number. It is called a variable because it can ***vary*** or change. You can use any letter for the variable, but it is a good idea to use a letter that helps you remember what you are counting, so we are going to use **c for chevron #**.

Another common letter choice is **n** which is easy to remember because it stands for "**n**-y" (any) number. In higher levels of math, the variables x and y are commonly used, but x is sometimes avoided at lower levels due to common confusion with the multiplication symbol.

Note: c x 2 – 1 (or 2 x c - 1) is an **expression** or **relationship** that can be simplified to a single number. It's like half of an equation. An equation is a statement of two expressions that are equal.
We can swap the variable in the expression with any chevron number to find out how many squares there will be in total. To find out how many squares there will be in the 30th chevron, **c = 30**

(2 x c) - 1
(2 x 30) - 1 *(swap out the* ***c*** *for 30)*
60 - 1 *(simplify)*
59

Explain that they can find the number of squares for any chevron number using this relationship. Explain that mathematicians usually leave out the multiplication sign and write the expression like this:

Expression Rule: 2c - 1

hidden **multiplication** symbol

The number multiplied by the variable is called a **coefficient**.

Note: Mathematicians always write the coefficient *before* the variable so c2 – 1, though technically not mathematically wrong, is not written correctly according to conventions.

Practical Usage: Twining the edges.

Now that the generalization is known, how might a weaver use this information when planning their cedar mat? If you wanted to finish the edges of your fish shaped mat by twining the edges where the fins protrude from the final chevron with sinew, you could use this information to determine about how much sinew would be needed. Twining is achieved by twisting two strands of thin bark or sinew between strips of cedar bark. See video https://www.youtube.com/watch?v=Y0Rn_mgTBKA&list=PL3wBN-dh9DMT-043en5-6YYpTuLogAwkU&index=8 and skip to 11:30 – 14:50 for an example of twining. Assuming that each square represents a centimetre, how much sinew would be needed for a mat with any number of chevrons?

(2c-1) x 2

Note: the expression must be multiplied by two because 2 strands are used when twining. Weavers would also add on a bit more, because the twisting in and out of the cedar strips also uses up some of the length of twine.

Calculate the minimum length needed for a fish mat with 30 chevrons.
Calculate the minimum length needed for a fish mat with 100 chevrons.

Formative Assessment: Keep or Toss Game

The object of the game is to get the largest output number by strategically placing rolled digits into various places in the expression. This game can be played in a small group or in pairs. Each group will need a one ten-sided die to share and a game sheet for each player.

Resources and Materials

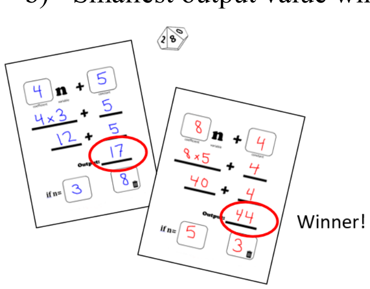
- 10-sided die
- BLM 15 – Keep or Toss Game Sheet A

The first player rolls the die and each player individually decides where to place the digit, as the **coefficien**t, the **constant**, the **value for n** (the variable) or in one of the two the garbage bins.

Repeat taking turns until the die has been rolled 5 times and all blanks have been filled. Players then evaluate (find the value of) their own expressions. The largest output value wins a point!

Variations:

a) Change the + sign to a – sign and try adding the constant instead of subtracting it!
b) Smallest output value wins.

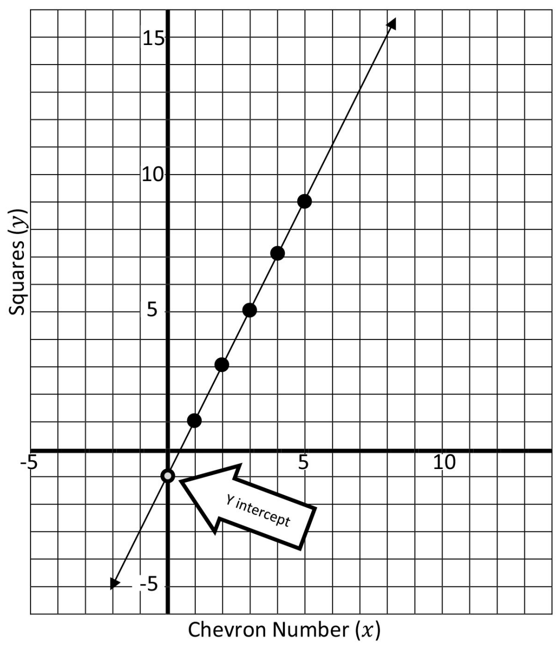


Activity 4: Graphing the Cedar Chevron Pattern

You can introduce graphing once students are confident in finding the rule or generalization. Explain that sometimes mathematicians like to show how numbers are changing by ploting it on a chart or graph.

Review the chart of the cedar chevron pattern. Show how the chart can also be shown in a graph.
Graph the expression with the variable x standing for the chevron number (term number or input) and y as the number of squares in the chevron (output): $\boldsymbol{y=2x-1}$

Show how the plotted dots for each stage of growth connect together to make a straight line. Because it makes a straight line, we call this a ***linear relation***. This is called a 'relation' because there is a relationship between x and y.



y = 2x - 1

x chevron	y squares
1	1
2	3
3	5
4	7
5	9

Explain that the place where the line crosses the y axis is called the **y intercept** (where x = 0).
Ask the students if they can find where the y intercept is in the expression rule. (the constant: -1)

The **slope** of the line shows the line increasing by a factor of 2 (It goes up 2 y every increment of x). Ask the students if they can find where the slope is in the expression rule. (the numerical coefficient: 2)

Practice Game: Cedar Mat

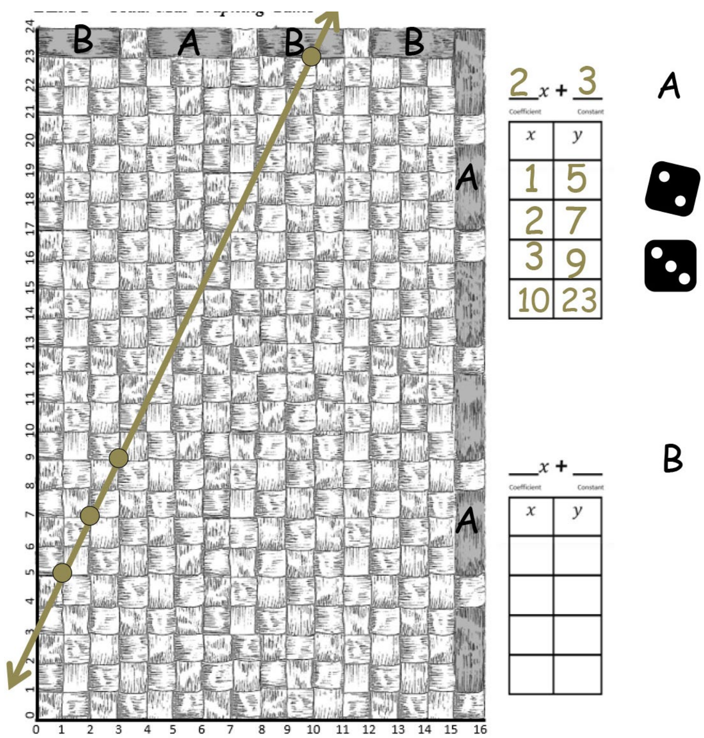
The purpose of this game is to graph a line on a chart to hit a target. If the line touches your edge piece, you win a point!

> ***Resources and Materials***
>
> For each pair of students (players):
> - one copy of BLM 12 – Cedar Mat Graphing Game in a dry erase sleeve
> - one dry erase marker
> - 2 dice

1. Taking turns, players A and B choose 2 or three dark border pieces each, Label player A or B.

2. Player A rolls both dice. Choose one number to be your coefficient and the other to be the constant. Write above a T Chart on the right side of the page. Repeat for Player B

3. Player A chooses values for x and then simplifies to find the value of (y) for each x value, completing one of the T charts on the right side of the BLM. Repeat for Player B (Once players have a good understanding of how to graph the line using the slope and y intercept, they can skip this step.)
4. Player A plots points and graphs the expression on the chart. Repeat for Player B
5. Any lines crossing through a claimed border section wins a point for the player that claimed it. (In the example below, Player B gets a point from player A's Line).



Questions to ponder while playing the game:

- Which border pieces are the hardest to hit?
- Where does the line cross the Y axis and how is it related to the expression?

Activity 5: Rainbow Pattern Investigation

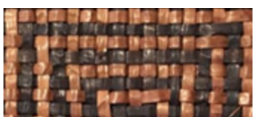
Resources and Materials

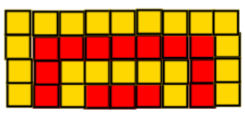
- square tiles in two different colours (you will need approximately 30 tiles of each colour for each pair of students)
- cedar mat nested boxes pattern (electronic resource or copy for each pair)

Show students the square nested box pattern up close image and discuss the types of patterns you see (alternating or repeating pattern moving from the centre outwards). This pattern can be seen on baskets as well as partition mats that were used to divide living space

View gallery

Cover a portion of the pattern so that it makes a rainbow pattern. Challenge them to recreate the rainbow pattern with coloured tiles or graph paper and chart each layer of alternating colours (each term), starting with the 3 dark tiles at the bottom-centre





term (n)	squares	
1	3	+4
2	7	+4
3	11	+4
4	15	
t	?	

At this point stop and ask the class if they can see a pattern in the number of tiles. (Are the numbers increasing or decreasing? How much is it increasing with each term?) Draw arrows and a +4 symbol to show that the numbers are increasing.

Ask students to generalize (make a rule) for any term number. Remind them that the regular increase (+4) is repeated addition and that another way to show repeated addition is multiplication.

4n + ???

In this case, multiplying the coefficient by the variable gives you an output that is larger than the actual number of blocks. Can we add a constant to make it work?

> Answer: *We can add a negative number, but most students will find it a little abstract to add negative numbers, so it is easier to explain it as subtracting the constant: "Instead we have to* ***subtract****. The constant is -1"*

Therefore, the generalization is:

4n – 1

Verify your generalization by checking a known term:
Example: verify if n = 3
4n – 1
4(3) – 1
12 – 1
11

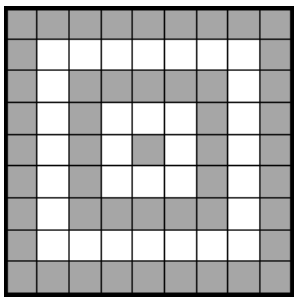
Activity 6: Increasing Patterns with Irregularities

Show the square nested boxes pattern once again, and discuss the types of patterns involved (alternating or repeating pattern moving from the centre outwards, growing from the middle outwards).

Demonstrate how to recreate the first 3 terms using square tiles or on graphing paper.

Resources and Materials

- square tiles in two different colours (you will need approximately 30 tiles of each colour for each pair of students)
- dry erase pockets and markers
- graph paper



Hand out T charts in dry erase folders with markers to each pair.

Invite the students in pairs to replicate the pattern using square coloured blocks or graphing paper, starting at the centre. Record the number of squares used in each term on the T chart, as in the previous activity. Ask them to stop after the 5th term.

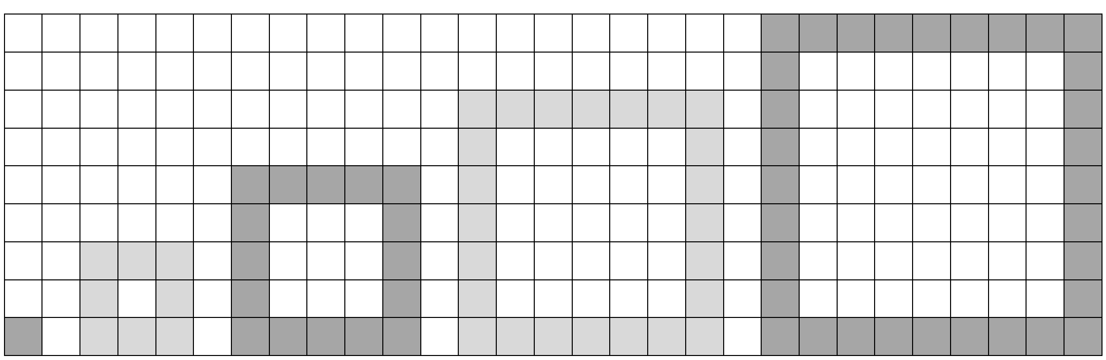
Term	Blocks
1	1
2	8
3	16
4	32
5	40

+7
+8
+8
+?
+?

Ask students if they notice an anomaly in the pattern (the jump from term 1 to 2 is different from all other changes) (+7 rather than +8).

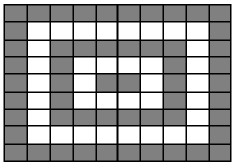
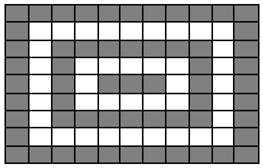
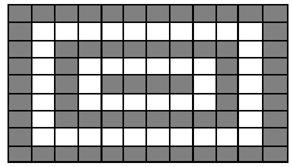
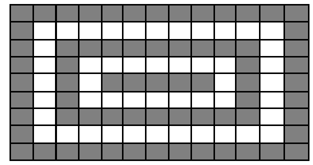
Discussion Topics

- Is this a linear pattern (no, not until term 2, then it becomes linear – graph to show how the coordinates of term 1 do not fall on the line with other coordinates).
- Is there a visual reason why term 1 might not be part of the linear pattern? (It might be helpful to reorganize the blocks in each term so that they are side by side. Ask them to look at terms 1 and 2 and to check if there is anything about either of them that is unlike the others. (Term 1 has a different shape: it is solid, not hollow like the rest).



Investigation

Part A: Do all nested box patterns with a solid centre have anomalies in the linear pattern? Use tiles or graphing paper to build variations of the nested boxes pattern with different sized centers. Is there a pattern to which ones have anomalies in their growth and which ones don't? Make a hypothesis and test it.

Solution: Nested box patterns are only linear starting with the first term that surrounds the centre (not including the centre). The centre is not part of the pattern. A nested box pattern with a two-square centre may appear to follow the linear pattern but this is coincidental. This can be examined closer – all nested box patterns have rings that grow by a factor of 8, but the growth from the solid centre to the first ring does not remain constant.

Solid centre	1st ring	
1	8	+2
2	10	+2
3	12	+2
4	14	
5	?	

Part B: After checking all 5 of the nested box patterns, see if you can find a pattern in the relationship between the number of solid-centre squares and the number of boxes it takes to surround the centre with the first ring. Fill in this chart to see if the pattern is linear. (Yes, it is!)

Activity 7: Collaborative Cedar Mat Project

Resources and Materials

- cedar strips or copies of BLM 9 – Imitation Cedar Strips (Alternating), BLM 10 – Imitation Cedar Strips (Yellow Cedar), and BLM 13 – Imitation Cedar Strips (Red Cedar)
- BLM 17 – Cedar Mat Design Options (variety)
- BLM 18 – Cedar Mat Design Options (using 2 alternating strip sheets)
- BLM 19 – Cedar Mat Design Options (using solid yellow and red strips)

Have students work on designing a large mat together. Explain that when large projects require more people working on it than just one artist, often a master artist will employ apprentices to work under the master to complete a project.

If possible, see if a master First Nations weaver is able to come into your class to plan a large-scale weaving project. If this is not possible, you may need to stand in this role. The master weaver, with guidance and suggestions from the class will design a mat using a number of squares (quilt style) that can later be woven together. Any of the designs shown in the booklet, *From Patterns to Linear Relations in a Ts'msyen Context*, may be incorporated into the larger design. Use the design options (BLM 18 – Cedar Mat Design Options [variety], BLM 19 – Cedar Mat Design Options [using 2 alternating strip sheets], or BLM 20 – Cedar Mat Design Options [using solid yellow and red strips]) to cut out and plan different designs. Plan the mat using a smaller scale and then assign sections to students to work on.

If real cedar is not available, the paper weaving strips may be used: see BLM 9 – Imitation Cedar Strips (Alternating), BLM 10 – Imitation Cedar Strips (Yellow Cedar), and BLM 11 – Imitation Cedar Strips (Red Cedar). The "Do not cut" section on the weaving strips may be carefully cut off or apart if students wish to weave the strip together into one mat. Alternatively, the paper mats can be glued or taped together on the back. If you opt to work with paper in the absence of natural, real-world materials, you and/or your students may find it helpful to refer directly to the on-line pdf version of this guide, which is in colour.

Mini-Unit: Coast Salish Wool Weaving

(Exploring Visual Patterns in Weaving)

Context-Setting Introductory Material for Students

(for teacher-facilitated sharing in a whole-class setting)

Wool weaving has been practised along the western coast of Canada for thousands of years, from the Tlingit in Alaska to the Ktunaxa in Washington. A variety of materials are used to make fiber; but the materials chosen by nations are dependent on access to the materials, seasonal changes, protocols of access to traditional territories and their ability to trade with other nations. The material we are focussing on in this unit is wool.

About Salish Weaving

When the women created the blankets, they did so with an awareness of the spirit world and the connections that people have with everything else in the world. They also had a deep respect for the knowledge that our ancestors had that continue to be passed down from generation to generation. The blankets are objects of power and, in a way, are alive. Please note that spirituality for Indigenous Peoples is not defined as religion but is how they are connected to the people, place, animals, plants, and the ecosystems that surround us. The artist's state of mind (emotions and physical well-being) plays a huge part in the weaving as these can be transferred into it. It is important as we are weaving that our intentions are good and that we are as positive as we can be while we work.

The fibers are harvested and prepared from spring to the fall. The fibers are spun in the winter months with the weaving happening during that time as well. The women mainly used mountain goat hair along with some dog hair and plant fibers to supplement and add warmth. The white mountain goat fiber is a symbol of purity and new beginnings. Hair from two mountain goats would make an average sized blanket. Plant dyes were used to colour the wool. They used brown, gray, black, white, and green from plants and tree barks. Green, red, blue, yellow, black, and white come from combined plants and minerals. What they could not find locally they traded for or had access to hunting/harvesting grounds through marriage, family connections, or trade alliances.

Tools were simple but often highly decorated. The spindle whorl was used for thick yarn and the drop spindle or thigh spinning was used for finer thread. The loom is not a true loom but is a fixed warp frame. It is a simple rectangular frame with the upper and lower beam supported on each side by long planks set into the floor. The sides of the frame are often highly decorated.

The Coast Salish people used three methods of weaving: tabby, twill, and twine. The tabby weave is the most basic and involves one warp thread going over one and under the next with every other row alternating the over and under. Twill weaving is a pattern of diagonal parallel ribs created by passing the weft thread over one or more warp threads then under two or more warp threads. Each row begins a step over. Twine weaving is the most ancient of the methods using two strands that are woven over and under opposite warp threads while twisting around each other. This is the method we will be using to weave the slant design. All three of these methods are used to add texture and pattern. Generally, blankets that are not dyed use twill weaving and blankets that have different colours and patterns use tabby and twine weaving.

Many objects are woven but the woven blankets were a source of wealth and a form of early money. Blankets were acquired to gain more wealth. Giving them to others gave prestige to the giver, created more social ties, and their generosity acknowledged, and repaid, in future feasts. A great chief is one who is able to tear blankets into strips and give them away at feasts. People would unravel their strips and reuse the material to weave a blanket. When used as money one blanket was traded for sixty fresh salmon. When Hudson Bay point blankets became available through trade three hundred were equivalent to thirty Coast Salish Blankets.

Today, Coast Salish people weave blankets, robes, sashes, and headbands. There are four types of blankets that they make: sitting, standing, memorial, and chiefly robes. A wedding blanket is also sometimes made double sized and draped around the couple's shoulders uniting them in spiritual protection. The sitting blanket is 0.6m by 0.9m and are given to people who are speakers, helpers in ceremony, or who made significant contributions to a feast. They are typically used to sit on when in a big house for a variety of occasions. The standing blanket is 1.2m by 1.2m and are used when starting a new stage in life. These are typically twill woven white blankets. People stand on them when getting a new name, leave childhood, or entering into marriage. These are also used to cover the big house floor with four of them piled in a central spot as a pure, clean space for witnesses and organizers to work. They are supposed to instill peace and calm. At the end, they are given as gifts to highly regarded guests or Elders. Memorial blankets are used to wrap the body in and also wrap a picture of the deceased. Four blankets placed under a chair that holds the picture are given to Elders but the blanket around the picture remain with the family. Chiefly robes are used in public events.

Many patterns are used in the blankets today and many designs are used to symbolize different things. For instance, triangles for mountains, wavy lines for the ocean, and a combination of two rectangles and a triangle for flying geese. Some patterns have been handed down for generations and are seen as belonging to particular weavers. Stories are often attached to the blankets and handed down as well. Often, weavers today, will think and dream about a pattern long before they weave it.

Haida, Tlingit, and Tsimshian people weave Chilkat Blankets. The Haida and Tsimshian also weave an earlier version of the Chilkat Blanket called Raven's Tail. These can be mentioned as examples of woven blankets in British Columbia along with the Coast Salish Blankets.

Preparatory Notes

In this unit students will weave a wool tile using a handmade loom. Avoiding a "trivializing," crafts-focussed approach to this activity is important. Please review the material on "Permissions, Protocols, and Respectful Practice" in the Foundations section of this guide.

Applicable Blackline Masters

BLM 20 – Loom Instructions
BLM 21 – DESMOS Instructions
BLM 22 – Cartesian Grid

Recommended Resources

- *Lily Hope Chilkat Weaver* (4:57 min) Video of Tlingit weaver Lily Hope explaining the process and significance of Chilkat blanket weaving. https://www.youtube.com/watch?v=YraJBuYfRgk
- *Weaving the Past in Whistler* (3:18 min). Alison Burns-Joseph (Squamish First Nation) talks about how she became a wool weaver has helped her connect to her culture and people. https://www.youtube.com/watch?v=wT2E6UjCn44
- Salish Woolly Dog Resources: Canadian Encyclopedia article by Regan Shrumm: https://www.thecanadianencyclopedia.ca/en/article/salish-woolly-dog

Additional Resources

- Chief Joe Capilano Blanket— https://www.youtube.com/watch?v=WLnBZgdbSyc
- Coast Salish Spinning and Weaving—UBC Blogs (pdf) http://blogs.ubc.ca/biologyinfosessions/files/2013/09/coast-salish-wool-dog-poster.pdf
- Coast Salish Weaving Lesson Plan (pdf) by Nadine McSpadden, https://aboriginalresourcesforteachers.weebly.com/uploads/3/0/3/5/30354089/exploring_patterns_through_coast_salish_weaving.pdf
- Hair from extinct B.C. woolly dog found in old Coast Salish blanket. Glenda Luymes. July 4, 2017: https://vancouversun.com/news/local-news/hair-from-extinct-b-c-woolly-dog-found-in-old-coast-salish-blanket

Guiding Questions

- Does the woven pattern create generally straight lines?
- Is the distance between any two lines the same distance all the way along both lines?
- How can you describe how steep each line is?

Activity 1: Introduction to Salish Weaving

Coast Salish people have developed weaving techniques for over 10,000 years. Woven blankets have been made by women from the mouth of the Columbia River in Oregon all the way north to Bute Inlet in British Columbia. The blankets are used for ceremonial purposes and are considered a status symbol of wealth and prosperity. Wearers of the blankets are often leaders in the Coast Salish communities. Traditionally, the blankets were also used as currency and bartered for goods.

Using resources such as the following, show students a variety of examples of Coast Salish wool weaving:

- *Musqueam Weavers Final* Museum of Anthropology (pdf) http://moa.ubc.ca/wp-content/uploads/2014/08/Sourcebooks-Weavers.pdf
- *Weaving a Quarter Bag* http://blogs.ubc.ca/aboriginalmathnetwork/files/2014/03/WeavingBagInstructions.pdf
- *Hands of Our Ancestors* by Elizabeth Lominska & Kathryn Berrick Johnson
- *Salish Blankets* by Leslie Tepper, Janice George & Willard Joseph
- *Salish Weaving* by Paula Gustafson

As students examine the different types of weaving you present to them, ask them to think about

- how the three different types of weaving (Twine, Twill, Tabby) are used to create different patterns and textures
- how colour and texture contribute to the pattern (e.g., How might one colour affect the pattern we see?)
- what possible story might be expressed in the patterns that are created.

Debrief by discussing students' perceptions and observations with respect to these aspects of the examples. Expand on the discussion by sharing the content and information from the Preparatory Notes for this mini-unit, as appropriate. If there are students in your class who have knowledge or experience of First Nations Weaving practices, this is an opportunity for them to share with the class.

Follow up by selecting from the following list videos and links to show the students:

- *Lily Hope Chilkat Weaver* (4:57 min) Video of Tlingit weaver Lily Hope explaining the process and significance of Chilkat blanket weaving. https://www.youtube.com/watch?v=YraJBuYfRgk
- *Weaving the Past in Whistler* (3:18 min). Alison Burns-Joseph (Squamish First Nation) talks about how she became a wool weaver has helped her connect to her culture and people. https://www.youtube.com/watch?v=wT2E6UjCn44
- *Salish Woolly Dog Resources*: Canadian Encyclopedia article by Regan Shrumm: https://www.thecanadianencyclopedia.ca/en/article/salish-woolly-dog
- "Hair from extinct B.C. woolly dog found in old Coast Salish blanket." Glenda Luymes. July 4, 2017: https://vancouversun.com/news/local-news/hair-from-extinct-b-c-woolly-dog-found-in-old-coast-salish-blanket

Give students a brief preview of what will be covered in this mini-unit and explain about the weaving project involved.

When starting the weaving project, have students consider to whom they will gift their first piece. In some First Nations cultures, when learning something new the protocol is to give away the first product created; so state of mind plays a part in the creation of this piece. The weaver needs to put positive energy and good intentions into it by (1) being extremely positive while weaving or (2) thinking of the gift's recipient and all the positive experiences this person has shared with the weaver. If the weaver doesn't have someone particular in mind, the piece can be kept until the right occasion arises. If during the weaving process, the weaver starts to feel angry, frustrated, or upset, suggest that she or he put it aside and take a break from weaving so that these feelings aren't transferred into the weaving. Such practices reflect our spiritual connections to the world.

Activity 2: Weaving Patterns with Wool

Preparing the Cardboard (Loom)

The cardboard used as the loom and the yarn should be prepared ahead of time. Demonstrate how to prepare the loom as shown in BLM 20 – Loom Instructions.

Weaving a Slant Design

Students learn to weave a slant design by following a modified set of instructions from Weaving a Quarter Bag by Anjeanette Dawson of the Squamish Nation at https://indigenous.mathnetwork.educ.ubc.ca/files/2019/08/WeavingBagInstructions.pdf. Note that the weaving process will take 2 or 3 instructional periods.

Resources and Materials

- BLM 20 – Loom Instructions
- BLM 21 – DESMOS Instructions
- 1.5 m of yarn of any colour for warps (for each student)
- 2 contrasting colours of Chunky Wool or Wool blend yarn cut to lengths of about 50cm
- yarn needles (optional)
- 12cm x 12cm cardboard
- scissors

On BLM 21, as students reach the end of the section "Weaving a Slant Design – Part 1," you may find that some try to save time by taking one colour and weaving it all the way to the end before going back to do the same with the other colour. This technique doesn't work, however. In twine weaving, the two strands need to be twined (twisted) together as you go. Although discovery learning and the First Peoples Principles of Learning both affirm the value of patience and time in the learning process, consider helping students avoid this particular error, which will require them to undo their work and start over.

Also note that when students reverse direction (start moving from right-to-left as opposed to left-to-right), if they don't follow the instructions carefully, they may end up creating a herring bone pattern, rather than parallel diagonal lines. If this happens, you can simply have students reverse the direction of the twining (e.g., red over black vs. black over red). Stress that small errors do not affect the overall linear pattern. Encourage students to use mathematical vocabulary throughout the weaving process and when helping others through the weaving process (e.g., "slope," "parallel lines," and "perpendicular lines").

Finishing

Once complete, show students how to weave in the ends and complete their weaving.

Activity 3: Slope (Equation of Line)

Students should have prior knowledge of slope and slope equations in slope intercept form. If they do not yet have this, refer back to *Activity 3: Graphing the Cedar Chevron Pattern* in the Cedar Weaving mini-unit (earlier in this resource guide) for an approach to covering it.

Activity 4: Graphing the Textile Weaving Pattern

Students will find the equation of the lines formed through weaving and describe the relationships that they find amongst the slopes. This lesson uses a web-based graphing program; however alternative no-computer based options will be provided.

Guiding Questions

- Does the woven pattern create generally straight lines?
- Is the distance between any two lines the same distance all the way along both lines?
- How can you describe how steep each line is?

Resources and Materials

- access to a computer lab with internet connections (optional)
- student Google accounts (optional)
- 2 digital photos taken (original and rotated 90 degrees) for DESMOS
- actual weaving projects from prior activities for non-computer option
- BLM 21 – DESMOS Instructions
- acetate transparencies of BLM 22 – Cartesian Grid for each group (for non-computer option)

Process (using DESMOS online)

Students will need a Google account to log into DESMOS. They will also need access to digital photos of their weaving prior to going to the computer lab. This can be done by taking photos with a smart phone and emailing them to the students' gmail accounts directly.

Demonstrate how to upload the weaving pattern image to DESMOS at https://www.desmos.com/calculator (see BLM 21 – DESMOS Instructions).

- On the left side of the screen at #2, type your best guess for the middle line using slope intercept form (y=mx+0) to calculate the drawn line that crosses through the origin.
- Layers #3 and 4, use the slope intercept form (y=mx+b) to find the other drawn lines

Process (without computer)

Students will need a transparency with BLM 22 – Cartesian Grid for each small group.

- Place the actual weaving or photo/photocopy of weaving under the transparency.
- Use a ruler to draw a line along the slant pattern that goes through the origin (0,0), one above and one below.
- Use the slope intercept form (y=mx+0) to calculate the drawn line that crosses through the origin.
- Use the slope intercept form (y=mx+b) to calculate the other drawn lines.

Repeat the above with the rotated image.

Formative Assessment

Ask students to answer the following questions using their weaving (have students compare their graphs and equations with each other as each woven tile will have a slightly different equation):

- A point of interest is that the same technique can produce so many different equations. Why would that be? (the size of carboard, the tension of the weave, errors…)
- What adjustments could be made in the process be made to affect that would result in different equations? (weight of the wool, size of cardboard, spacing of the warps…)
- Is the woven pattern straight? If not, did you use the line of best fit (a line that goes through the majority of the line).
- Are the line patterns parallel? How do you know? (Looking at the slopes/numerical-coefficient of each line, the student should see that they are the same. The y-intercept/constant can be different.)

Regarding the rotated image(s):

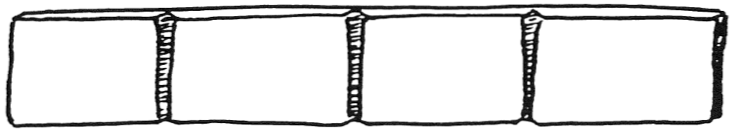
- Can you find the equation(s) for at least three lines of weaving?
- Are any lines perpendicular to the previous equations? How do you know? (Students should notice that the slopes of the rotated image are the negative reciprocal of the original. For example, original is $y = \frac{3}{4}x + 2$ and the negative reciprocal is $y = -\frac{4}{3}x + 2$. They should know that the product of the two slopes is -1)

Extensions

- Students can create line segments in DESMOS by including the domain (where the image starts and ends along the horizontal)
- Students can download images of other Coast Salish weaving and investigate their patterns and equations.
- Quarter bags can be made using a similar process. See videos below by Lynn Swift, Indigenous Education Curriculum Support Teacher- Elementary in SD 71 (Comox Valley).
  - https://www.youtube.com/watch?time_continue=4&v=xV2Gr-dVVFo
  - https://www.youtube.com/watch?v=KxCz50OppDs
  - https://www.youtube.com/watch?v=8H9eXh6r4s4
  - https://www.youtube.com/watch?time_continue=60&v=Z4kHXSOvwfw
  - https://www.youtube.com/watch?time_continue=5&v=5OiS8ES4BjA

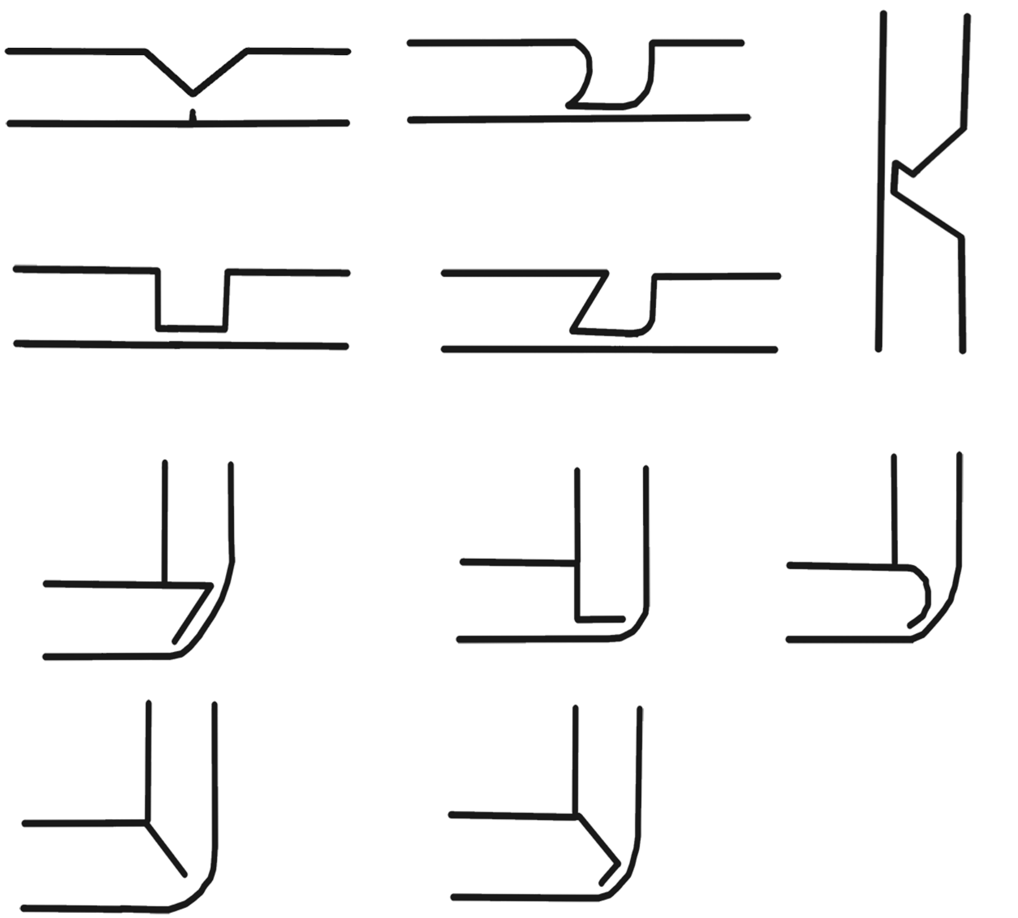
BLM 1 – *Bentwood Box Kerf Exploration*

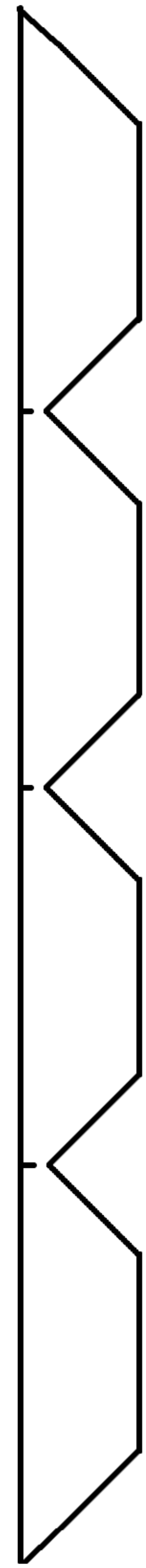
A kerf is the groove that is carved out on the interior side of a bentwood box before steaming and bending to help facilitate a bend without causing the wood to snap or break. A wooden plank is carefully prepared, and the three kerfs are carved in the places where the plank will be bent.



There are different styles of kerfs that can be used to make a bentwood box. Below are 5 examples of kerfs profiles shown both before bending and after bending. Cut out all 10 profile diagrams and bend or unbend them. Can you find the bent corner that matches each unbent kerf?

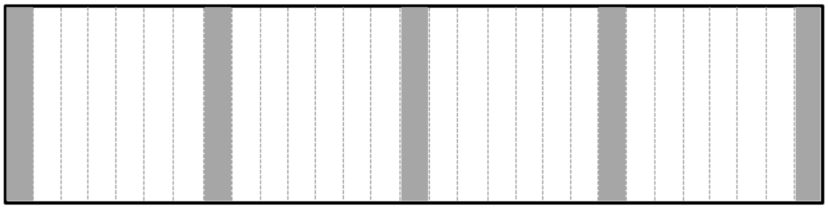
The long strip on the right with 3 kerf shows the profile of a full plank that can be bent into a full square.





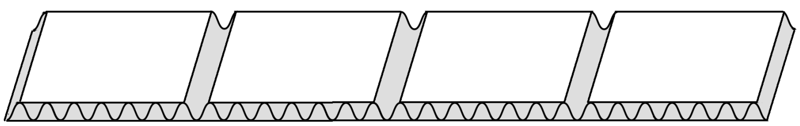
BLM 2 – *Modeling a Bentwood Box with Corrugated Cardboard*

1. When cutting strips of cardboard into "planks," make sure that the lines on the cardboard run as shown in the diagram below. This will become very important when carving out the kerfs.



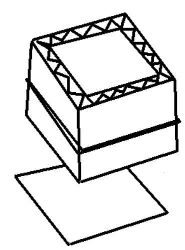
2. Divide your cardboard plank 4 sections of equal length, using the lines and spaces on the cardboard to gauge your measurement. Each section should be separated by one space between the lines (see shaded area in diagram).

3. Carve out the shaded areas by carefully removing one layer of the cardboard. These will become your kerfs.



4. Bend the cardboard to make a box with the kerfs on the inside of each corner, hold together with an elastic band.

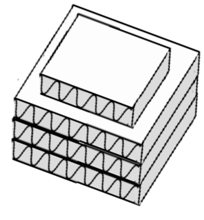
5. Trace the exterior perimeter on a piece of cardboard and cut it out to make a square for the bottom part of the base.



6. Trace the interior perimeter of the box to make the insert for the lid.

7. Glue the corner of the box together and to the base (or sew using a needle and thread). Continue to use the elastic band to hold the box together until the glue dries.

8. To create the top part of the lid, draw a square that is about 0.5cm wider and longer than the dimensions of the exterior perimeter. Cut it out and trace it to make 2 more squares the same size.

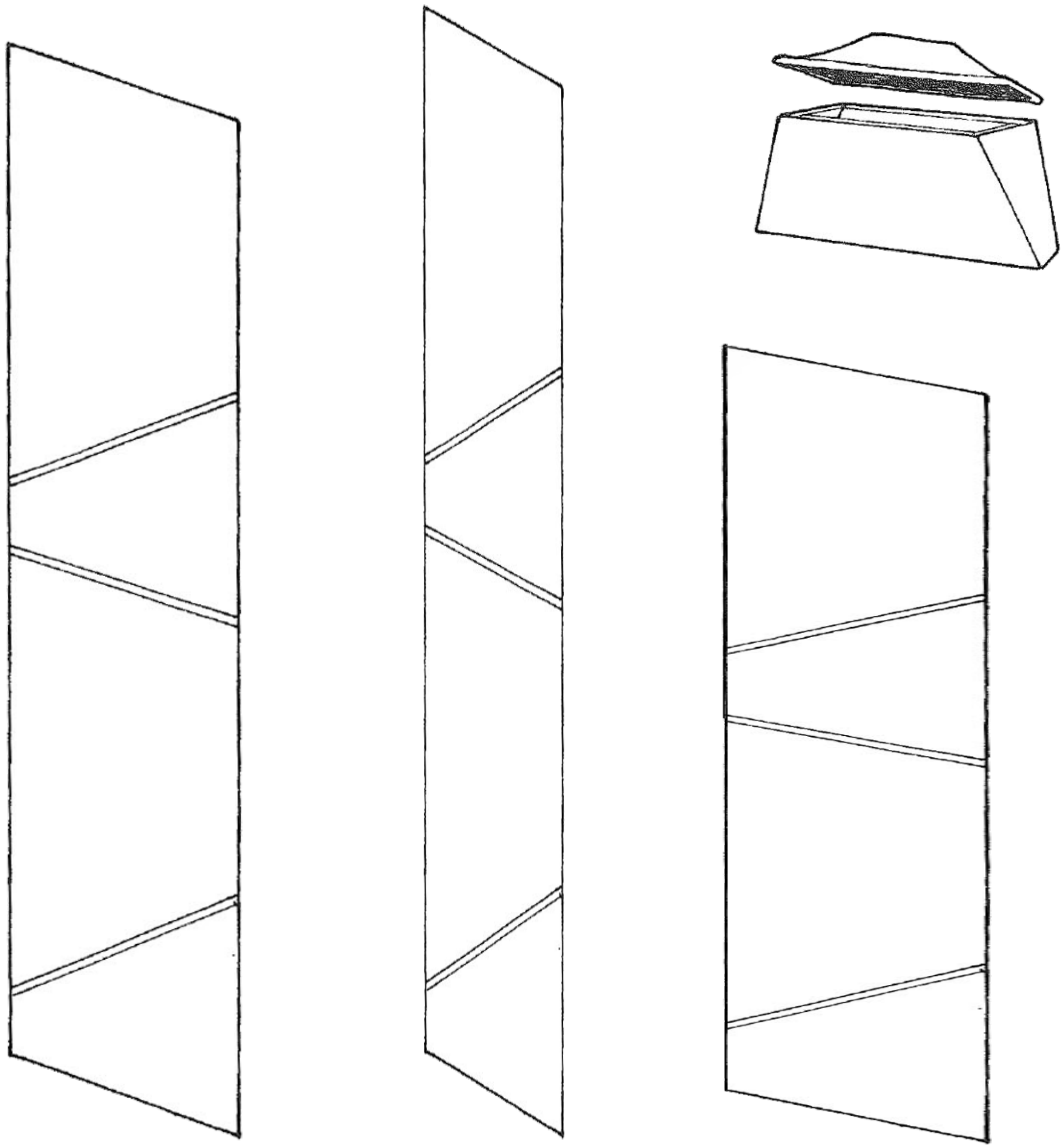


9. Glue the 3 upper lid parts together to make a lid with an appropriate thickness and glue the lid insert on the bottom layer. (Lid shown upside down)

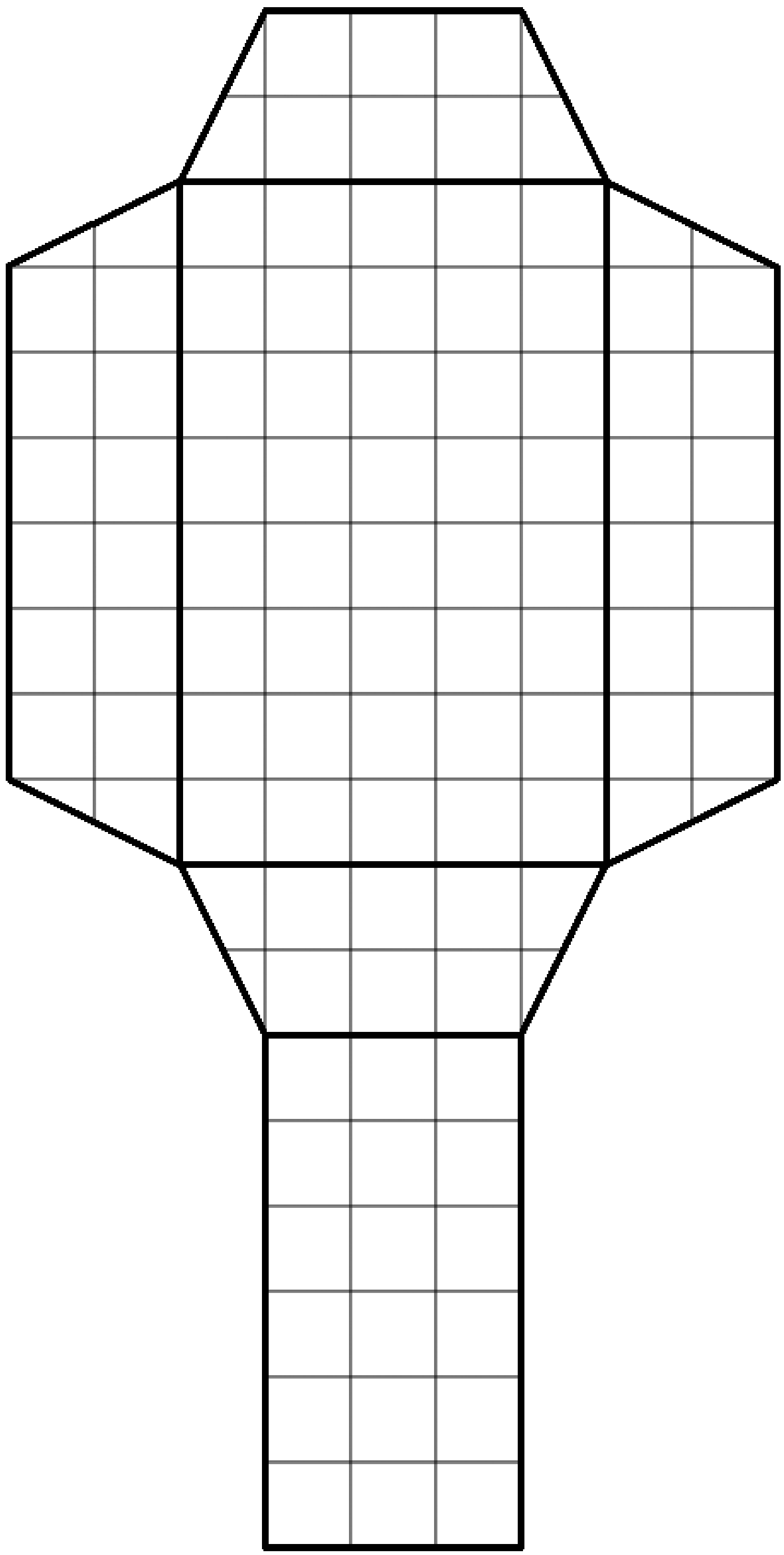
10. Let glue dry overnight and trim if needed when glue dries. Remove the elastic band and decorate your box if desired.

BLM 3 – *Canoe Box Angle Exploration*

Below are 3 different nets that, when bent along the kerf-lines, will form the sides of a box that fits into the bow of a canoe. Measure the angles for each trapezoid that makes up a face of the box. What do you notice? How could you use this information to design your own Canoe -bow box? What would the dimensions of the base and lid for each box be?



BLM 4 – *Template for Bentwood Box Lid Prism*



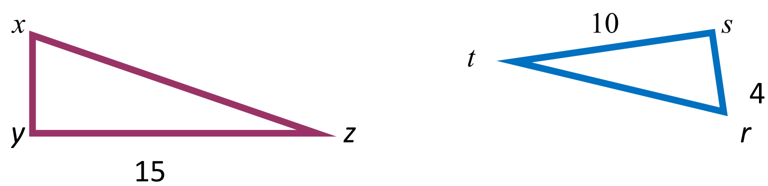
BLM 5 – *Similar Polygons*

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

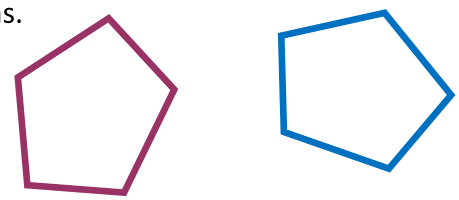
2. 

Which shapes are similar?

3. These triangles are similar. What is the length of side *xy*?

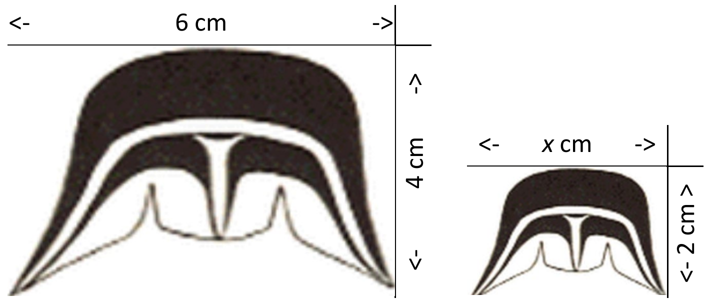


4. Measure the sides of the polygons.
Are they similar? Explain.



BLM 6 – *Scale: Use of Basic Design Shapes*

1. Jenny is designing a pattern to put on her blanket. This is one of the shapes she will be using. Jenny needs to reduce the pattern to fit on the border. How far apart should she make the bottom points of her inverted U shape?



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.

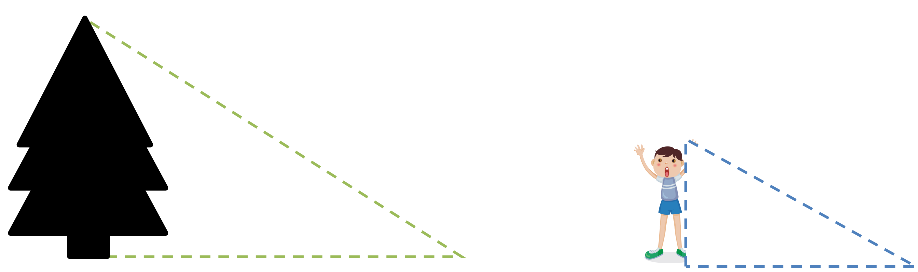
   Reduce by a scale factor of 1/3.

3. Draw a polygon, on graph paper, which you would use for a border around the bottom of a blanket. Draw 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?



BLM 7 – *Transformations*

Definitions

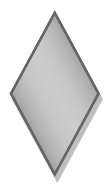
- **Symmetry** is when one shape becomes exactly like another if you flip, slide or turn it.
- The **line of symmetry** is the line that divides a 2-D shape in half.
- **Rotational symmetry** describes a rotating shape that, when turned less than 360 degrees, fits exactly over its original position.
- **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.

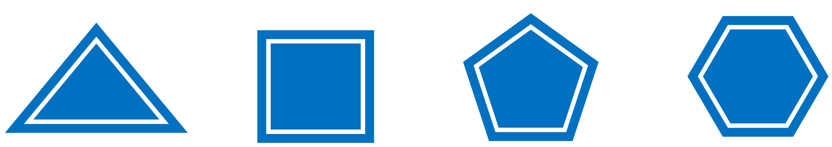
2. Draw and cut out this shape; the internal angle at C is 60 degrees. Rotate the shape (and trace) on the vertex to make a shape with rotational symmetry. What is the order of rotation symmetry?

   C = the centre of rotation

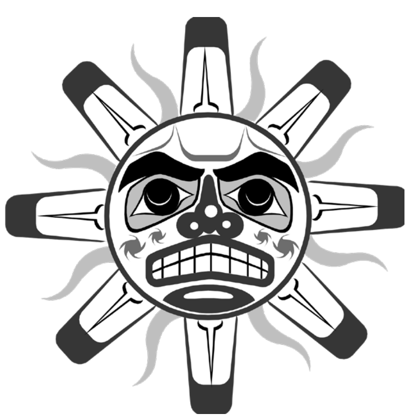


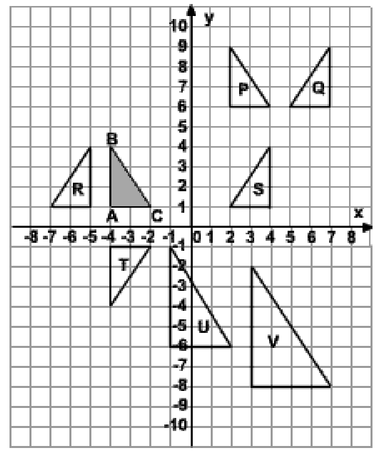
C

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. Consider the triangles pictured.

   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. Using triangle ABC perform 3 different transformations. What are the new co-ordinates for point 'C'?

6. Draw 2 similar triangles.

   a. Translate one triangle and describe the translation.

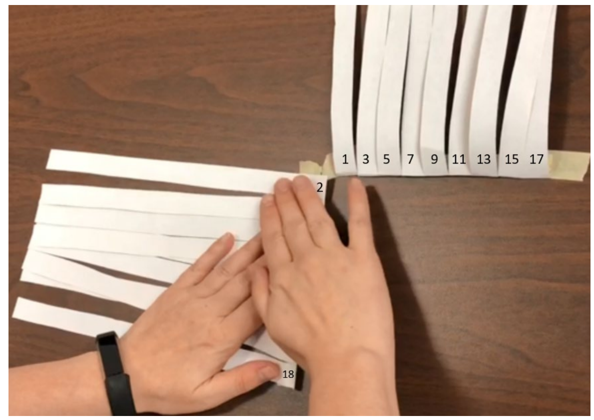
   b. Reflect one triangle and give the new coordinates.

   c. Enlarge a triangle to create a new similar triangle. Determine the scaled enlargement.

BLM 8 – *Growing Chevron Pattern Fish*

1. Cut out the strips

2. Tape down 1 set of strips vertically and the other strips horizontally so they overlap.



3. Fold back all of the strips

   Number the underside of the vertical strips from left to right with odd numbers (1,3,5,7, …)

   Number the underside of the horizontal strips from top to bottom with even numbers (2, 4, 6, 8, …)

   Flip down strip #1,

4. Check the colour of the next numbered strip and see where is will lay when flipped forward (colour side showing).

   a) Fold back (under side showing) any strips the new strip will cross over if they are the *same colour* as the new strip.

   b) Flip the new strip forward so it crosses over any strips that are a *different* colour.

   c) Flip forward (colour side showing) any strips you just folded back again so that they now cross on top of the most recently placed strip.

5. Repeat #7 until done, alternating vertical and horizontal strips.

6. Fold “Do not cut” tabs under and tape use glue stick to secure. Trim edges to look like a fish if desired, use scraps to make an eye and glue or tape on.

Simplified Rule: Flip back matching colours.

BLM 9 – *Imitation Cedar Strips (Alternating)*

DO NOT CUT

Imitation Cedar Weaving Strips

Instructions:

1) Cut off the white on left side of strips (do NOT cut off the white on the right side).
2) Cut off white area containg the title and instructions.
3) Cut between the strips leaving the DO NOT CUT strip attached.

BLM 10 – *Imitation Cedar Strips (Yellow Cedar)*

DO NOT CUT

Imitation Cedar Weaving Strips

Instructions:

1) *Cut off the white on left side of strips (do NOT cut off the white on the right side).*
2) *Cut off white area containg the title and instructions.*
3) *Cut between the strips leaving the DO NOT CUT strip attached.*

BLM 11 – *Imitation Cedar Strips (Red Cedar)*

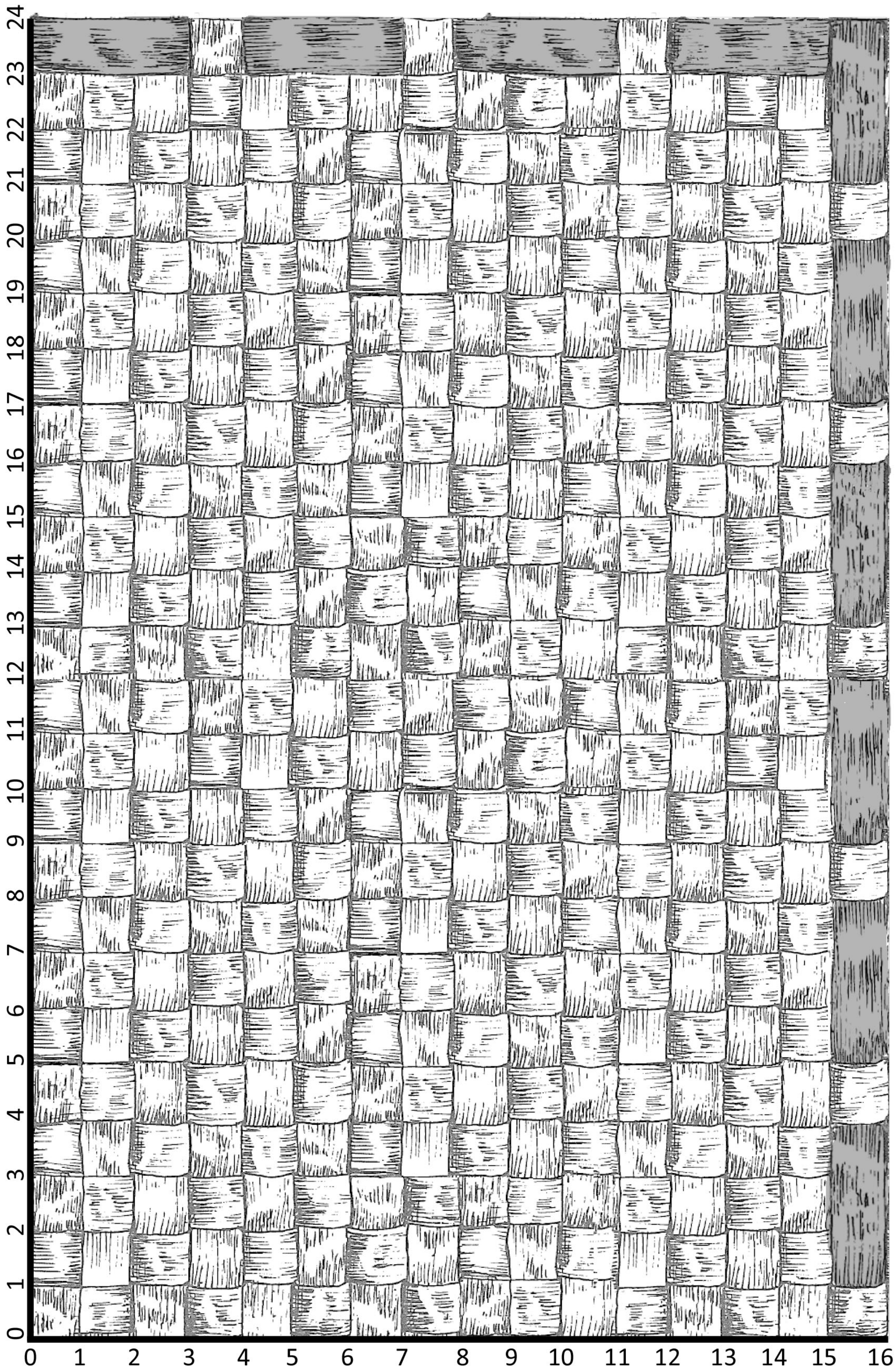
DO NOT CUT

Imitation Red Cedar Weaving Strips

Instructions:

1) *Cut off the white on left side of strips (do NOT cut off the white on the right side).*
2) *Cut off white area containg the title and instructions.*
3) *Cut between the strips leaving the DO NOT CUT strip attached.*

BLM 12 – *Cedar Mat Graphing Game*



___ x + ___

Coefficient Constant

x	y

___ x + ___

Coefficient Constant

x	y

BLM 13 – *Chevron Mat Game*

Roll and multiply by 100 to find the Co-efficient for your Rule

Rule:

chevrons	squares

____

____

____

BLM 14 – *Blank Chart*

Rule: ____________

BLM 15 – *Keep or Toss Game Sheet A*

(coefficient x variable + constant)

Directions: Roll a 10-siced die 5 times. Record the numbers and then make the largest output possible, by placing each number in the right "bin" (coefficient, variable, constant, or 2 trash bins)

Game 1

Die Roll Numbers: ____, ____, ____, ____, ____

[ ] **n** + [ ]

coefficient variable constant

________ + ____

______ + ____

Output: ______

if n= [ ]

Game 2

Die Roll Numbers: ____, ____, ____, ____, ____

[ ] **n** + [ ]

coefficient variable constant

________ + ____

______ + ____

Output: ______

if n= [ ]

Game 3

Die Roll Numbers: ____, ____, ____, ____, ____

[ ] **n** + [ ]

coefficient variable constant

________ + ____

______ + ____

Output: ______

if n= [ ]

Game 4

Die Roll Numbers: ____, ____, ____, ____, ____

[ ] **n** + [ ]

coefficient variable constant

________ + ____

______ + ____

Output: ______

if n= [ ]

BLM 16 – *Keep or Toss Game Sheet B*

(coefficient x variable - constant)

Directions: Roll a 10-sided die 5 times. Record the numbers and then make the largest output possible, by placing each number in the right "bin" (coefficient, variable, constant, or 2 trash bins)

Game 1

Die Roll Numbers: ____, ____, ____, ____, ____

n -

coefficient variable constant

______ - ____

____ - ____

Output: ______

if n=

Game 2

Die Roll Numbers: ____, ____, ____, ____, ____

n -

coefficient variable constant

______ - ____

____ - ____

Output: ______

if n=

Game 3

Die Roll Numbers: ____, ____, ____, ____, ____

n -

coefficient variable constant

______ - ____

____ - ____

Output: ______

if n=

Game 4

Die Roll Numbers: ____, ____, ____, ____, ____

n -

coefficient variable constant

______ - ____

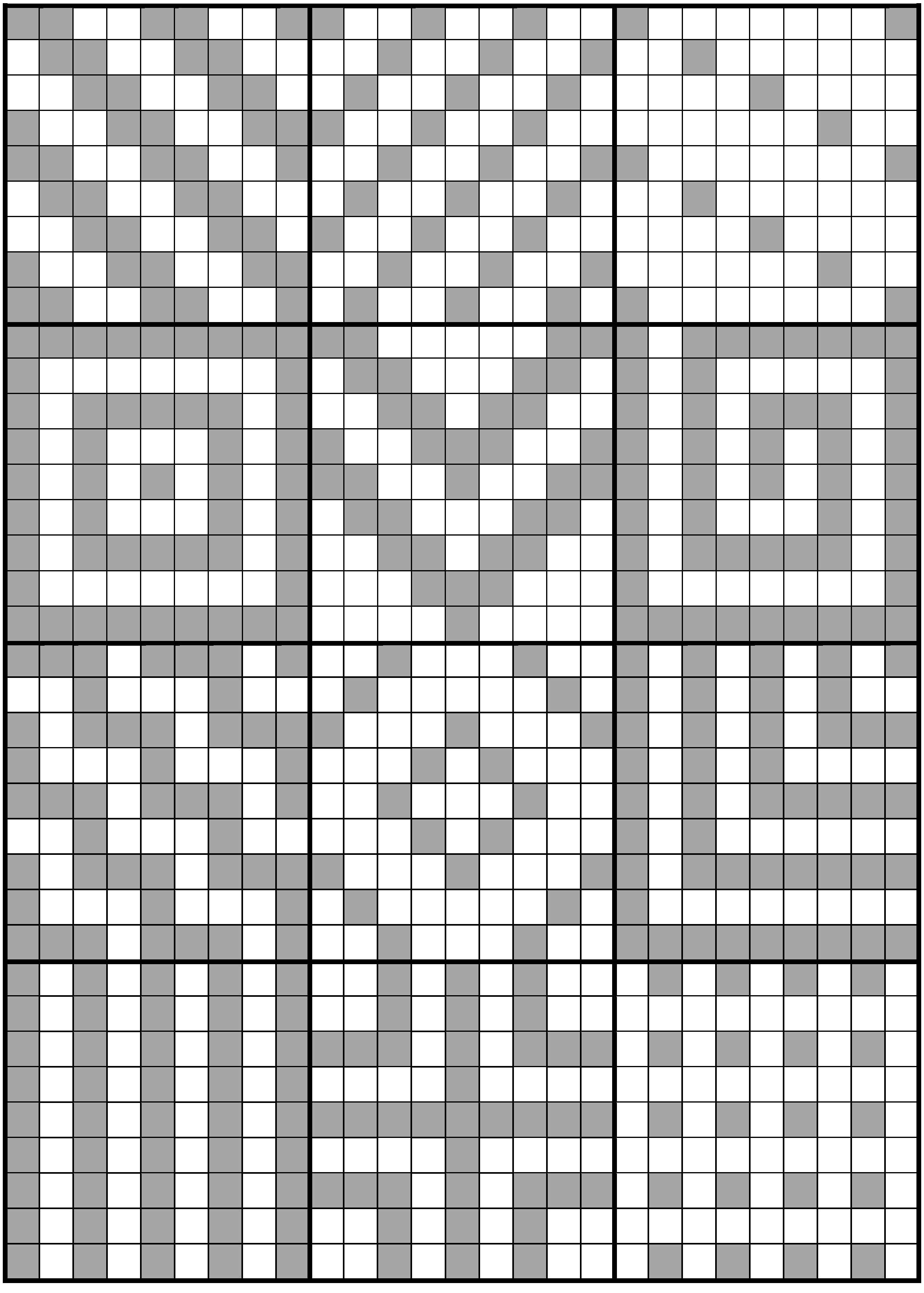
____ - ____

Output: ______

if n=

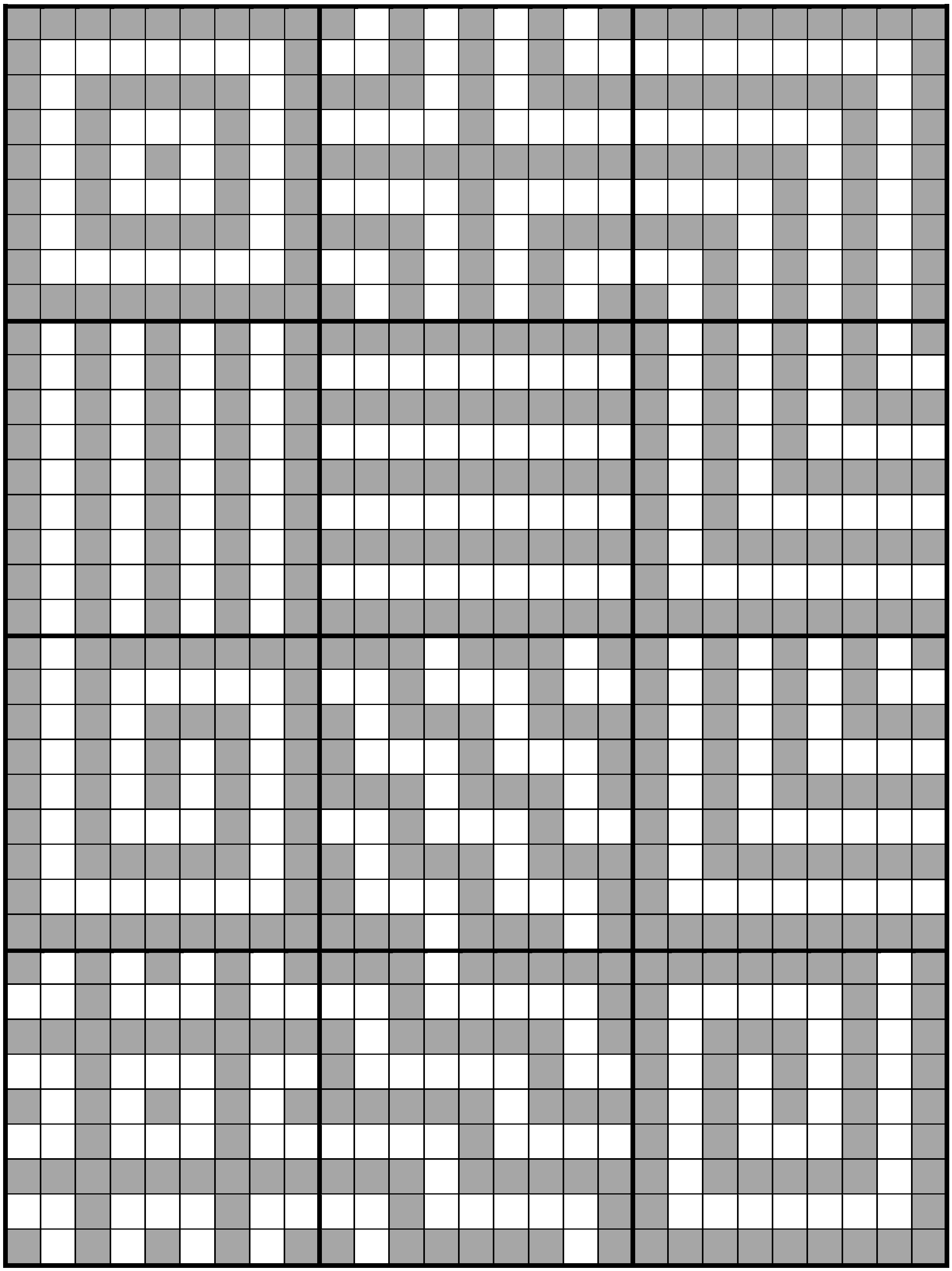
BLM 17 – *Cedar Mat Design Options (variety)*

Use the following pattern squares to plan a larger Cedar Mat design. Copy multiple pages and cut apart to create a design. Which strip sheets will be needed for each design?



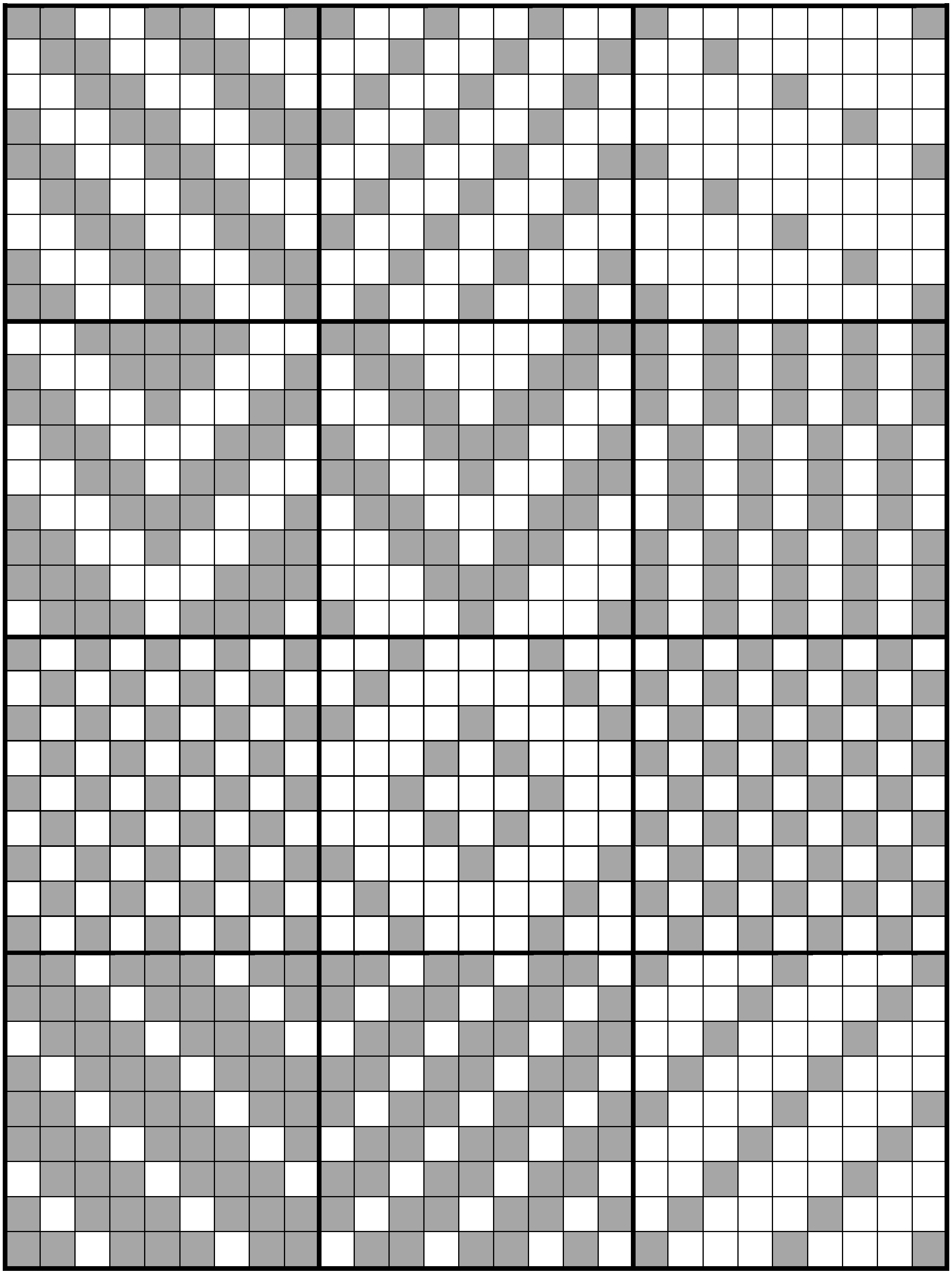
BLM 18 – *Cedar Mat Design Options (using 2 alternating strip sheets)*

The following patterns can be woven with 2 sets of coloured cedar strips. Use the following pattern squares to plan a larger Cedar Mat design. Copy multiple pages and cut apart to create a design.



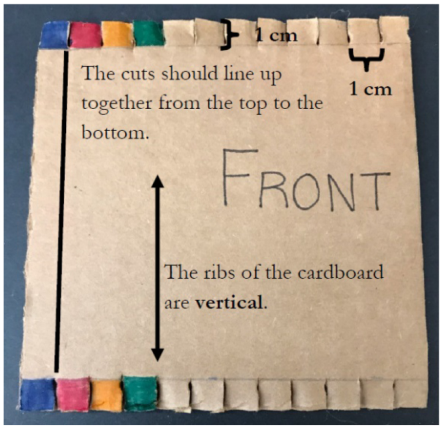
BLM 19 – *Cedar Mat Design Options (using solid yellow and red strips)*

The following patterns can be woven with 2 sets of solid colour (dark and light) cedar strips. Use the following pattern squares to plan a larger cedar mat design. Copy multiple pages and cut apart.



BLM 20 – *Loom Instructions*

Preparing the Loom:



Cut a **12cm by 12 cm square** of cardboard to make your loom.

Cut 1 cm notches in the top and bottom of the cardboard 1cm apart.

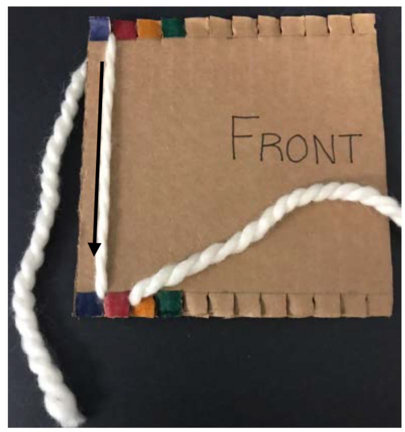
For your warp (yarn attached to the loom) cut a **1.5 m long length of yarn.** Beginners should use a colour that is different than your weft threads (the 2 colours you will see in the pattern).

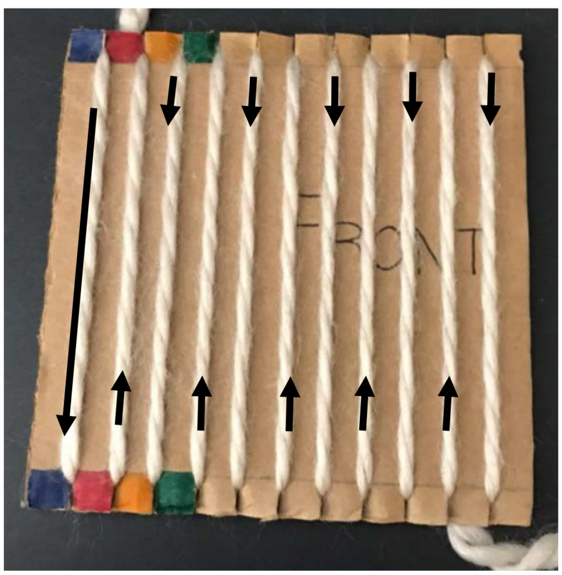
Leave at least 15 cm of yarn at the beginning of your loom. This will be woven into the end product. You may choose to make a knot at the back so that it does not slip out.

Warping the Loom:

Weave the warp yarn up and down on the front of the cardboard loom, tucking it under the cut taps at the top and bottom.

Leave at least 15 cm of yarn at the end of warping your loom as well.





Weaving a Slant Design - Part 1

To start weaving, take two different coloured yarns and knot them together on one end. We are using the twine weaving method that was used by Coast Salish people and this requires weaving two strands into the warp, twining them together as you go. Each piece should be as long as your outstretched arms from finger to finger. Longer yarn will fray and become fragile. Using two contrasting colours of weft yarn with make the slope lines easier to see.The 12 cm by 12 cm loom will need 3 strands each of the two colours (6 altogether).

Warp—lengthwise yarns held stationary in tension on a frame (loom)
Weft (also known as a woof)—yarn drawn through and inserted over and under the warp

Knot two colours of yarn together.

Starting from the top left corner of the loom (Coast Salish people weave from the top to the bottom) bring the yarn under the first strand of the warp and pull through until you get to your knot under the first warp.

Moving Left to right:

Take the left weft strand (the red yarn in this example) and bring it **over the right weft** strand (black yarn in this example) and **under** the **second warp**.

Note that now the black yarn becomes the left weft strand and the red yarn becomes the right weft strand.

Take the left weft strand (black) and bring it **over the right weft** strand (red) and **under** the **next (third) warp**.

Note that the red strand is now on the left again.

Continue weaving left weft over right weft and under next warp until you get to the end.

Make sure that the tension is correct. If the weft yarn is pulled too tightly than the warp strands are pulled out of shape. The warps should be still straight up and down. Use your fingers like a comb to push up on the yarn so that it is snug to the top. You can also look over the row you have completed and make sure you haven`t made a mistake.

Weaving a Slant Design – Part 2

Moving Right to Left:

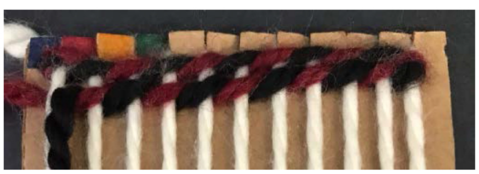
To begin the second row, take the left weft strand (red) and bring it over the right weft strand (black).
The black strand then becomes the left weft and the red strand becomes the right weft.

Next take the right weft strand (red) and bring it **under the left weft** strand (black) and **under the first warp**. Bringing it under the left weft strand ensures that it has "captured" the yarn and there will be no holes in the side of the weaving.

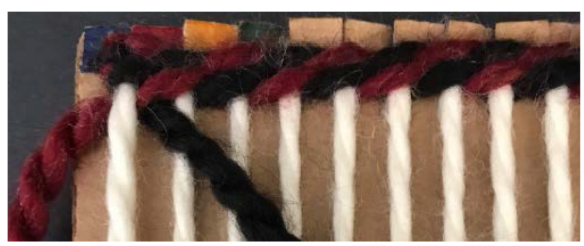
Take the right weft strand (black) and bring it under the left weft (red) and under the second warp. In the second row moving towards the left, remember to always go under the left weft.

**** Remember – Over the weft going right, under the weft going left.**

Use your fingers to push the second row up nice and snugly against the first row. You should be able to see the beginning of the slant design.



At the end of the row, take the black weft (the strand not under the first warp) and bring it **under the left weft** strand (red), then put it **under the first warp**.



The first weft to go under the first warp strand in a row is the last weft strand in the previous row. This is also the strand that is used to "capture" the other weft strand so there is no hole in the sides of the weaving. Please refer to the instructions for beginning the rows going left to right and the rows going right to left. Remember that the colours will alternate.

When you reach the end of the row, use your fingers as a comb and push up on the row. This insures that the weaving is tight enough that it stays together when taken off. Too loose and the ends will not weave in properly and the weaving may unravel. At this point, you may also pull on the weft strands (separately) so that the tension on the warp is just right. Do not pull too tightly as this will twist the warp strands out of shape. Once you do this than the weaving will not be as straight as it needs to be.

Weaving a Slant Design – Part 3

Adding in New Yarn:

Continue to weave until you almost run out of yarn. You will need to weave in the ends so leave enough length to work with. Too little and it will unravel if there is not enough of a length to weave in with the other strands. It is also best for beginner weavers to add in extra yarn at the end of a row rather than add it in the middle of a row. If the student weaves to the end of the row and has very little yarn to eventually weave in (they need at least 6-7 cm) they should undo the row. It is better to have too much yarn than too little.

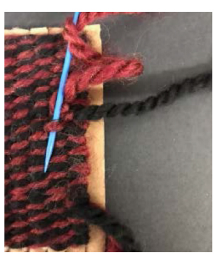
Take one new length of each colour and simply knot together or use a weaver's knot to tie them together.

Add it to the next row by placing one of the strands under the first warp. For the slanted design the first weft strand to go under the warp should be the colour of the last strand to go over the last warp strand in the previous row. In this case it is the red weft strand. Continue to weave as normal.

Finishing:

When the weaving is completed use a yarn needle to weave in the ends.
Weave the yarn end into the same colour yarn in your weaving. With this wool it will be bulky but this side could be considered the back side of your piece. This is also the side where any knots you have made will show.

Try to weave the weft ends through at least three picks (one strand of weft crossing the warp) to make sure the yarn is secure and won't unravel. Also, remember to bring the last weft strand under the other weft strand in order to make sure there is not an obvious hole in the side. This would be the same method you use at the end of the rows to continue weaving.



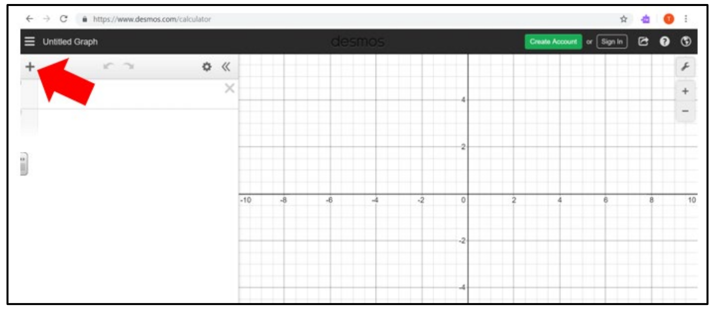
Once you've woven it through then cut off the yarn you did not weave in. Weave in all the other weft ends.

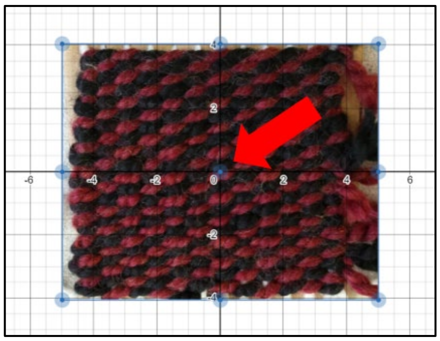
When you have woven in all the ends, except the two warp ends, simply bend the tabs and slip the warp strands off the loom.

Weave the warp ends through the loops. It is visible because we used a different colour for the warp to make it easier for beginner weavers.

BLM 21 – *DESMOS Instructions*

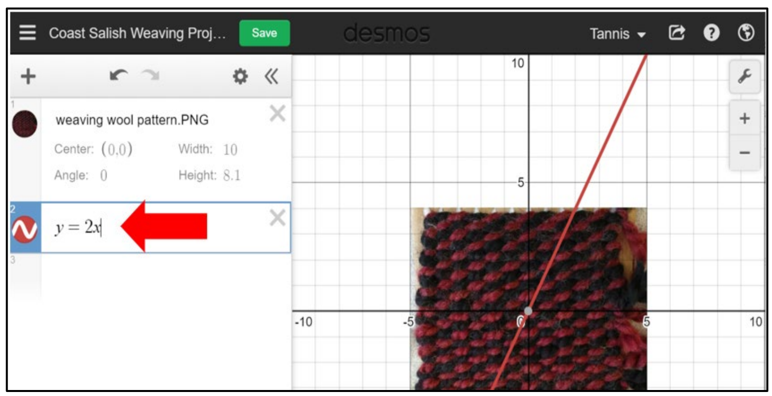
Go to https://www.desmos.com/calculator and click on "+" to upload your digital photo of your weaving.
Sign In with your google account to save your work

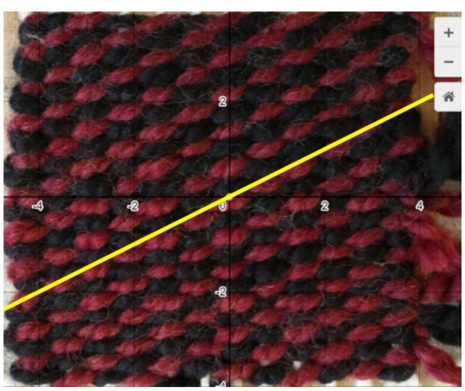




Use the center dot on the image to move the pattern so that the origin is centred on one of the lines in the pattern.

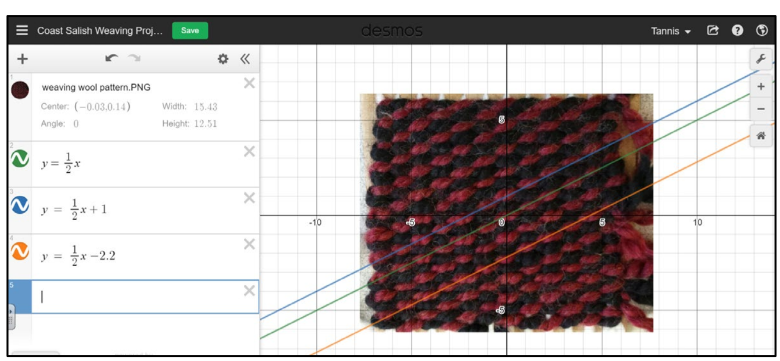
On the left side of the screen at #2, type your best guess for the middle line using slope intercept form (y=mx+0) to calculate the drawn line that crosses through the origin.



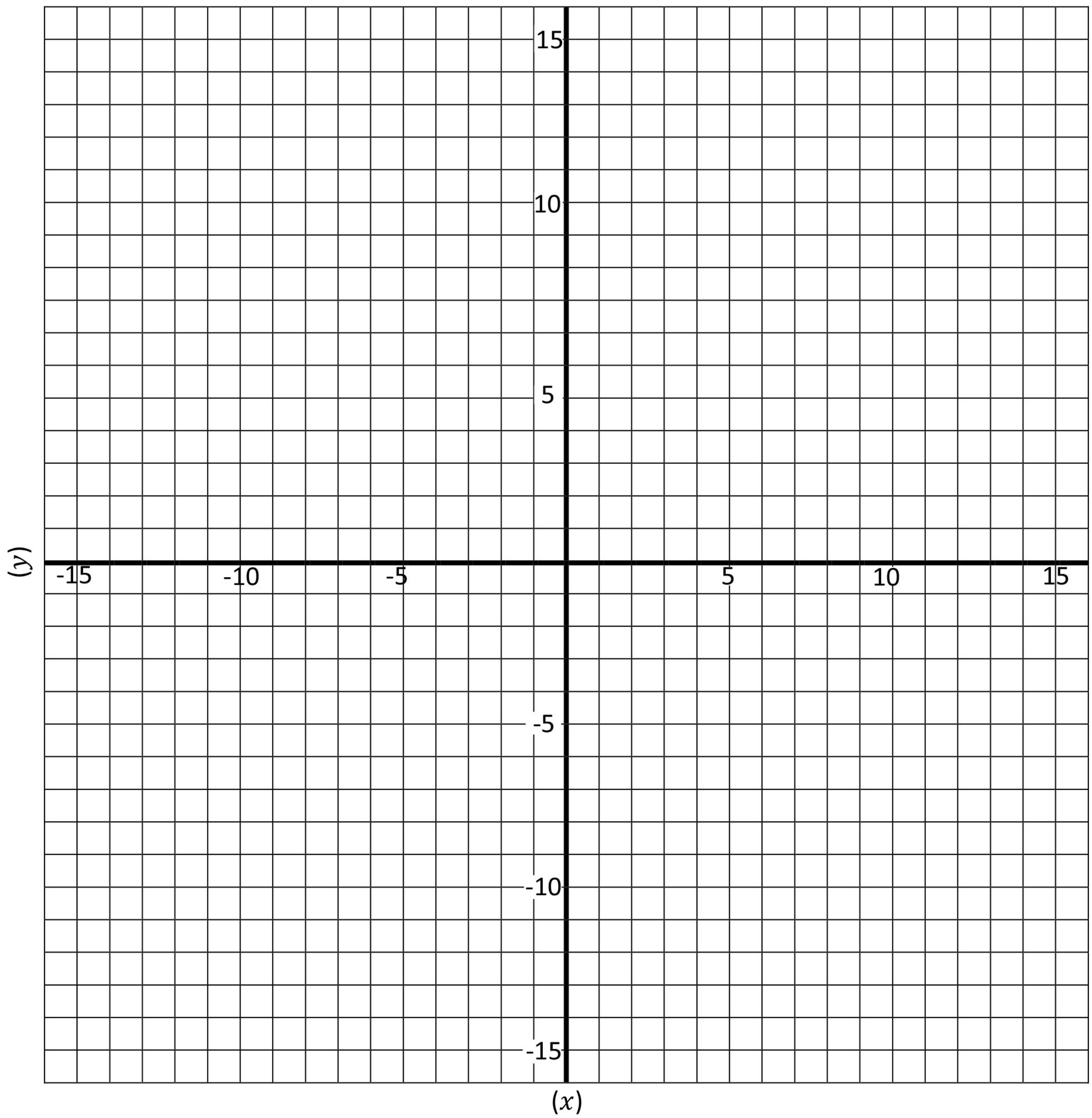


Play around with the numbers until find the correct slope of line to follow the pattern. Change the colour of the line (if needed) by clicking on the gear and choosing edit.

Add 2 more lines, one above the origin and one below the origin using the using slope intercept form (y=mx+b)



BLM 22 – *Cartesian Grid*



Ceremony and Storytelling

Multi-Grade Thematic Unit

Masks

Masks have an important role and function in the lives of First Peoples of the Pacific Coast of BC. They are used for ceremonial purposes (e.g., feasts, secret society rituals), for story, and for healing. Masks are objects that define a clan's place in the world and connect clan members to their ancestors. They are representations of story and are used in dramatic ways to validate the history of the clans and families. Masks are used to tell about the origins and ancestors of a clan, the clan's accomplishments, and the clan's histories. Often, they tell the story of the supernatural beings an ancestor may have encountered. Using the mask in a performance during ceremony emphasizes the honour and the prestige that a clan holds. Masks are closely intertwined with story, song, and dance. Today, masks are also used for entertainment and as display pieces. Pieces made as "trade masks" are easily identifiable, as they lack attachments that would allow them to be worn.

Masks were most commonly made from red cedar, yellow cedar, and alder. Sometimes masks were made from maple, yew, or even from stone. There are three main types of masks: single face, mechanical (single face with movable parts), and transformation (more than one face). Masks would depict humans, animals, forces of nature, and supernatural beings.

Masks are handed down from generation to generation and are not owned by individuals but by the clan whose stories they depict. These masks are not considered decoration and are handled according to protocols. Often, they are stored in special boxes and taken out only for ceremonial purposes.

Drums

Drums are used by every Indigenous nation in Canada. They are used to communicate, in ceremony, and for entertainment. Drums are most often circular, but they can also be large rectangular boxes. They are made of wood and animal skins and sinew. The size and shape of the drum depends on the First Peoples who make (or made) it. There are mini drums, hand drums, water drums, and large ceremonial drums. No two drums are the same, and the size and thickness of the hide affects the sound, making each one distinct.

The shape of the circular drum symbolizes balance, equality, wholeness, and connection. Each nation has its own protocols for the making, use, and storage of the drums. Commonly, drums are closely related to story, song, and dance. They are made to be played, to be shared, and to bring people together. It is said that the drum is the heartbeat of the Earth and therefore has an emotional connection to and relationship with all living things.

Poles

Poles were traditionally made by coastal BC First Peoples, but the practice has spread to other areas in the province. Poles come in a variety of forms and serve various purposes. Basically, the pole is an illustration of a story that would be read from the bottom to the top. This means that the most important part (and the largest part) of the pole is often at the bottom. The stories are not fully told on a pole; but people would know the story details because they have been a part of the feasts that celebrate the poles. A pole commemorates important historical events or serves as a monument to a chief after his death. Poles are a publication of a clan's rights and privileges, and raising a pole also enhances the clan's prestige. It is important to recognize that poles illustrate story and tradition and were not worshipped. They should accordingly be referred to as poles and not as totem poles.

It would often take a clan a number of years to raise a pole – time to select the tree to be felled (usually by the father's family who would be paid publicly) and time to gather the resources to have a feast to celebrate the raising of the pole. The father's family would also carve or select people to carve the pole. The figures selected for the pole were chosen by the owners who would use it to explain the origins of their crests, tell a story, and relate to phenomena (including ancestors' encounters with the supernatural). Often the pole would depict animals important to their territories. Most of the cost of the pole was associated with putting it in the ground and with the feast that followed. During the feast, clan members would tell the stories of ownership to remind the community of the clan's history, to denote the power and wealth of the clan, and to have this acknowledged by the participants at the feast. Poles served to announce one's identity to the world (and the rights and privileges of families, including their access to natural resources), to commemorate the dead, to decorate a house, to preserve story, and to proclaim the wealth and power of families. Each pole is raised in a ceremony and given a name.

Poles often faced rivers and oceans as the front of the clan's houses. There are house-front poles, corner (house) posts, memorial poles, mortuary poles, and welcome poles. Today, another pole is the commercial pole commissioned by people and organizations outside of the originating cultures. The Reconciliation Pole at UBC raised in April 2017 is a good example of this. The pole was carved by Haida carver, James Hart, raised according to the protocols of the Haida, and with the blessing of the Musqueam people on whose unceded traditional territory the pole stands. More information can be found in the article "What is the Reconciliation Pole? at https://students.ubc.ca/ubclife/what-reconciliation-pole . A detailed description of the pole can be found as a pdf at http://aboriginal-2.sites.olt.ubc.ca/files/2017/10/UBC_Plaque_2017-Reconciliation_Pole-8-1.pdf .

Traditionally poles were carved by the Haida, Haisla, Heiltsuk, Gitxsan, Kwak'wakw'wakw, Nisga'a, Nuu-chah-nulth, Nuxalk, Tlingit, and Tsimshian Nations. The Coast Salish Nation had no freestanding poles, but did have house posts, welcome figures, and grave figures. Poles were present in these nations prior to contact with Europeans but flourished after contact because of the tools now available for them to use. The tallest pole in the 1800's was 80 feet and today the tallest pole is 173 feet tall (in Alert Bay). A pole generally stands from 60 to 100 years. When the pole falls, the natural process is to allow it to become a part of the earth again. This illustrates the life cycle of the pole as a living being who should be allowed to go through the process of life and death and not be interfered with. The clan would then commission a new pole where they would either replicate the old pole as an exact copy or have an entirely new one made.

Due to the indoctrination of Christian beliefs and government policies to assimilate First Peoples into mainstream Canadian society many poles were destroyed, sold, or taken from abandoned villages or villages whose inhabitants participated in seasonal rounds and were absent during certain times. Many of these poles were taken to museums around the world or to private collectors. More information can be found at https://indigenousfoundations.arts.ubc.ca/totem_poles/ and http://www.gingolx.ca/nisgaaculture/nisgaapoles/index.html.

Today, poles are being raised around the province in ceremony, and the living tradition of the nations is acknowledged and celebrated in a continuation of the rich legacy passed on from generation to generation.

Curriculum Connections

Mini-Unit: Masks

Big Ideas

Math 8: The relationship between surface area and volume of 3D objects can be used to describe, measure, and compare spatial relationships.
Workplace 10: Proportional reasoning is used to make sense of multiplicative relationships.
Pre-calculus 10: Algebra allows us to generalize relationships through abstract thinking.
Pre-calculus 10: Representing and analyzing situations allows us to notice and wonder about relationships.
Pre-calculus 12: Understanding the characteristics of families of functions allows us to model and understand relationships and to build connections between classes of functions.

Grade	8	Workplace 10	Pre-calculus 10	Geometry 12	Pre-calculus 12
Curricular Competencies	• Use reasoning and logic to explore, analyze, and apply mathematical ideas • Use mathematical vocabulary and language to contribute to mathematical discussions • Represent mathematical ideas in concrete, pictorials, and symbolic forms • Explore, analyze, and apply mathematical ideas using reason, technology, and other tools • Model with mathematics in situational contexts • Visualize to explore and illustrate mathematical concepts and relationships • Take risks when offering ideas in classroom discourse • Reflect on mathematical thinking • Use mistakes as opportunities to advance learning • Think creatively and with curiosity and wonder when exploring problems • Apply flexible and strategic approaches to solve problems • Explain and justify mathematical ideas and decisions in many ways				
Content	expressions using substitution	metric and imperial measurements and conversions	systems of linear equations	geometric proofs	extension
Core Competencies	Social Awareness and Responsibility Creative Thinking Critical and Reflective Thinking				

Cross-Curricular Connections

- BC First Peoples 12
- Visual Arts 3D
- Visual Arts 10

Mini-Unit: Drums

Big Ideas

Pre-calculus 12: Understanding the characteristics of families of functions allows us to model and understand relationships and to build connections between classes of functions.

Grade	Precalculus 12
Curricular Competencies	• Explore, analyze, and apply mathematical ideas using reason, technology, and other tools • Model with mathematics in situational contexts • Think creatively and with curiosity and wonder when exploring problems
Content	trigonometry functions
Core Competencies	Social Awareness and Responsibility Critical and Reflective Thinking

Cross-Curricular Connections

- BC First Peoples 12
- Visual Arts 3D
- Visual Arts 10

Mini-Unit: Poles

Big Ideas

Math 8: The relationship between surface area and volume of 3D objects can be used to describe, measure, and compare spatial relationships.

Grade	8	Workplace 11
Curricular Competencies	• Estimate reasonably • Explore, analyze, and apply mathematical ideas using reason, technology, and other tools • Model with mathematics in contextual experiences • Develop, compare, apply mathematical thinking through play, inquiry, and problem solving • Think creatively and with curiosity and wonder when exploring problems • Communicate mathematical ideas in multiple ways • Reflect on mathematical thinking	
Content	nets/viewpoints of 3D objects ratio, rates, proportionality	nets/viewpoints of 3D objects scale
Core Competencies	Social Awareness and Responsibility Creative Thinking	

Cross-Curricular Connections

- BC First Peoples 12
- Visual Arts 3D
- Visual Arts 10

Mini-Unit: Masks

Context-Setting Introductory Material for Students

(for teacher-facilitated sharing in a whole-class setting)

"How we got the Hamat΄sa"

from Virtual Museum.ca
https://umistapotlatch.ca/enseignants-education/cours_5_partie_2-lesson_5_part_2-eng.php

Four brothers, the sons of a powerful chief, found the house of the man-eater, Baxwbakwalanuksiwe'. They are allowed into the house, but once inside realize that those living inside intend to make them into a meal for the supernatural being. They shoot arrows out the door of the house and walk out as if they were simply chasing the arrows…. and then run for home. The cannibal chases them, but they are able to get away by creating a mountain (from a whetstone), a lake (from mountain goat tallow), a thicket (from a comb), and a fog (from the fuzz of mountain goat fur). All of these obstacles slow down Baxwbakwalanuksiwe' and the brothers reach home safely.

Knowing that the cannibal is close behind, the brothers and their father prepare for his arrival. They greet the cannibal politely and encourage him to return to his house at the north end of the world and come back with his wife and child. This gave the chief and his sons time to dig a pit in the floor of the house, over which they placed a seat.

When Baxwbakwalanuksiwe' returns with his family, the chief invited him to sit on the new seat while the sons entertained them with stories. Eventually, the guests fell asleep. The four sons quickly pulled the seat apart, so that the cannibal family fell into the hole. Red hot stones and boiling water were poured into the pit, killing the cannibal and scattering ashes in the air. These ashes became the mosquitoes and biting insects of our world who consume human blood just like the cannibal Baxwbakwalanuksiwe'.

Finally, the young men returned to the home of the cannibal and gathered up the masks of Raven and Huxwhukw, which became their property and an essential part of the Hamat΄sa ceremony.

◇◇◇

See also the further contextual information available at https://umistapotlatch.ca/enseignants-education/cours_5_partie_3-lesson_5_part_3-eng.php

Preparatory Notes

Masks are a form of representation that involve story and becoming. Masks are used for ceremonial purposes as well as for entertainment or display. There are masks for dances and stories in which the dancer becomes a different character. Masks can serve to make political statements or give historical accounts. They can also have social or commercial value. Often masks are carved, usually from yellow or red cedar, and then decorated with paint, dye, feathers, bark, shells, or pebbles. There are masks that transform into other masks, traditionally opened and closed through the use of holes and strings to reveal embedded pieces and features. There is a beauty in the fluidity of the transformation process. Masks are often handed down to new dancers and considered a hereditary item along with the dance and story. As masks were easily transportable, they were often taken or confiscated and are currently part of the repatriation process for many First Nations. To avoid a "trivializing," crafts-focussed approach to understanding masks, this mini-unit does not propose having students make replica masks. For more about this, please review the material on "Permissions, Protocols, and Respectful Practice" in the Foundations section of this guide. For more on masks, see

- Meaning behind the mask https://www.canadiangeographic.ca/article/meaning-behind-masks

Guiding Questions

- How can, at first glance, two things that are not the same on the surface, be the same?
- What does transformation mean? How is this different from the mathematical definition?
- Why is substitution important when exploring relationships?

- How is the of role substitution important to understanding transformation?
- What does transformation look like in mathematics, where one thing looks like something else?
- In what ways can we represent a number?

Activity 1: Becoming Something Else

In the story, Baxwbakwalanuksiwe' changes from a man to a mosquito, but maintains the central part of who he is as a cannibal. How can math equations or number be represented in multiple ways? For example, in Mathematics, it is possible for $x=2$. However, x doesn't look like 2, but x IS 2. So, given an expression $3x+5$ and using substitution, this expression is equivalent to 11 when $x=2$. Over time, students will encounter increasingly sophisticated applications of substitution and equivalence (e.g., eventually in Mathematics 12 they will work with Trigonometric Identities where $\sin^2 x + \cos^2 x = 1$).

Substitution happens in many forms, such as in formulas for surface area or the Pythagorean theorem. We are looking at the basis for substitution in algebraic thinking and conversion factor

Imagine substituting salad for French fries or having a substitute teacher in when the teacher is away. Have students brainstorm their real-life observations or experiences with substitutions. Discuss why these situations are considered substitution. Be sure to access prior knowledge using terms such as coefficients, variables, and constants building towards order of operations.

Formative Assessment

Have students define substitution and how it applies to algebra. How do students see masks as a form of substitution?

Activity 2: Equivalency

Have students use an image of themselves (photo or drawn) to measure their own features (eyes, nose, mouth, face length/width…), using metric measurement.

Research the characteristics of people masks in Indigenous culture. A good site to start is https://www.sfu.ca/brc/online_exhibits/masks-2-0.html.

Challenge students to draw a mask that will perfectly fit their features, converting the dimensions to imperial (conversions). Follow by having them actually create the masks (using the imperial measurements) and seeing if the masks fit their faces. Encourage students to think of reasonableness and how images need to be developed to go from 2 dimensions into 3 dimensions.

Resources and Materials

- provincial exam formula sheet
- plasticine or plaster or floral foam or other materials
- tools for making
- metric rulers
- imperial rulers

Formative Assessment

- What adjustments (if any) are required to "make the mask fit"? What is the student evidence to support this?

Activity 3: System of Equations

A mask has no life to it until it is brought alive through dance and story. It carries the potential of becoming alive. Within a transformation mask, the same mask has 2 different versions that can be worn at the same time. Like the story, there is more than what is seen on the surface. Likewise, in systems of equations, the two variables have the same connection to each other.

Resources and Materials

- student copies of https://www.khanacademy.org/humanities/ap-art-history/indigenous-americas/a/transformation-masks

Have students read the "Transformation masks" article at https://www.khanacademy.org/humanities/ap-art-history/indigenous-americas-apah/north-america-apah/a/transformation-masks. Discuss how masks are used and the cultural significance of the masks. Discuss with the students the ways in which a double or triple mask acts as substitution, and how variables can be embedded within other variables.

Caution: The Khan Academy uses the term "myth" when referring to transformation and masks. When using or discussing a traditional First Nations story, it is most appropriate to refer to it as a ***story***, ***traditional story***, or ***narrative***, and avoid the terms ***legend*** and ***myth***, because of their connotations (i.e., that they are fiction). Discuss this with the students before they read the article. For more information, please review "Finding and Using Story/Narratives for Teaching Mathematics" in the Foundations section of this guide.

Use an example of

$3x - y = 7$
$2x + 3y = 1$

Show students how if they solve for y in one equation, they then have an embedded variable.
$3x - y = 7$
is the same as:
$y = 3x - 7$

This new value of y can then be substituted into the other original equation in order to determine the variables.

$$2x + 3(3x - 7) = 1$$
$$11x - 21 = 1$$
$$\frac{11x}{11} = \frac{22}{11}$$
$$x = 2$$

This value can then be re-entered into the original equation to determine the value of y.

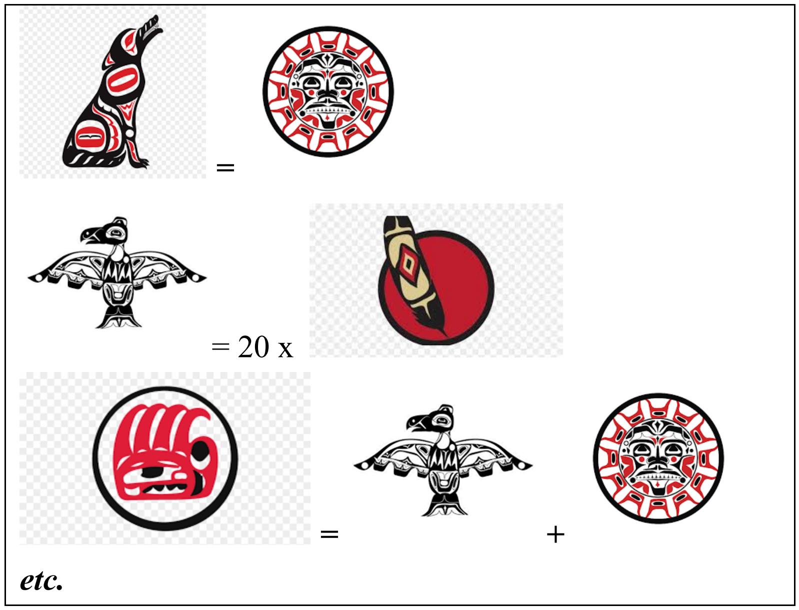
$$y = 3(2) - 7$$
$$y = -1$$

Formative Assessment

Complete a Think Pair Share describing in words the process of solving a system of equations. Can the pair come up with a joint description that is easy to understand? See if the pair can teach the concept to someone who doesn't know substitution.

Activity 4: Recognition

Have students create a legend of 6-10 image items. Then have students create expressions that are equivalent based on the symbols found in their legend. Have students arrange 3-5 expressions and share with 2 other students. Have the students attempt to simplify the expressions using the legends and compare their results, remembering that simplifying is the goal. Explain that the same outcome may have been achieved in multiple pathways.



When doing Trigonometric identities, there is no standard way to complete a Trigonometric proof; so recognizing when substitution is appropriate matters greatly to finding an efficient solution.

For example

$$\frac{\cos^2 x}{1 - \sin x} = 1 + \sin x$$

becomes

$$\frac{\cos^2 x}{1 - \sin x} = 1 + \sin x$$

$$\frac{1 - \sin^2 x}{1 - \sin x} = 1 + \sin x$$

$$\frac{(1 + \sin x)(1 - \sin x)}{1 - \sin x} = 1 + \sin x$$

$$1 + \sin x = 1 + \sin x$$

Formative Assessment

Ask students what they noticed about linking substitution and trig identities. They can then reflect on their learning in a math journal.

Mini-Unit: Drums

Context-Setting Introductory Material for Students

(for teacher-facilitated sharing in a whole-class setting)

<u>When We Play Our Drums, They Sing!</u>

From Richard Van Camp (2018). "When We Play Our Drums, They Sing!" in *The Journey Forward, Novellas on Reconciliation*. McKellar & Martin Publishing Group, Ltd., British Columbia (orders@mckellarmartin.com), p.58.

We shook hands once Dene style, but he held onto my hand and spoke, "I am blind, but I can still see, and what I see is a protector. That's why you are so angry. You see how things should be. That's a gift. It comes with a price, and that price is rage. Underneath that rage is hurt. Every leader I know has the same kind of hurt because you carry the pain of how things should be, could be, and deserve to be. It is an honour to meet you. You make my heart happy."

I blushed as he let my hand go.

"Naa. Take your drum," he said. "Go get me another one. Any one. I'm going to remind you of a song you listened to when you were dreaming inside your mummy's tummy."

I stand and grab a drum off the wall. There's a drumstick resting on top. "Naa," I say and hand the drum to him as he hands me my drum.

I sit and watch him carefully. I want to learn this. I need to learn this. I've been waiting so long to hear this.

Snowbird nods and points the drumstick in my direction to the left and then to the right. "There are people standing behind you. They are your ancestors. There are people standing beside you. They are your friends and family. There are people standing ahead of you. They are your children, your grandchildren, the generations to come. When you sing, when you play, all of them are with you. You're in the middle of your world, together. When you drum, they all sing with you. The drum is the heartbeat of Mother Earth. It's also the heartbeat of the people. Naa. I'll teach you a song you already know.

The Song Within My Heart by David Bouchard

Listen to the beating drum
It tells a hundred stories
Of our people, of our homeland
Some of birds and beasts and sweet grass.

Close your eyes and listen
You might come to hear a story
That no one hears but you alone
A story of your very own.

BOOM boom boom boom BOOM boom boom boom
BOOM boom boom boom Boom boom boom boom
BOOM boom boom boom BOOM boom boom boom
BOOM boom boom boom BOOM boom boom boom

Preparatory Notes

Drums are a cultural item used for communication, ceremony, and entertainment. Drums can be circular, with a skin or hide of an animal stretched over a wooden frame and tied with lashings made from the remaining hide or string at the back. Drums can also be rectangular wooden boxes. They can be a variety of sizes. No two drums are the same. To avoid a "trivializing," crafts-focussed approach to understanding drums, this mini-unit does not propose having students make replica drums. For more about this, please review the material on "Permissions, Protocols, and Respectful Practice" in the Foundations section of this guide. Each region has its own protocols for drumming and who is allowed to drum. Be sure to check with your local area for specific protocols and customs. It is customary for the first drum someone makes to be gifted to another person.

Guiding Question

- How do different variables influence the quality and quantity in making drums?

Applicable Blackline Masters

BLM 1 – Sample Deer Hide
BLM 2 – Outline of a Hide

Activity 1: Investigating the Drum

Using the circumference, diameter, or radius of a set of different-sized drums, graph the relationship to the note produced (e.g., use an appropriate phone app or tuning device) to determine the correlation between size and sound. Is a given circle measurement correlated to the sound it makes? Justify the findings (line of best fit, table of values, etc.). Does this hold true for the surface area of the drums? How does the volume of the drums change the outcome? We encourage the teacher to continue the conversation with questioning, rather than providing the answers.

Activity 2: The Making of a Drum

> ***Resources and Materials***
> - video: https://www.youtube.com/watch?v=EQihS0-MtHg
> - BLM 1 – Sample Deer Hide

Watch the video https://www.youtube.com/watch?v=EQihS0-MtHg. If it can be arranged, have students observe or be a part of a drum-making session with a local First Nations Elder who is a drum-maker. Having students make and use their own drum(s) would integrate well with several of the activities in this mini-unit.

To construct the frame of a drum, some First Nations bend the wood into a circle, others use cut pieces called staves to create a frame in a more circular polygon. In order to calculate the angles needed you first must decide if you will cut one side of the stave on an angle, or both sides. To calculate the angles:

360 / (# of staves x number of sides cut) = angle of cut

Using BLM 1 – Sample Deer Hide, challenge students to calculate how many drum heads of a specified size can be made from the given sample hide. They may need to be reminded that the hide must come down on the sides of the drum, ideally halfway down the depth of the frame. Is there a way to use one hide to make several sizes of drum? How do you calculate the amount of hide needed based on the drums brought into class?

Activity 3: The Beat of a Drum

> ***Resources and Materials***
> - oscilloscope or online sound wave app

Have a guest speaker come in to talk about the local protocols around drumming, when drumming occurs, and what it means to be drumming. If appropriate, ask if the guest is willing to drum a song for the class. Refer to the introduction for protocols around inviting a guest speaker. If a guest drummer is not available, any drum will work for this activity.

Hypothesize the sound of a drum with a description. Have a guest in to assist with testing the resonance of the drum. What does the drum surface do? What do students know about sound? Have students make a conjecture. Can they find a counter example?

Compare the sounds using an online app or oscilloscope that will measure the sound waves. What do the students notice? (i.e., repeating, peaks and valleys, continual).

Use the reading of the drumbeat to identify the amplitude, frequency, and phase shift of the sinusoidal graph.

Formative Assessment

Is there a connection between their conjecture and the oscilloscope findings? Have the students explain why.

Activity 4: Making the Lashings for a Drum

> ***Resources and Materials***
> - online video: https://www.goneferal.org/make-rawhide-lashingslacing/
> - one copy per student of BLM 1 – Sample Deer Hide and/or BLM2 – Outline of a Hide

Using the suggested video, explain how lashings to tie the drums are made.

Give each student a copy of BLM 1 – Sample Deer Hide or BLM2 – Outline of a Hide. For either handout, you may find it helpful to enlarge to 11x17”. Specify a fixed diameter (i.e., 4-6 cm) of drum. Have students determine how many drums they can make from their hide. The leftover hide will be used to make the lashing; so students must allow for enough left over hide to serve this purpose. Challenge students to maximize the number of drums by

- determining how many drum-head circles they can get from the hide
- calculating the length of the needed lashing, given a constant width (minimum 0.5 cm)
- minimizing the amount of overall waste (i.e., compare the area of the lashing to the area of the hide minus the circles to determine the amount of waste)

Formative Assessment

Have students pair up and discuss what worked well and what they would do differently.
Give students three iterations of this, so they can re-strategize. How did the class do as a whole?

Activity 5: Circle Geometry of a Drum

For circle geometry ideas to apply with a drum, refer to the Mini-Unit: Circle Dwellings in “The Built Environment: Multi-Grade Thematic Unit.”

Mini-Unit: Poles

Context-Setting Introductory Material for Students

(for teacher-facilitated sharing in a whole-class setting)

Story: The First Totem Pole: Part 1

From: Rosa Bell and Christian White
Retrieved July 2019 from virtualmuseum.ca Teachers' Centre (chin.gc.ca)
http://www.virtualmuseum.ca/edu/ViewLoitLo.do?method=preview&lang=EN&id=9652;

Many, many years ago a Haida family lived in a village called Yan. In that family there was a boy named Sta-th. He was one of the Eagle clan. He wore an Eagle carving around his neck.

Sta-th's mother was called Koon-jaat. She was also from the Eagle clan. Her hat had an eagle on top of it.

Sta-th's father's name was An-o-wat. An-o-wat was from a different clan. He was one of the raven clan. He wore a Raven crest on his clothes.

One day An-o-wat was fixing their fishing canoe. Sta-th went over to help his father. Soon the canoe was ready. An-o-wat started to take the canoe down to the water. Sta-th asked, "May I go, Father? May I go with you?"

An-o-wat said, "Yes, I will take you. We'll go as far as Rose Spit. I want to see if there are any more holes in the canoe to fix up."

Sta-th jumped into the canoe. It was a beautiful day for a ride

The water was very calm. The canoe moved smoothly through the water. An-o-wat was glad to see that there were no holes in the canoe. The canoe was now ready for fishing.

By the time they got to Rose Spit, the sun had begun to set. They wanted to get home before dark, so they started back.

Sta-th was fascinated with the water. He bent over the side of the canoe. Sta-th watched the clear blue-green water as they travelled. He saw big crabs and pretty starfish. Jellyfish flashed here and there.

Suddenly, Sta-th shouted, "Stop, Father, stop! Look into the water."

Sta-th is pointing at something in the water.

They both looked down. They saw the most beautiful village. It looked like their own village. There were lots of longhouses and many canoes. However, this village was different from theirs. It had tall, tall poles. These poles had beautiful carvings on them.

They looked at this village for a long time. An-o-wat looked carefully at the poles. He saw a raven and eagle carved on the poles. He saw a bear and a whale, too.

Soon it grew too dark to see. They decided it was best not to tell anyone about what they had seen. People might not believe their story.

The next day, An-o-wat and Sta-th went into the forest. They were looking for a big cedar tree. An-o-wat wanted to make a pole like the one in the underwater village. He wanted to show his pole to the people of Yan. Then he knew they would believe him.

At last, they found a good cedar tree.

An-o-wat and Sta-th began to carve the pole. An-o-wat put a raven on top. Then he carved a strong bear and a killer whale. That night they shared their secret with Koon-jaat.

Each day they worked long and hard on their pole. It took many, many days to finish it. At last the big day came. They were ready to take the pole to the village.

An-o-wat called a meeting with his family. His brothers and sisters came. His aunts and uncles came. His grandfathers and grandmothers came, too. They all came to hear what An-o-wat had to say.

An-o-wat told them the story. Sta-th told them what he had seen at the bottom of the sea. Then An-o-wat showed them the pole.

An-o-wat called for a village meeting. Everyone thought that the Eagle clan should raise the pole. An-o-wat and his family would have to pay them. An-o-wat asked the Eagle clan for help. He asked them to help bring the pole to the village. The people of Yan saw them pulling the beautiful pole. They were very excited.

The next day, An-o-wat and Sta-th dressed in their best clothes. They both felt proud of the work they had done. Many people were invited to come and see the pole. An-o-wat and his family met their guests at the beach. They welcomed the guests with a song. People came from all over the islands. They came to see the first totem pole.

Soon the Eagle clan raised the pole. All the people went into the longhouse for a feast. An-o-wat's family gave gifts to the Eagle clan. They gave songs and dances. They gave drums and rattles. They gave canoes and animal skins, too. There was singing and dancing long into the night.

The sun was rising as the people went home. Everyone was thinking of what they might carve.

This is how the Haida people began to carve poles. This is the story of the first carved pole.

Preparatory Notes

To create a pole, a carver would go out and choose a red cedar. The tree that is to become a pole would be ceremonially acknowledged and thanked. The master carver would plan the best way to represent the story that the pole is to tell and would spend up to a year with apprentice carvers carving the images into the pole. The pole would be finished by sanding and treating. When painted, the paint was made by grinding minerals mixed with salmon eggs or fat as a binding agent.

Traditionally, the six West Coast First Nations (Haida, Nuxalt, Kwakwaka'wakw, Tlingit, Tsimshian, and Salish) were the only pole carvers, but the tradition has spread to others. Poles come in a variety of forms and for a variety of purposes. Each contains story-inspired images that are related to the pole's community "sponsors." The most important part of a pole is the bottom, since it is foundational and since its story is meant to be read from bottom to top. The pole is raised in a ceremony and given a name. A pole-raising is often done by the entire community or clan and is followed by feasting and further ceremony. Generally, a pole will stand for about 100 years and when it falls is left to lie and slowly disintegrate as part of the process.

Following contact, many poles were taken from the territories. In order to keep their poles, many communities hid them as part of the foundations of houses. More information can be found at https://indigenousfoundations.arts.ubc.ca/totem_poles/ and http://www.gingolx.ca/nisgaaculture/nisgaapoles/index.html. To avoid a "trivializing," crafts-focussed approach to understanding poles, this mini-unit does not propose having students make replica poles. For more about this, please review the material on "Permissions, Protocols, and Respectful Practice" in the Foundations section of this guide.

Guiding Question

- What does the community have to consider in their place in order to raise a pole?

Activity 1: What is a Pole?

Have students investigate the different types of poles (memorial, welcome, house, shaming, etc.) in BC. Where are they found? What are the distinguishing features?

Have students go to a pole and see the different parts that make up the entire pole. Have them

Resources and Materials

- the story, "Totem Pole Reunites Metlakatla Community" (p. 6 from https://www.aadnc-aandc.gc.ca/DAM/DAM-INTER-BC/STAGING/texte-text/cmstry10_1100100021664_eng.pdf) estimate the height, width, and hidden portion. What is it made of and what tools needed to make this? What kind of pole is this? Sometimes the traditional poles were carved after hollowing out by burning areas. How did they delineate the parts that needed to be burnt?

Have students read "Totem Pole Reunites Metlakatla Community" and complete a 3-2-1+1 response to the article (i.e., as a post-reading activity, each student records "3 important ideas to remember, 2 things you need more information on, and 1 idea you will write about;" students then share their work within a small group, and group members add new thoughts to their individual records in a separate +1 section).

Activity 2: Calculating the Dimensions

Have an artist explain how they choose a tree and pole to carve. If possible, have the artists do this outside, and have an example tree. Students should be able to help choose a possible tree using developed criteria for the type of pole they chose.

Have students estimate the weight of the pole, the height and diameter. Give the students some referents to be able to fine-tune their estimates. Take the measurement of the circumference; use this to calculate the diameter. Can the students use similar triangles to determine the height of the tree? Use a clinometer to determine the actual height of the tree.

Part of the pole will need to go into the ground. How many sections should the pole be separated into? How long does the buried part need to be to ensure that the pole will be secure? Generally, this would be one fifth to one sixth the pole. How would this be determined for the class pole?

Activity 3: Identifying a Pole

Resources and Materials

- art materials (e.g., pencil and graph paper) for producing schematic images of poles (elevations, perspectives)

Figures on poles typically represent families and ancestors. Each image would have a related story or narrative. Using the story at the beginning of the unit, have students choose three images that will make up the pole. Focussing on the symmetry of the images, have students think about how the images will need to align to be symmetrical. Students should be able to draw the pole from 5 sides/views (left, right, top, front, back).

Alternatively, have students find a pole within their community or online. Students should determine the type of pole and find the story and artist associated with this pole. Students then draw the 5 sides/views of the pole.

Have students measure the dimensions of their images. Compile the data from the class and have students determine if there is a pattern of ratios to the images (i.e., head to body). Is there a proportionality? Can this proportionality be applied to pictures of poles they find online?

Have the students do a scale conversion of 1:30 ratio. Students will need to enlarge or reduce as needed. Can the students convert between units of inches/feet and centimeters/meters, calculating within and between the imperial and metric systems?

Have an artist come in and explain the process, help the students plan the class pole, and choose the images to go on the pole.

Activity 4: Pole Raising

Have students watch the video and read the story about the creation and raising of a Reconciliation Pole at UBC Vancouver. If possible, attend an actual pole-raising ceremony.

Resources and Materials

- video about the UBC pole (https://www.youtube.com/watch?v=alZQ1a58A0I&feature=youtube)
- story about the UBC pole (https://www.straight.com/arts/888571/haida-master-carver-james-hart-tells-story-indian-residential-schools-reconciliation)

How many people they would need to carry the student's pole to the area? Bring in three different sizes/diameters of the log. Have students determine how many people they would need to carry the log, and then extrapolate how many people they would need to carry the finished pole. Is this a rate or is it a correlation based on weight, or on length and width? How fast does the weight increase with an increase in diameter?

How do the participants make sure that the pole is upright without canting to one side? Is there a way to plan where the rope pullers should end up? (Consider equal forces, vectors, Pythagorean theorem.) Students should be able to justify their decisions mathematically.

Activity 5: Math Lab:

This small-group activity involves modelling the raising of poles with differing characteristics using string and dowelling pieces of varying lengths (the dowelling pieces will need to be pre-cut).

In groups of 3-4, students will design how to raise the poles in dirt. This best done outside; but it can be done inside with adaptation. Students should consider the width and depth of the pit needed to support the pole. Ensure students document their proceedings as they go. Have students participate in trying to raise each pole.

Resources and Materials

Provide the following for each group:

- space in which to dig a small model of a pit in which the "pole" will stand
- string (+ scissors that will allow students to cut it to varying lengths)
- a tall, thin piece of dowelling
- a short, thick piece of dowelling
- a piece of dowelling with a second aspect, representing a top figurehead (e.g., the addition of a crosspiece to represent wings or a ball to represent a head)

Follow up with a class discussion about what the experience was like. Students should write a reflection on the math that is embedded in what they did.

Activity 6: Making Rope

Have students determine the optimal length of the rope that was needed for each pulling group.
Have an Elder come in and explain how to make cording or rope in your local area. Some First Nations use cedar bark, stinging nettle, willow bark, tule reed, or sinew, among other materials, to make rope. Students can make rope by twisting plant material as described to make twine, then doubling back on itself to make rope. Have students make a 30 cm length of rope. How much of the original material was needed? How much would be needed to make enough rope for one of the pulling groups? …for all the groups to raise the pole?

How long will it take to make enough rope? As an extension, how strong is the rope? How much weight can your rope carry? Is it related to the diameter of your rope?

Make a video as a class with the Elder about how to make rope in your local area. Be sure your video is compliant with the Freedom of Information and Protection of Privacy Act (FOIPPA).

Activity 7: Repatriation of Poles

Poles from the Royal Museum of British Columbia are being repatriated. Have students read the article: https://www.cbc.ca/news/canada/british-columbia/b-c-museum-returns-indigenous-poles-in-spirit-of-repatriation-1.5156168.

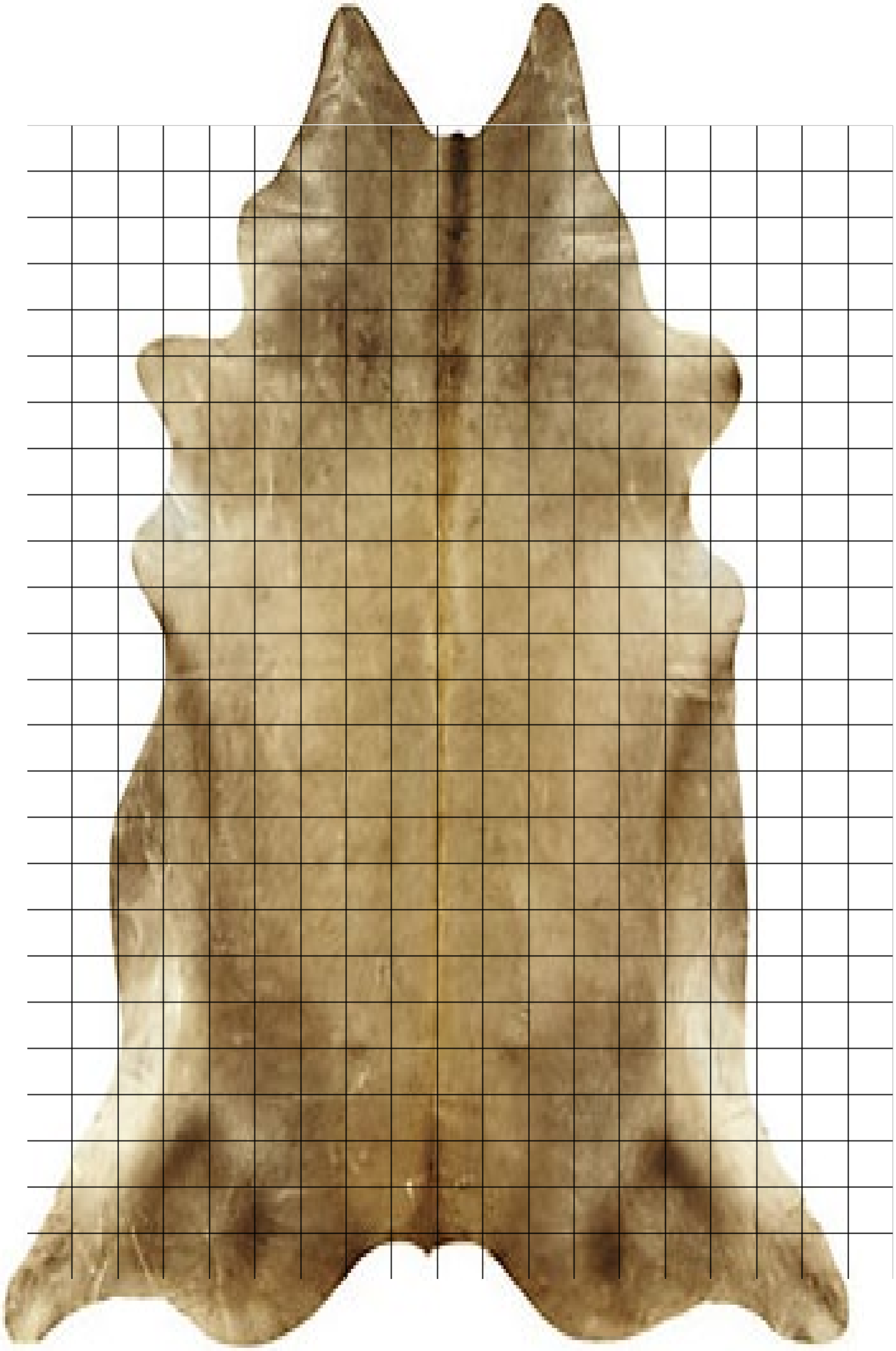
Hold a class discussion around the repatriation of Indigenous cultural materials. What mathematical questions does the class have? Create a list of numeracy-based considerations for this type of event to happen. Have each student research the answer to one of the questions that arose.

Resources and Materials

- online CBC article on pole repatriation (https://www.cbc.ca/news/canada/british-columbia/b-c-museum-returns-indigenous-poles-in-spirit-of-repatriation-1.5156168)

BLM 1 – *Sample Deer Hide*

BLM 2 – *Outline of a Hide*



“SPACE” AND THE COSMOS

Multi-Grade Thematic Unit

This multi-grade thematic unit uses the *adaawx*, "Raven Steals the Light" as a context for exploring the geometry of space and shape as well as linear relations. "Raven Steals the Light" is an important story to many First Nations communities along the west coast. Consequently, among First Nations in BC, there are many variants of the story. The version provided here comes from a Ts'msyen story teller and was originally told in the Sm'algyax language, but before using this version of the story it is suggested that you first inquire locally if there is a version of the story that is more suitable and appropriate for your area.

Adaawx is the Sm'algyax word for a story that is believed to be true. It is neither a myth for entertainment nor a lesson to be learned (for which there is a separate word). Although it might seem impossible to actually fit all the stars, sun, and moon into a small box, it is important to understand that apprehending the truth in this story, with its supernatural components, requires an understanding of metaphor and an appreciation of cultural context (it comes from a time when the world was different than it is today).

In working with this unit, it also helps to be aware of the following:

- Transformation is a common element in many Indigenous stories and among many west coast First Nations. Raven is a key figure who often transforms himself to suit his will and likewise has the power to transform the world around him. See also pp. 372-373 in *First Peoples English* and pp. 214-218 in *B.C. First Nations Studies* for more information about transformation in Canadian Indigenous narratives.
- The nested bentwood boxes in this story are an example of the traditional bentwood boxes used among many west coast Indigenous communities. For more information on Bentwood boxes, please see the Bentwood Boxes mini-unit in the *Contemporary Cultural Artifacts* thematic unit.
- Additional activities focussing on linear relations can also be found in the Weaving mini-unit within the *Contemporary Cultural Artifacts* thematic unit. One of the weaving patterns in this unit is a nested boxes pattern which provides an additional connection to this story.

Curriculum Connections

<u>Mini-Unit: Inside the Box</u>

Big Ideas

Math 7: The constant ratio between the circumference and diameter of circles can be used to describe, measure, and compare spatial relationships.

Math 8: The relationship between surface area and volume of 3D objects can be used to describe, measure, and compare spatial relationships.

Math 9: Similar shapes have proportional relationships that can be described, measured, and compared.

Grade	7	8	9
Curricular Competencies	• Model mathematics in contextualized experiences • Use reasoning and logic to explore, analyze, and apply mathematical ideas • Explain and justify mathematical ideas and decisions • Apply multiple strategies to solve problems in both abstract and contextualized situations • Use tools or technology to explore and create patterns and relationships, and test conjectures • Develop, demonstrate, and apply mathematical understanding through play, inquiry, and problem solving • Visualize to explore mathematical concepts		

Grade	7	8	9
Content	circumference and area of circles volume of rectangular prisms and cylinders	surface area and volume of regular solids	spatial proportional reasoning
Core Competencies	Social Awareness and Responsibility Creative Thinking		

Mini-Unit: Raven Transforms

Big Ideas

Math 7: Linear relations can be represented in many connected ways to identify regularities and make generalizations.

Math 8: Discrete linear relationships can be represented in many connected ways and used to identify and make generalizations.

Math 9: Continuous linear relationships can be identified and represented in many connected ways to identify regularities and make generalizations.

Math 9: Computational fluency and flexibility with numbers extend to operations with rational numbers.

Grade	7	8	9
Curricular Competencies	• Model mathematics in contextualized experiences • Use reasoning and logic to explore, analyze, and apply mathematical ideas • Explain and justify mathematical ideas and decisions • Apply multiple strategies to solve problems in both abstract and contextualized situations • Use tools or technology to explore and create patterns and relationships, and test conjectures • Develop, demonstrate, and apply mathematical understanding through play, inquiry, and problem solving • Visualize to explore mathematical concepts		
Content	discrete linear relations, using expressions, tables, and graphs two-step equations with whole-number coefficients, constants, and solutions Cartesian coordinates and graphing	discrete linear relations (extended to larger numbers, limited to integers) expressions- writing and evaluating using substitution	two-variable linear relations, using graphing, interpolation, and extrapolation (including rational numbers) multi-step one-variable linear equations
Core Competencies	Social Awareness and Responsibility Creative Thinking		

Mini-Unit: Outside the Box-Graphing the Constellations

Big Ideas

Math 7: Linear relations can be represented in many connected ways to identify regularities and make generalizations.
Math 8: Discrete linear relationships can be represented in many connected ways and used to identify and make generalizations.
Math 9: Continuous linear relationships can be identified and represented in many connected ways to identify regularities and make generalizations.
Math 9: Computational fluency and flexibility with numbers extend to operations with rational numbers.

Grade	7	8	9
Curricular Competencies	• Model mathematics in contextualized experiences • Use reasoning and logic to explore, analyze, and apply mathematical ideas • Explain and justify mathematical ideas and decisions • Apply multiple strategies to solve problems in both abstract and contextualized situations • Use tools or technology to explore and create patterns and relationships, and test conjectures • Develop, demonstrate, and apply mathematical understanding through play, inquiry, and problem solving • Visualize to explore mathematical concepts		
Content	discrete linear relations, using expressions, tables, and graphs two-step equations with whole-number coefficients, constants, and solutions Cartesian coordinates and graphing	discrete linear relations (extended to larger numbers, limited to integers) expressions- writing and evaluating using substitution	two-variable linear relations, using graphing, interpolation, and extrapolation (including rational numbers)
Core Competencies	Social Awareness and Responsibility Creative Thinking		

Mini-Unit: Inside the Box

Context-Setting Introductory Material for Students

(for teacher-facilitated sharing in a whole-class setting)

Txamsm Brings Light to the World

Many thanks to the Ts'msyen Nation and School District #52 (Prince Rupert) for allowing us to reprint this story. An illustrated version of *Txamsm Brings Light to the World* was previously published with a Sm'algyax language translation.

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 chief's 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 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]

Guiding Questions

- How big would a box need to be in order to hold the actual sun, the moon, and the stars? (It is recognized that the story has a supernatural premise.)

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[1] ***Wilt Dagoydiksdit Txasms Goy'pa Da Ha'lidzookx*, "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.

Activity 1: Story Context

Begin with the story, *Txamsm Brings Light to the World* ("Raven Brings the Light" or "Raven Steals the Light"). There are different versions of the story in many different nations, all of which should work for this project.

- Legends of the Old Masset Haida: Gaaw Xaadee Gyaahlaangaay — beginning approximately at approximately at 42:00 min: https://www.cbc.ca/radio/ideas/legends-of-the-old-massett-haida-1.2913322
- other local versions available in print form

While some older materials use the word "legends," this is not the preferred terminology. Today, these would be referred to as "stories." To honour the First Peoples oral tradition, the story should be read aloud (if using a print version), played on CD, or from the website listed if using the CBC version. 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.

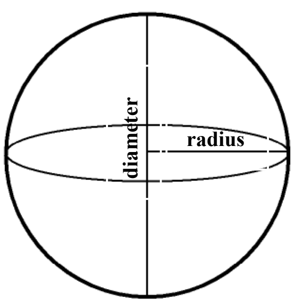
You may also need to teach a preliminary lesson on capacity of a cube to help facilitate the understanding of the objects and vocabulary.

Activity 2: Calculating the Volume of Spheres

As explained in the Bentwood Box mini-unit (Contemporary Cultural Artefacts), bentwood boxes are used to hold a variety of objects. In the story, "Raven Brings the Light," the box is holding the sun, the moon, and the stars. These celestial bodies are all spheres. A sphere is a 3-dimensional shape where every point on the surface is the same distance away from the centre. This distance is called the radius (r). The distance through the centre from one side of the sphere to the other is called the diameter (d).

Resources and Materials

- Size of Earth, moon, sun and other stars: https://www.youtube.com/watch?v=1Eh5BpSnBBw
- Replacing the moon with other planets: https://www.youtube.com/watch?v=usYC_Z36rHw



How much longer is the diameter than the radius?

The Volume of a Sphere formula is:

Volume = $\frac{4}{3} \times \pi \times r^3 = 4 \times \pi \times r \times r \times r \div 3$

Where $\pi \cong 3.14$

If you do not have a calculator, $\pi \cong 3$

Example: What is the volume of the sphere with radius equal to 5 cm?

Volume = $4 \times \pi \times r \times r \times r \div 3$
Volume = $4\times 3 \times 5\text{cm} \times 5\text{cm}\times 5\text{cm}\div 3$
Volume = $12\times 5\text{cm} \times 5\text{cm}\times 5\text{cm}\div 3$
Volume = $60\text{cm} \times 5\text{cm}\times 5\text{cm}\div 3$
Volume = $300\text{cm}^2 \times 5\text{cm}\div 3$
Volume = $1500\text{cm}^3 \div 3$
Volume = 500cm^3

Calculate the volume of the

- moon (radius ≅ 1,737 km),
- Earth (radius ≅ 6,371km or 6500 km), and
- sun (radius ≅695,510 km)

Please note: if no calculators are available, use 2,000km, 6,500km and 700,000km

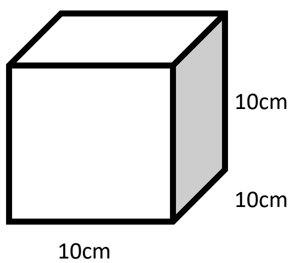
How much larger is the sun vs the moon vs the Earth?

Could the moon or sun box fit on the Earth?

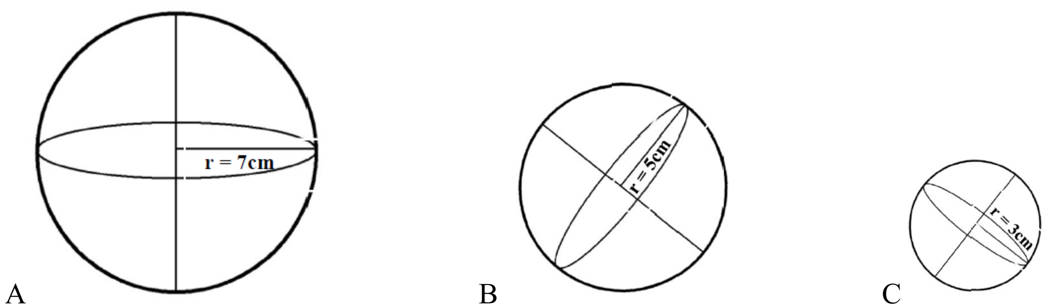
Activity 3: Celestial Bodies: Cubes, Rectangular Prisms and Spheres

If you had a cube-shaped box and a sphere, how would you be able to fit the sphere completely in the box?

> ***Resources and Materials***
> - Putting the planets between the Earth and moon: https://www.youtube.com/watch?v=KEoqv0PAAT8
> - Cool facts about our night sky: https://www.youtube.com/watch?v=GCTuirkcRwo

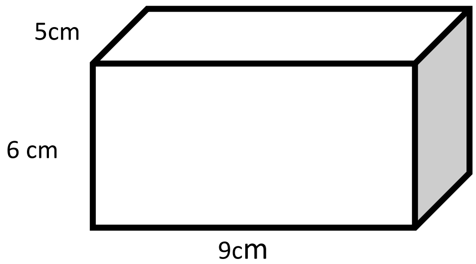


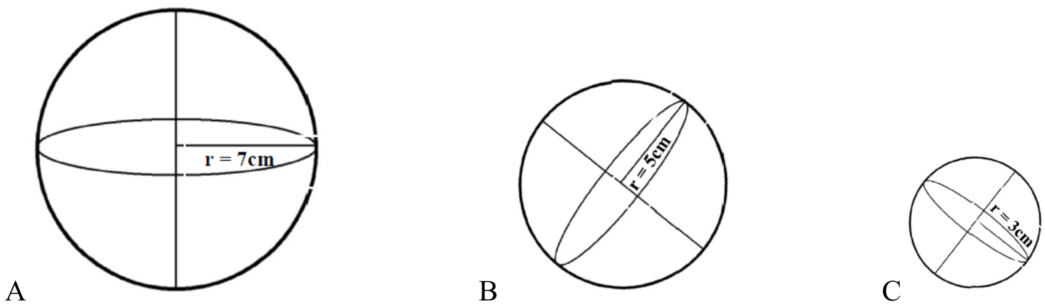
If we scaled down three celestial bodies so that they were spheres with radii of 7cm, 5cm, and 3cm, which spheres would fit in a 10cm cubed box?



Which spheres fit in the cube?
Can you describe how much they fit? Is there very much space for them?

If we used a rectangular prism box and the same spheres, which would fit?





Which critical measurement is needed to determine if a sphere will fit inside a box? (i.e., diameter)
How would the specified spheres (celestial bodies) fit? Could more than one sphere fit in the box whose measurements are given here?
If the spheres fit, how much extra space is there for them in the box?
Could the three specified spheres represent the sun, moon, and stars? Why or why not? (issues of scale)

Formative Assessment

Pose questions that extend the situation with different variables (e.g., "How big would the box need to be to hold 10 stars?") to ensure that students have grasped the concept of capacity and the process of calculating it.

Mini-Unit: Raven Transforms

Context-Setting Introductory Material for Students

(for teacher-facilitated sharing in a whole-class setting)

This mini-unit draws upon the same story (Txamsm Brings Light to the World) used to set the context for the previous mini-unit. This time the focus is on the Raven's power of transformation and on the properties of the sun once it has been released from the box.

Applicable Blackline Masters

BLM 1 – Raven Transforms
BLM 2 – Rule T-Chart
BLM 3 – Aim the Pine Needle
BLM 4 – Spinners
BLM 5 – Keep or Toss Game Sheet
BLM 6 – Graph Sheet
BLM 7 – Aim the Pine Needle (Fractional Coefficients)
BLM 8 – Around the Riverbend
BLM 9 – Up and down the River (Fractional Coefficients and Negative Constants)

Activity 1: The Pine Needle Problem

Remind students how in the story *Raven (Txamsm) Brings Light to the World*, raven transforms himself into a pine needle, which is then swallowed by the Chief's daughter. Ask them to consider what if Raven had transformed himself into not just one, but multiple pine needles in order to increase the likelihood of being swallowed?

Resources and Materials

- pine needle manipulatives (cut out or electronic resource)
- copies of BLM 1 – Raven Transforms for each student
- clear dry erase folders and marker for each student
- 6-sided and 10-sided dice for each student (12-sided dice for students requiring extra challenge)

Making Connections: Math in Nature

If possible, take the class outside to examine the needles on a pine tree. Have the students investigate how the needles grow in groups. Pine needles always grow in groups of two or three. Take a look at other trees and plants in the area and investigate grouping numbers in nature: petals on a flower, cone swirls (see "Fibonacci sequence"), leaf sections, etc.

Proposing the Problem

Let's assume that the pine needle Raven transformed into was grouped in twos, one needle for each wing:

Draw 1 group of 2 needles on the board.

What if, after his transformation, needles floated past the Chief's daughter? Luckily, being quite powerful, Raven would be able to transform himself into multiple sets of needles. Instead of just one pair or needles, he transformed himself into 2 pairs of needles. (drag another pair over). How many individual needles are there now? (4)

Let's assume, he missed the Chief's daughter again and became a third pair of needles floating down the stream. How many needles are there now? (6)
Ask the students, "If it took 4 transformations before he was swallowed by the Chief's daughter, how many individual pine needles would there have been in 4 transformations? Explain how you know." (8, it is increasing by 2 each time)

What if it took 10 transformations?

Give students a moment to think about the problem and try to work it out with a white board and a marker. Ask them to draw diagrams, numbers and pictures to prove their answer. Have students share their ideas. Show various methods on the board. Be sure to include an example of a chart like the one shown here (t = transformations).

(t)	needles
1	2
2	4
3	6
4	8
5	10
6	12

Organizing thinking with a chart

Hand out to each student a copy of BLM 1 – Raven Transforms. This is to be used in a dry-erase folder. Explain to your students that they are going to use the chart to organize their ideas. (Mathematicians and scientists often find it helpful to use charts to organize their thinking).

Discuss the change or difference in the total # of needles after each transformation. Demonstrate how you can show the change along the side of the chart.

Challenge students to figure out how many pine needles there would be if he had to transform 30 times (or any other number of times you care to specify).

Ask them: ***What is the rule for <u>any</u> number of transformations?***

Have students share their thinking. Tell them they are thinking like mathematicians when they express a pattern rule in the form of a generalization that works for <u>any</u> number.

(t)	needles	
1	2	
2	4	+2
3	6	+2
4	8	+2
5	10	+2
6	12	+2

Steer them toward thinking about what **operation** (adding, subtracting, multiplying or dividing) must be used. Ask if they can see the ***relationship*** between the # of transformations and the number of needles (multiply by 2).

Write out each equation next to chart to help solidify the idea. (see below).

	(t)	needles	
2 x 1 = 2	1	2	
2 x 2 = 4	2	4	+2
2 x 3 = 6	3	6	+2
2 x 4 = 8	4	8	+2
2 x 5 = 10	5	10	+2
2 x 6 = 12	6	12	+2

Rule: 2 x transformations
or 2 x t

Explain that t = the number of transformations. This letter is called a ***variable***. A variable is a symbol for a number we don't know yet. It stands for ***any*** number. It is called a variable because it can vary or change. You can use any letter for the variable, but it is a good idea to use a letter that helps you remember what you are counting; so we are going to use ***t for transformations***.

Another common letter choice is **n** which is easy to remember because it stands for “**n**-y” (any) number.

Note: 2 x t is an **expression** or **relationship** that stands for a single number. It’s like half of an equation. An equation is a statement of two expressions that are equal.
We can swap the variable in the expression with any number of transformations to find out how many needles there will be in total. To find out how many needles after 30 transformations, **t = 30**

2 x t

2 x 30 ***(swap out the t for 30)***

60

Explain that they can find the number of pine needles for any number of transformations using this relationship. Explain that mathematicians usually leave out the multiplication sign and write the expression like this:

Expression Rule: 2t

hidden **multiplication** symbol

Mathematicians always write the number before the variable. The number multiplied by the variable is called a **coefficient**.

Next, ask them what would happen to the chart if instead of 2 needles floating down the stream, there were needles grouped in threes.

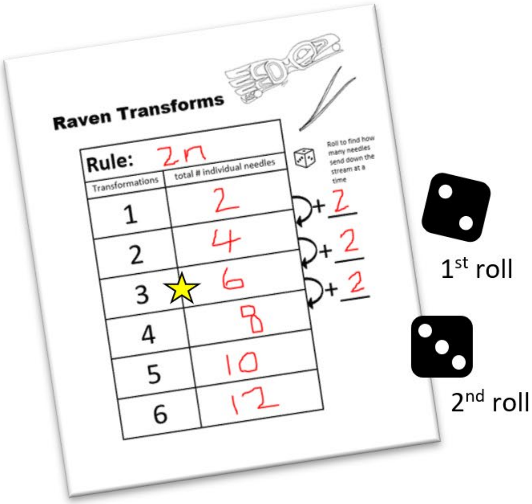
Fill out the chart individually or as a class as a formative assessment.

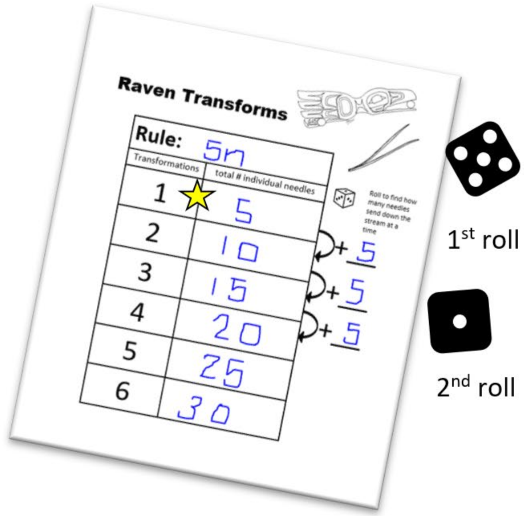
Repeat and have the students fill out the chart independently with a new number generated by a roll of the die.

Formative Assessment: Raven Transforms Game

Play the game to practice with a partner. The partner with the most pine needles wins!

- Roll a die to determine how many pine needles are floating down the stream at a time. Write the number below the needle, next to each + sign. (In the example below, red rolled a 2, blue rolled a 5.)
- Complete the chart.
- Roll the die again (2nd time) to see how many transformations you will use to compete with your partner.
    - Red rolled a 3 and will compete with 3 transformations of 2 needles, which is 6.
    - Blue rolled a 1 and will compete with 1 transformation of 5 needles, which is 5.
- The greatest number of needles wins.
    - 6 > 5 so red wins!





Play the game again; but roll the dice to make the rule. Add the rule at the top of the chart. Use a 12 or 20-sided die for the 1st for student pairs needing an extra challenge.

Variation: On the board fill in a chart with a pattern and have the students use their own dry-erase charts to figure out what the rule is by first finding the pattern of increase, then finding the rule.

Activity 2: Graphing the Relationship

Resources and Materials

- student copies as needed of BLM 2 – Rule T-Chart
- one double die-10 or two 10-sided dice per player.
- one copy per group of BLM 3 – Spinners (about 4 students to a group) plus paper clips and pencils as needed
- one copy per student of BLM 4 – Aim the Pine Needle in a dry erase sleeve and a dry erase marker

Explain that sometimes mathematicians like to show how fast something grows by plotting it on a chart or graph. Show students how to plot each of the Activity 1 coordinates on a cartesian grid. Show how the plotted dots connect together to make a straight line. Because it makes a straight line, we call this a *linear relation*.

Before graphing, the relation needs to be in the form of an equation. We can write it as:

Pine Needles = 2 x transformations or **p = 2t**

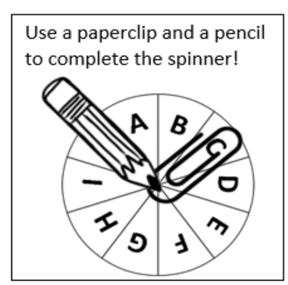
p = 2t

Transformations (t)	Pine needles (p)
0	0
1	2
2	4
10	20

Have students graph the relationship by using BLM 2 – Rule T-Chart to identify points.

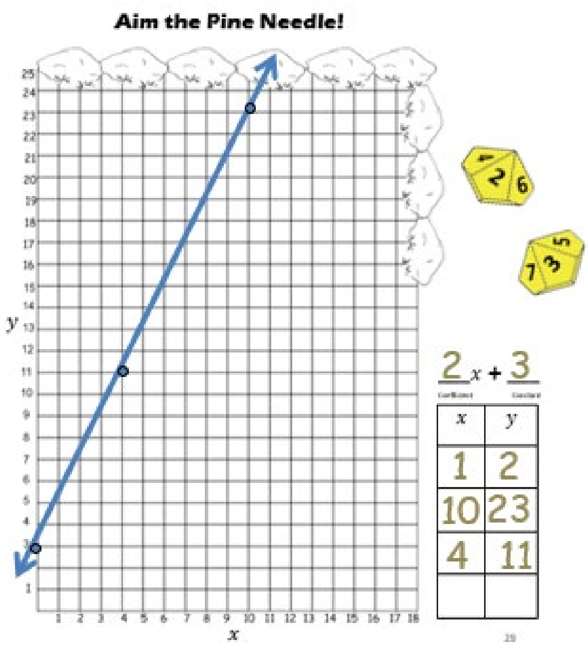
Practice Game: Aim the Pine Needle

The purpose of this game is to graph a line on a chart to guide the pine needle (Raven Transformed) "across the river" to the Chief's Daughter. If the line touches the rock where she is sitting, you win a point!



1. Have each group use BLM 3 – Spinners to make themselves a spinner. Each player starts by flicking the paperclip spinner. Whatever letter it lands on is your rock. At the start of your turn, the Chief's Daughter will go to your rock to drink from the stream. Your rock will remain the same until the Chief's Daughter drinks the pine needle.
2. At the start of each player's turn, roll 2 dice (ten sided). Choose one number to be your coefficient and the other to be the constant.

3. Use the T chart to find values for y. Take turns using the T chart on the game sheet or each player can use their own chart using BLM 2 – Rule T-Chart. Choose at least three values for X and simplify to find the value of (y) using the provided T chart. (Once players have a good understanding of how to graph the line using the slope and y intercept, they can skip this step.)
4. Plot the points from the expression on BLM 5 – Aim the Pine Needle (or use the slope and y intercept to graph).
5. If you hit your rock (where the Chief's daughter is drinking), she swallows the pine needles. You win a point!



Questions to ponder while playing the game:

- Which rock targets are the hardest to hit?
- Where does the line cross the Y axis and how is it related to the expression?

From Patterns to Linear Relations in a Ts'msyen Context by Tannis Calder (2020, SD 52 Aboriginal/Indigenous Education dep't)

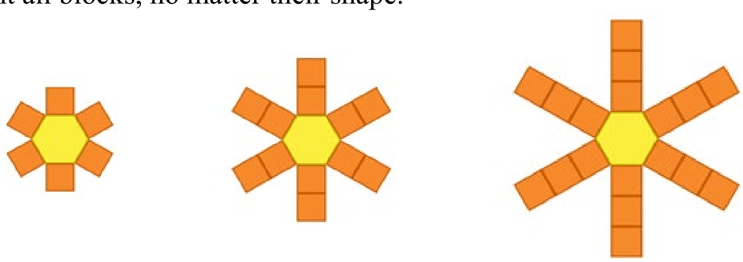
Activity 3: The Sun Problem

Modeling the Sun's growth:

After the students are familiar with the story, explain to them that they will be building a model of the sun after Raven placed it in the sky. Each hour the sun grew brighter as the rays extended down to the land. Demonstrate how to represent the sun using pattern blocks. Record the first three hours using a T chart. Count all blocks, no matter their shape.

Resources and Materials

- a bin of pattern blocks for each pair or group of students
- clear dry erase folders and marker for each student
- copies of BLM 2 – Rule T-Chart for each student



hour 1 (7 blocks) hour 2 (13 blocks) hour 3 (19 bocks)

hour	Bocks
1	7
2	13
3	19

Invite the students to replicate the sun with blocks in partners and fill in the T chart. Give each pair about 25 blocks and encourage them to look for a pattern in the numbers to chart when they run out of blocks.

Discuss the findings as a class. Highlight the change in the number of blocks each hour (see red text). And ask students if they can find the **generalization** (the rule) for the pattern for any number of hours (h).

Hours (h)	# of Blocks (brightness)	
1	7	+6
2	13	+6
3	19	+6
4	25	
5	31	
6	37	

Students will probably remember from the previous lesson that when the number increases by the same amount, they can use it to find the rule. Check to validate your generalization. Does it work for all figures?

What is the rule?

This may stump them. They may suggest that 6h is the generalization; but find that the numbers do not work when checking.

$6 \times 1 \neq 7$

$6 \times 2 \neq 13$

$6 \times 3 \neq 19$

Ask the students, **"What can we do to each number to get it to the correct number?"** (add 1)

As mathematicians we write the expression: **6h+1**
Check to validate your generalization by putting the figure number where the h is in the expression.
Does it work for all figures? (yes)

6 x 1 + 1 = 7

6 x 2 + 1 = 13

6 x 3 + 1 = 19

Ask the students to record the rule at the top of their chart. Explain that the rule is like a code and now that they know it, they could find out how bright the sun will be after ***any*** number of hours.

Ask students if they can see the +1 in the models of the sun (the yellow block in the centre). Explain we call this the **constant** because it is it does not change – it is constant.

The Expression Rule Chant

Chant the generalization a few times and invite the students to join you:

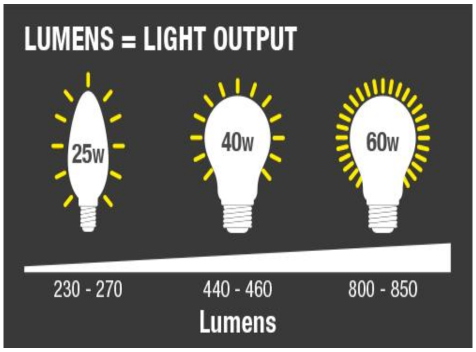
> *It's growing by **six,** so it's **6h**,*
> *We started with **one** so we **add 1**,*
> *6h plus 1.*

Challenge students with some large, but simple-to-calculate numbers (e.g., 10 hours) and guide them through the calculations with the following questions:

What's the rule? (students answer 6 x h +1 or 6h+1)
How many hours? (point to the h in the rule) (10)
What's 6 x 10? *(60)*
Are we done yet? *(no, we need to add one more)*

Try other easy numbers such as 20 hours, 50 hours and 100 hours.

> Write on the Board:
> ***6h + 1 =***
> ***6 x 10 + 1 =***
> ***60 + 1 = 61 blocks***



Optional Science Connection: Lumens

Assume each block represents one lumen (a unit for measuring light output). Count lumens instead of blocks.

You may want to discuss the pattern of light and day (a repeating pattern in nature) and how it is probably good that night eventually comes and that the sun does not grow eternally brigher.

Formative Assessment Practice Game

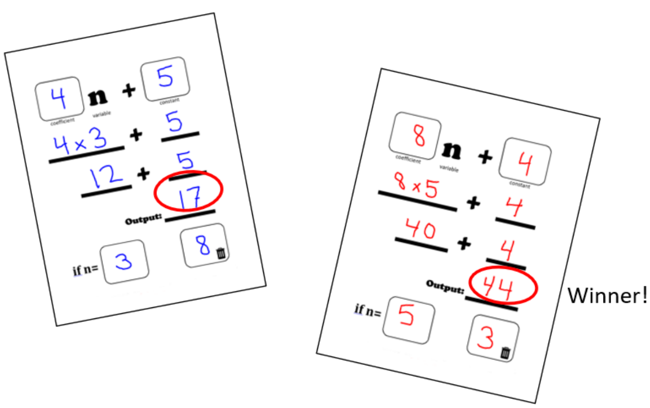
> ***Resources and Materials***
> - copies of BLM 5 – Keep or Toss Game Sheet for each student

The Keep or Toss Game is a good way to give students practice with linear relations and enables you to conduct formative assessment of their learning. Detailed instructions for playing the game are provided in the Contemporary Cultural Artefacts unit (see the Weaving mini-unit). The object of the game is to get the largest output number by strategically placing rolled digits into various places in the expression.

This game can be played in a small group or in pairs. Each group will need a one ten-sided die to share and a game sheet for each player.

The first player rolls the die and each player individually decides where to place the digit, as the **coefficien**t, the **constant**, the **value for n** (the variable) or in the garbage.

Repeat taking turns until the die has been rolled 4 times and all blanks have been filled. Each player evaluates (finds the value of) their own expression. The largest value wins a point!

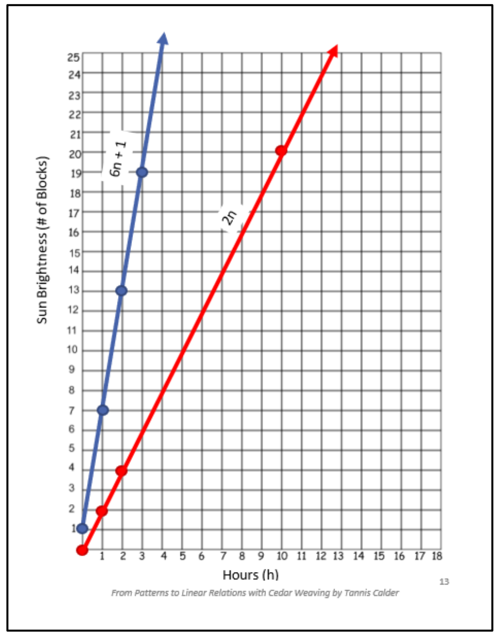


Explain that sometimes mathematicians like to show how fast something grows by plotting it on a chart or graph. Show students how to plot each of the coordinates on a cartesian grid. Show how the plotted dots connect together to make a straight line. Because it makes a straight line, we call this a *linear relation* (or, more specifically, a *linear function*, which is a type of *linear relation* in which each input is related to only one output).

When undertaking to graph the relation, mathematicians express it in the form of an equation. We can write it as:

Pine Needles = 2 x transformations
or
p = 2t

Graph the relationship by using the t chart to plot points on the chart:



p = 2t

Transformations (t)	Pine needles (p)
0	0
1	2
2	4
10	20

Explain that the place where the line crosses the y axis is called the **y intercep**t. Ask if they can find where the y intercept is in the expression rule. Experiment with different ways of changing the expression and have the students predict how it will change the graph:

Activity 4: The Gentle Slope Inquiry

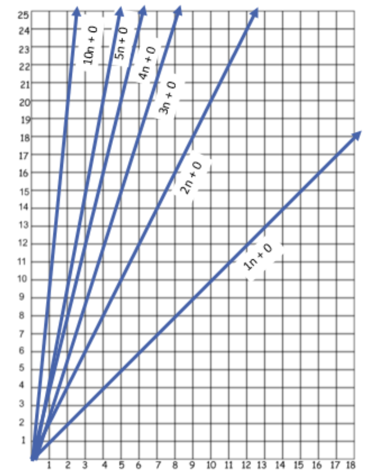
Gentle slopes with decimal and fractional coefficients.

Resources and Materials

- large graph paper for front of the class
- copies of BLM 6 – Graph Sheet in a dry erase folder for each student

Conduct this activity as a class demo with the students providing the varying data. Use a large graphing sheet on chart paper or projected so that all students can see the results of the graphing on one sheet. Hand out copies of BLM 6 – Graph Sheet in dry erase folders and a marker to each student.

- Tell students that everyone will start with 0 (zero) as the constant (the number added on).
- Ask each student to pick *any* number between 1-10 for the coefficient (or roll a d10) then complete the chart substituting each input for x to find the output.
- As a class, plot each expression on the same graph (use a graphing chart paper or smart board to show on the board to the class.



Ask students what they notice. (The bigger the coefficient, the steeper the slope.)

Challenge students to find an expression that creates a gentle slope that does not go beyond a 45-degree angle. (The trick is to use a coefficient that is less than a whole.)

Try with constants other than zero as well to see how the graph changes.

Practice Games: Aim the Pine Needle Variants

Have students play Aim the Pine Needle as explained in the previous activity with the variation of fractional coefficients.

Resources and Materials

- BLM 7 – Aim the Pine Needle (Fractional Coefficients)
- BLM 8 – Up and Down the River
- BLM 9 – Around the Riverbend
- dry erase sleeves and markers
- dice (d-10 or d-6 depending on game variant)

Aim the Pine Needle (Fractional Coefficients)

- Focus: graphing gentle slopes with fractional coefficients
- Use 1 quadrant and **6-sided dice**.

Up and Down the River

- Focus: graphing fractional coefficients with negative constants
- Use 2 quadrants and **10-sided dice**.

Around the Riverbend

- Focus: extending graph lines into other quadrants
- 3 quadrants
- Each player chooses any rock at the start of each round.
- Use **6-sided dice** – roll the dice and use the grid to select your coefficient. When 2 options are available, choose the one you think is most likely to score a point. 6s are wild; choose any number to replace a 6.

Mini-Unit: Outside the Box – Graphing the Constellations

Context-Setting Introductory Material for Students

(for teacher-facilitated sharing in a whole-class setting)

<u>Biyaals: Stars</u>

(From Persistence and Change, p. 71)

A knowledge of the stars was very important to the Ts'msyen in the past. They used them to navigate as they travelled the coast in their canoes. We know very little about what names the ancient Ts'msyen gave to the stars and constellations.

In the *adaawx*, the stars were considered to be the messengers of the sun, or of Sm'ooygidm Laxa. In one *adaawx*, Asdiwal marries the Evening Star, which today we know as the planet Venus. That narrative also mentions other stars, such as *Yiłteet* or *Yeełda* (the Kite), a star which does not blink like others do. Others are the Dipper, *Yagaxet* (Halibut Fishing Line), *Gankdax* (Stern Board in the Canoe) and the Old-Bark-Box.

Another source for names of stars comes from the 1917 interview with Sidney Campbell. Some of the words are very old and the spellings reflect the original transcription, not the current form used for Sm'algya̱x.

The Milky Way was called the Bar of Stars. "It represents where the wind is from," said Sidney. "You can always tell. You can see if the wind is from the west; it will turn around to the west. It points to the west, or the wind swings it around the other way.

Campbell mentioned two individual stars. One is *Gyemk lis'yaan* the Mink Star. "Called Mink Star because this little star never goes out. The moon may be dark; but this little star always shines. It lights the mink on his journeys in the woods and on the shore."

Yesh-deh, he said, is the brightest star. (Probably Jupiter, wrote Henry Welcome, Campbell's interviewer) "This is the fastest star of all the stars. Some nights you will see it here and the next night it will be away off. The Ginadoiks had a Travelers' Song about it. The words are "I travel, I travel all around the stars. I travel, I travel" repeated over and over again. And the second verse: "I would like to travel as you are. I would like to travel with you through the stars. You little Yesh-deh. You and I can travel, and I would like to travel with you -until the end. I would like to travel all the time."

One constellation was said to be made up of four stars in a diamond represented a bentwood box which had been squeezed together. In another part of the sky were two stars side by side that were named "Cockle's Eyes."

Another is similar to the English name. Skelsh *(or Seł)* is the Big Dipper. Campbell said "Skelsh means some sort of big spoon. Some young fellows went out on a picnic and they have got their spoons along with them. One spoon disappeared and there is the spoon hanging up there in the sky."

E-gooh or The Fishermen is a con-stellation made up of six stars. "The three upper stars represent three persons, and the three lower ones represent three fishing lines. There is a story about that. Three men went out fishing and they never came back in their little canoe. They were lost and their friends looked all over for them and never found them. At last they saw these new stars and they knew right away they had been taken up. They are fishing yet."
Sidney Campbell also explained the phases of the moon. The people envisioned it as flat disk. "The moon when it has disappeared, it had just [turned.] on edge towards you. You look at the moon; but you don't see it. It seems the moon is so flat, just like a thin fin. It is pivoted at the top and just swings around. So the first day it just pivots a bit, and you can just see it and it turns all the time, and keeps on turning every night until it is facing to you, and then it is full; and she keeps on turning, and then it disappears on that side and a little left on this side, and then she is gone again so you can't see it."

Applicable Blackline Masters

BLM 10 – Star Gazer Game Sheet (1 Quadrant)
BLM 11 – Star Gazer Game Sheet (2 Quadrants)
BLM 12 – Star Gazer Game Sheet (4 Quadrants)

Activity 1: Star Gazer Game

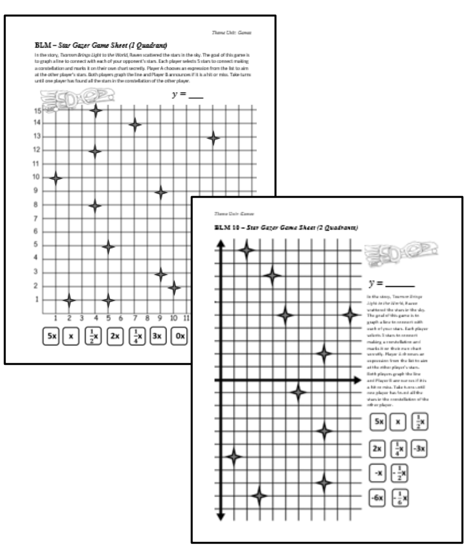
> ***Resources and Materials***
> - BLM 10 – Star Gazer Game Sheet (1 Quadrant)
> - BLM 11 – Star Gazer Game Sheet (2 Quadrants)
> - BLM 12 – Star Gazer Game Sheet (4 Quadrants)
> - dry erase folder for each player

In this activity, students work in pairs to practice graphing skills and develop a better understanding of how the coefficient in an expression effects the slope of a line. As stars move across the night sky, their positions relative to each other remain fixed, but their positions in relation to landmarks on Earth play an important role in understanding the change in seasons and knowing when certain seasonal food is expected or ready to harvest.

In the story, *Txamsm Brings Light to the World*, Raven scattered the stars in the sky. The goal of this Star Gazer Game (a variant of the familiar "battleships" game) is to graph a line to find each of the stars in an opponent's constellation. To begin, choose the appropriate game board for your students – 1 quadrant, 2 quadrants, or all 4 quadrants (BLM 10, BLM 11, BLM 12) and have students pair up. Each player is to select 5 stars to connect (making a constellation) and mark them secretly on a personal chart (they should not show the other player). Player A chooses an expression from the list and inserts it into the equation y = ____ to aim at the other player's stars. Both players graph the line and Player B announces if it is a hit or miss. Opponents take turns until one player has found all the stars in the constellation of the other player, winning the game. To facilitate play and analysis, each player can use 2 sheets – one for their own constellation and the other to keep track of hits and misses in relation to the other player's constellation.

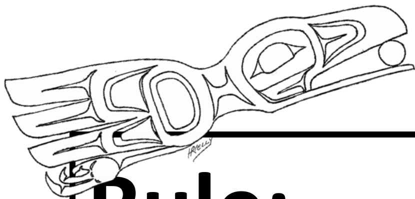
Monitoring and Debrief

During or after the game play, check to ensure students are connecting the points on the graph to get a line (some students fixate on winning and just follow the rule until they "hit" a star). To debrief the activity, try graphing all the equations as a class on the board. Once students see all the lines graphed, they will more easily see the connection between the coefficient and the slope.

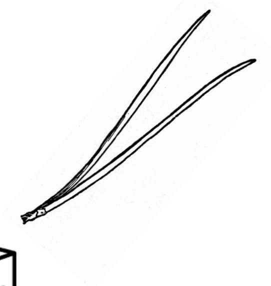


> One of the most specialized areas of knowledge in Ts'msyen society was understanding the seasons (the moons) and the stars. These people were the Gwildmniits, the moon readers. Sometimes this is translated as astronomers.
>
> The Gwildmniits watched the tides, the seasons, the stars, sun and moon very carefully. They could predict what the weather was going to be like for the upcoming season and could tell how successful fishing or other food harvests might be.
>
> They had special observation sites where they marked the passage of the sun and moon. The house of the Gits'ilaasü Chief Gaum's house at Gitla̱xdzawk had a door built into that led out to a point overlooking the Skeena River. From there the Gwildmniits observed the sun as it set behind the Kitselas Mountains. When the setting sun lined up with a certain notch in the mountains, it was the end of salmon season.
>
> There were two or three such people in each tribe. They were taught the special knowledge by Elder Gwildmniits.
>
> From *Persistence and Change*, p 70

BLM 1 – *Raven Transforms*



Rule:	
Transformations	total # individual needles
1	
2	
3	
4	
5	
6	



+__

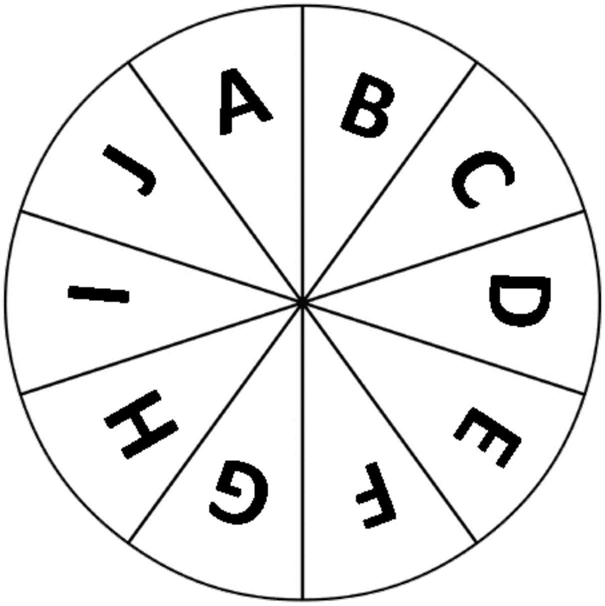
+__

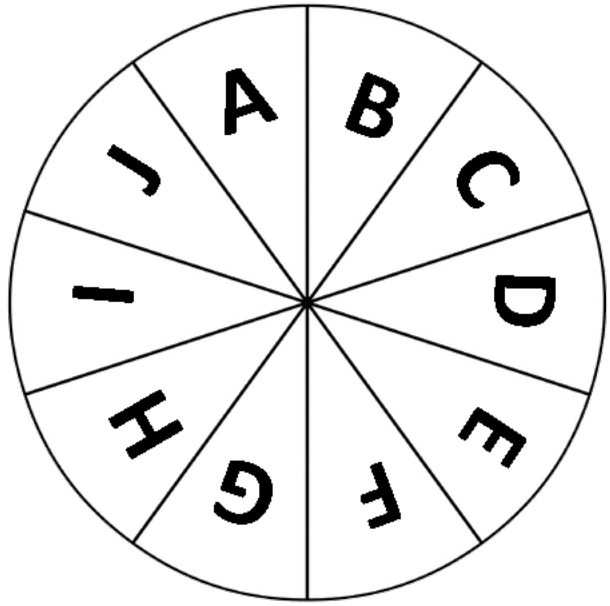
+__

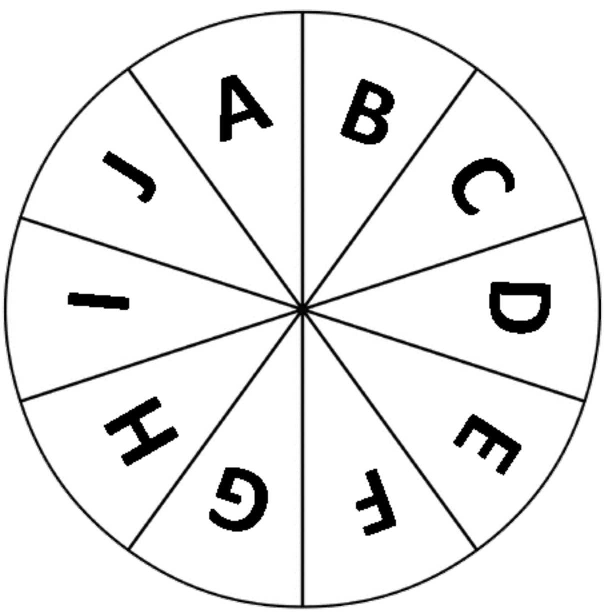
BLM 2 – *Rule T-Chart*

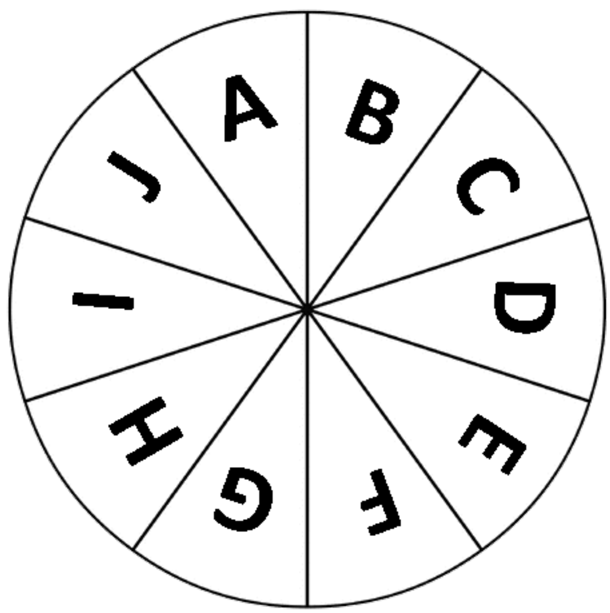
Rule: ______________

BLM 3 – *Spinners*

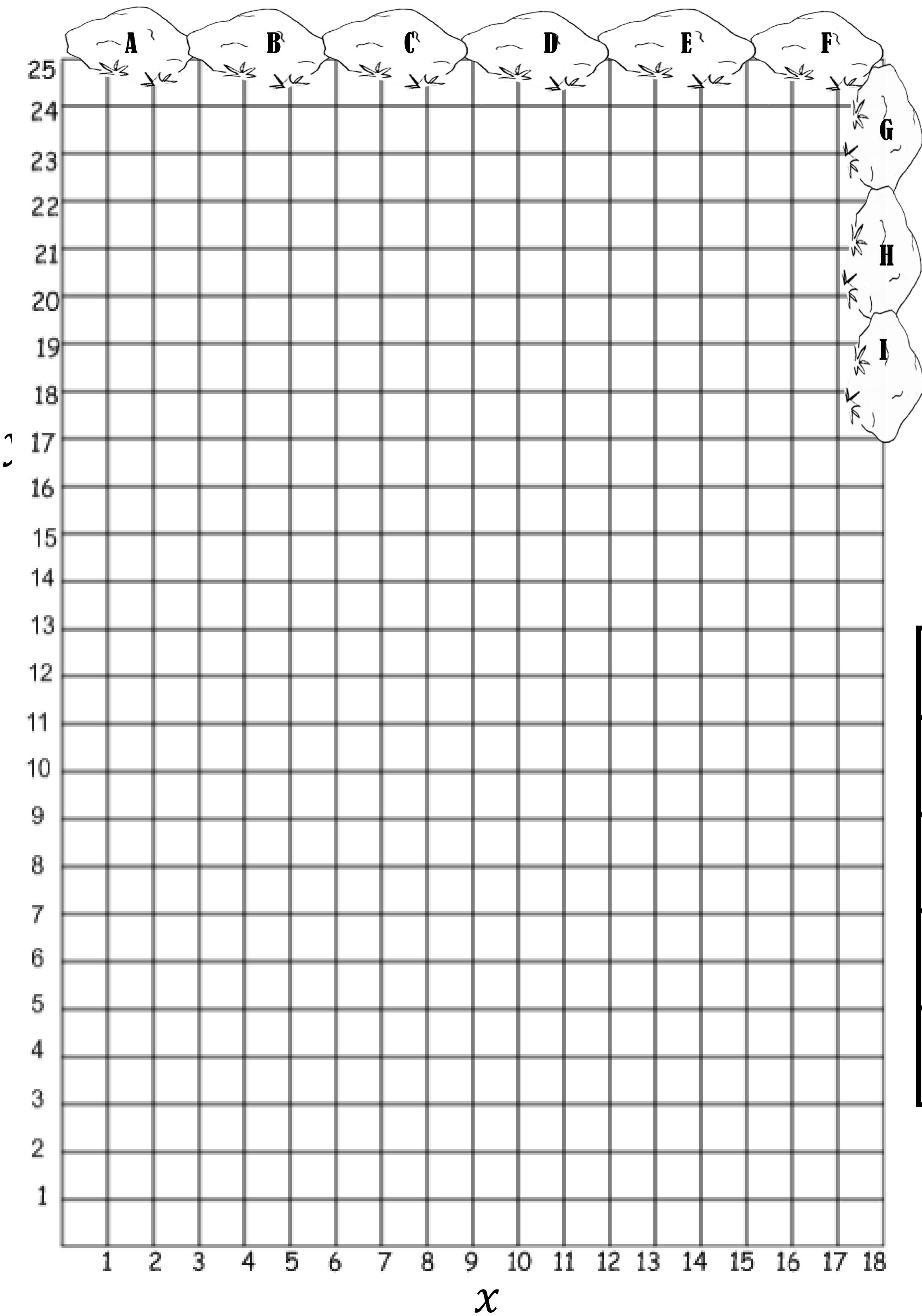








BLM 4 – *Aim the Pine Needle*



$y = \underline{\qquad}\,x + \underline{\qquad}$

Coefficient Constant

x	y

BLM 5 – *Keep or Toss Game Sheet*

n +

coefficient variable constant

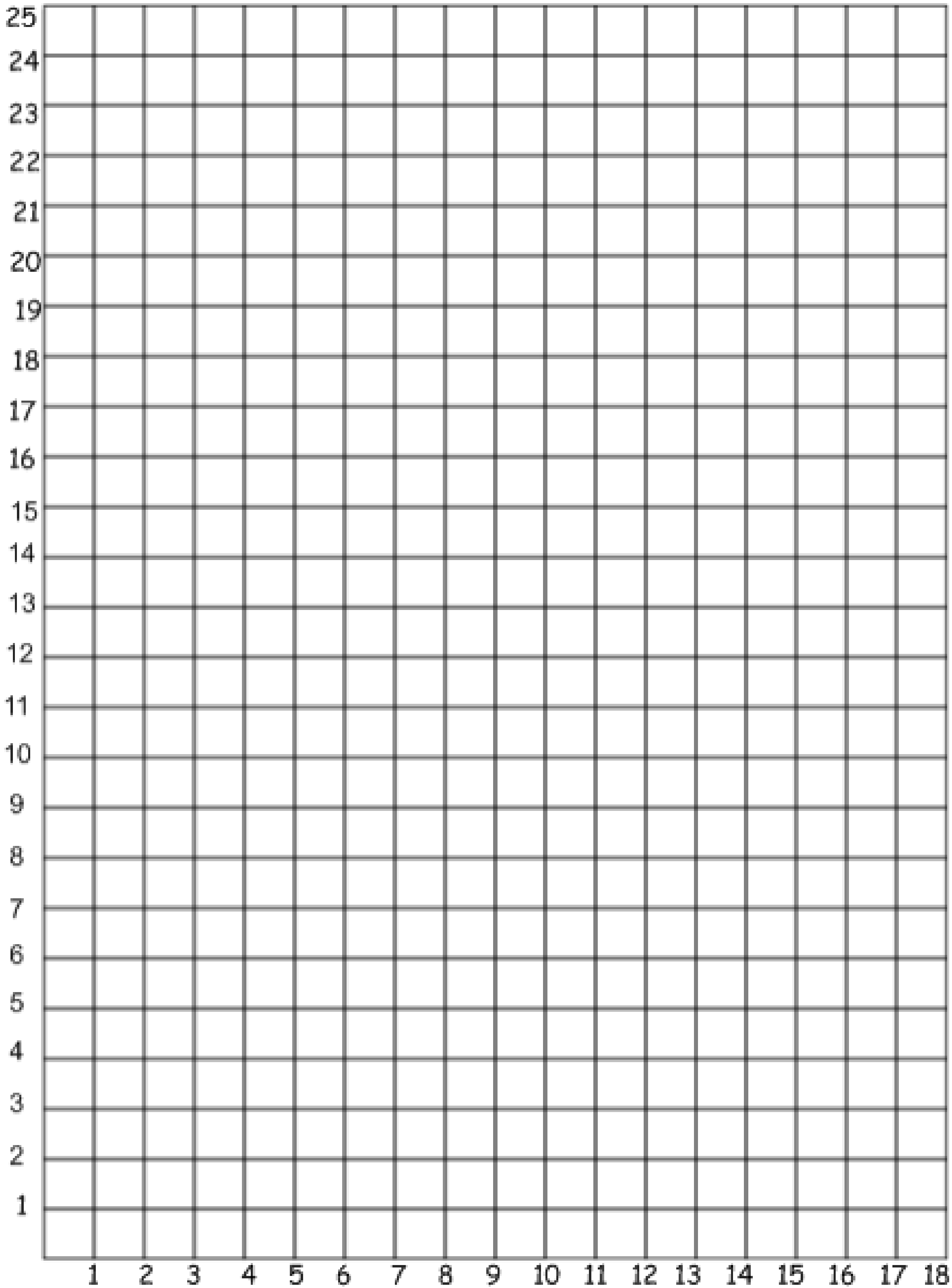
____________ + ______

________ + ______

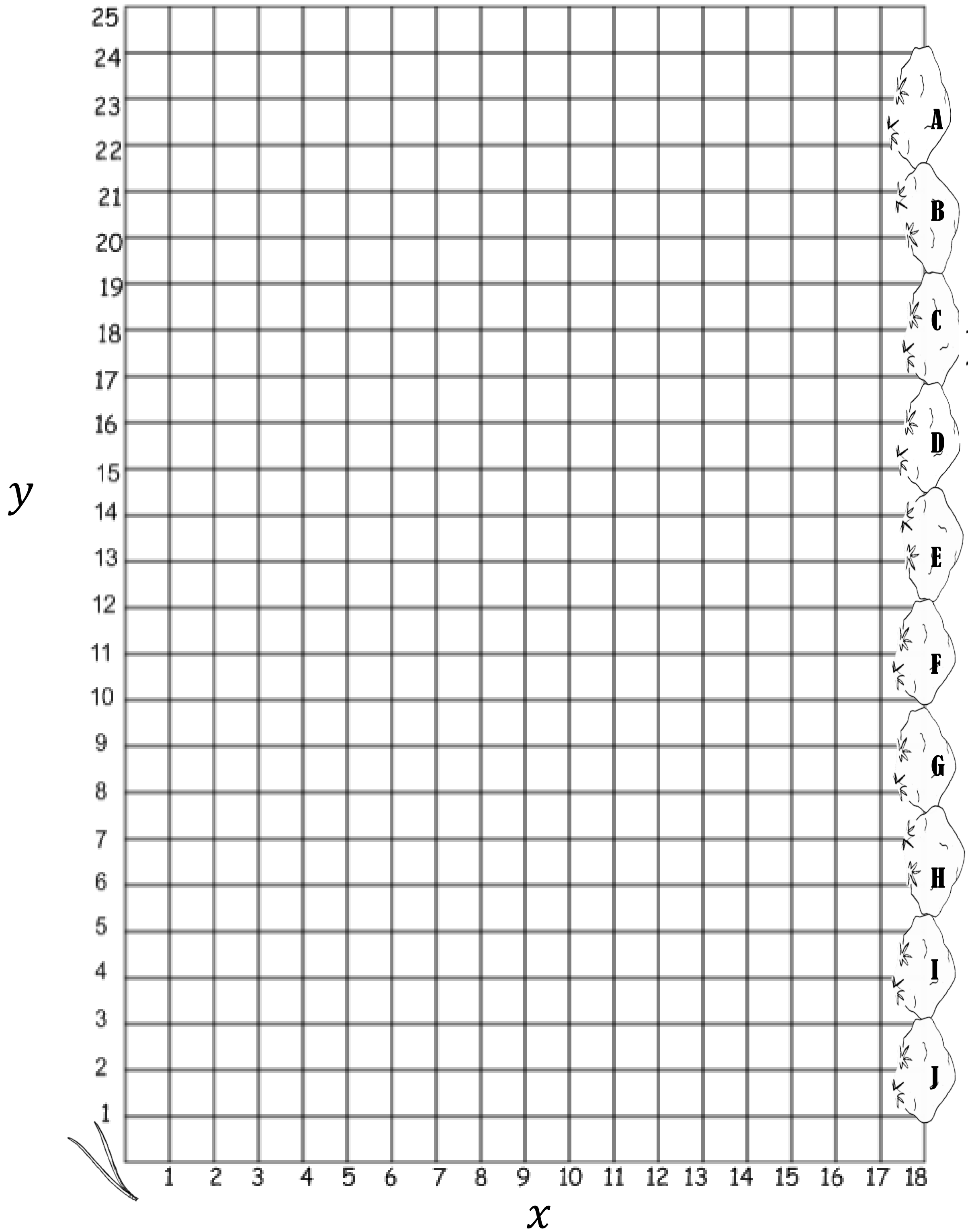
Output: ________

if n=

BLM 6 – *Graph Sheet*



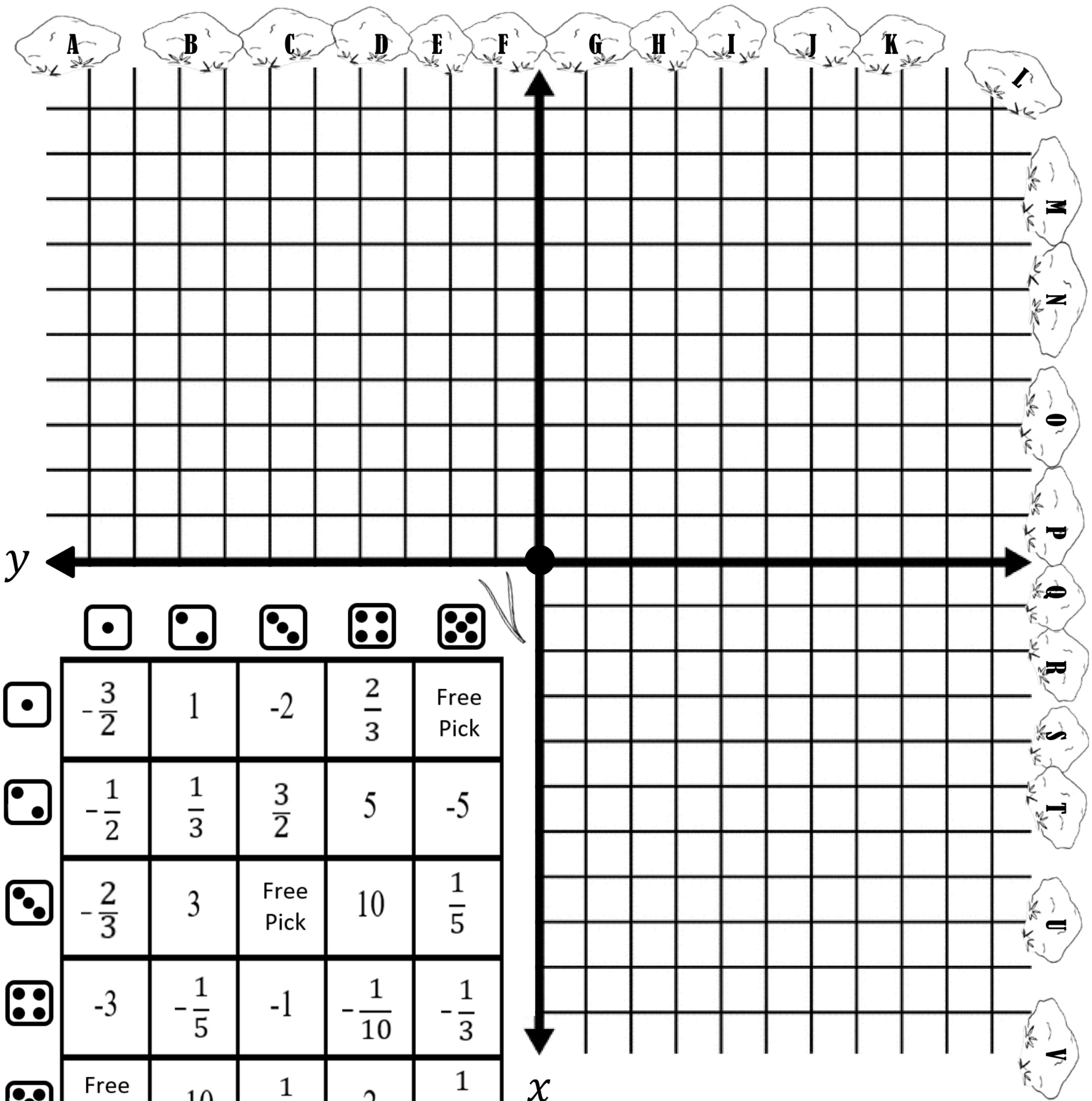
BLM 7 – *Aim the Pine Needle (Fractional Coefficients)*



$$y = \frac{1}{\square}x + \square$$

x	y

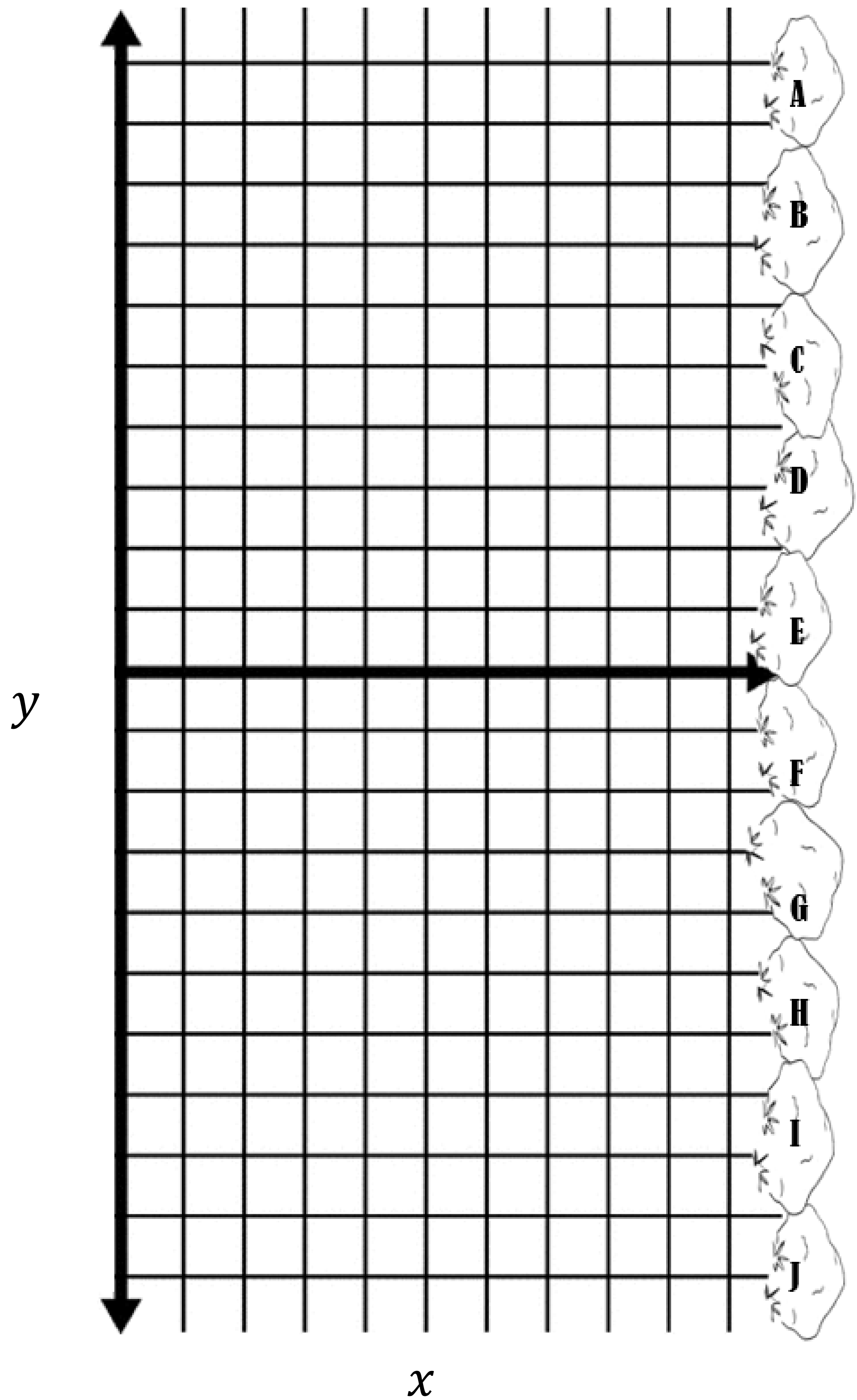
BLM 8 – *Around the Riverbend*

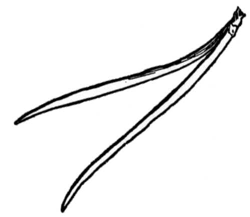


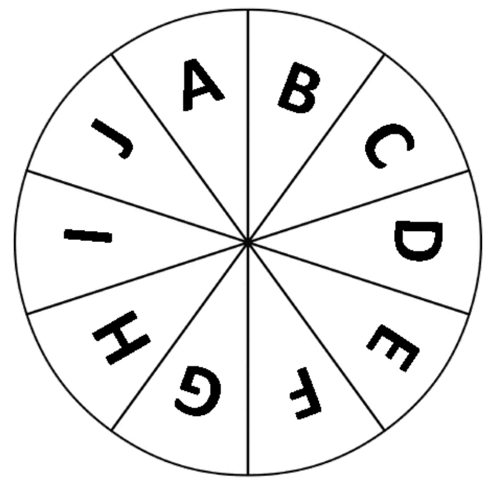
	⚀	⚁	⚂	⚃	⚄
⚀	$-\frac{3}{2}$	1	-2	$\frac{2}{3}$	Free Pick
⚁	$-\frac{1}{2}$	$\frac{1}{3}$	$\frac{3}{2}$	5	-5
⚂	$-\frac{2}{3}$	3	Free Pick	10	$\frac{1}{5}$
⚃	-3	$-\frac{1}{5}$	-1	$-\frac{1}{10}$	$-\frac{1}{3}$
⚄	Free Pick	-10	$\frac{1}{10}$	2	$\frac{1}{2}$

$y = \_\_\_ x + 0$

BLM 9 –*Up and down the River (Fractional Coefficients and Negative Constants)*





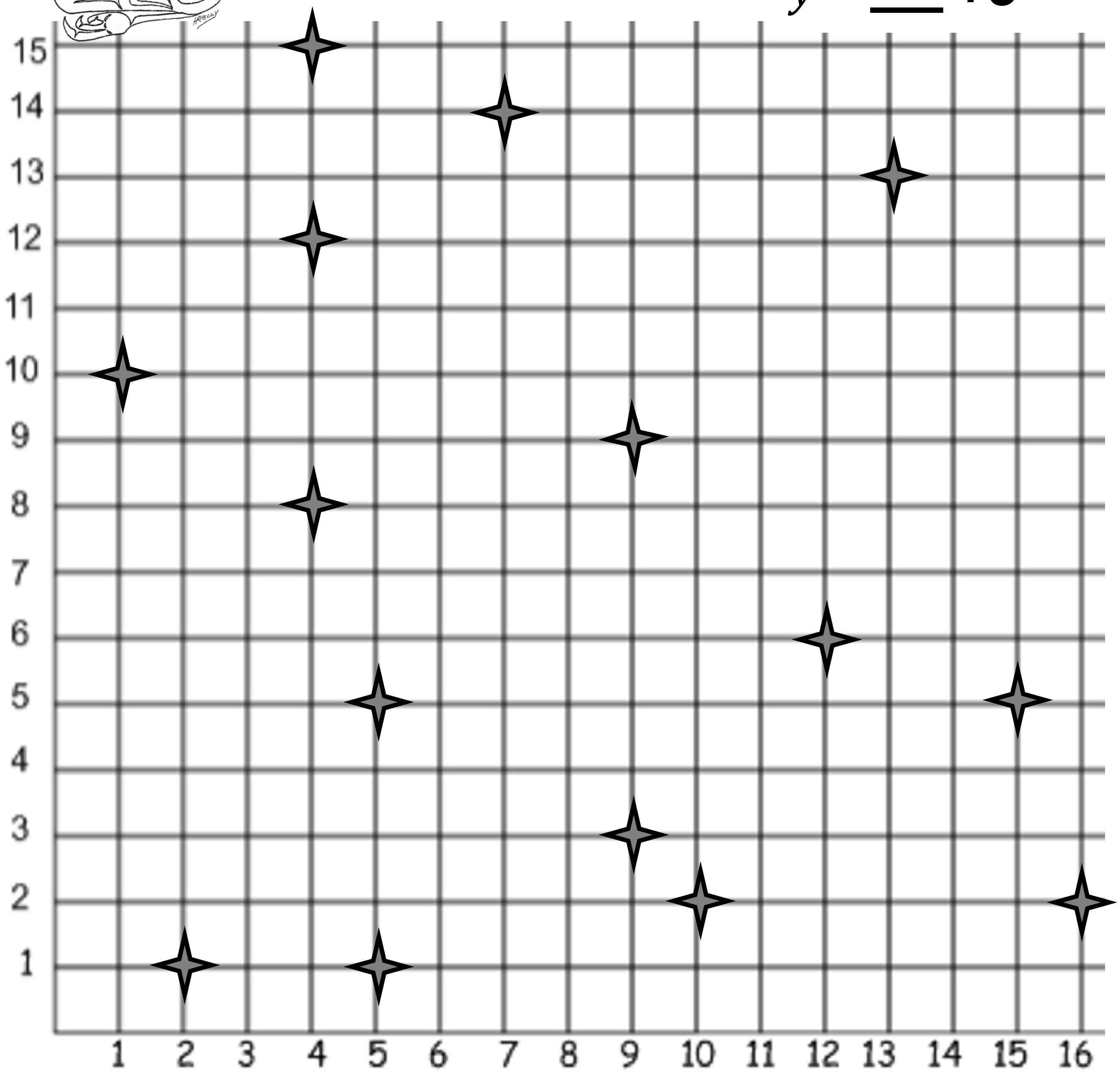


$$y = \frac{1}{\square}x - \square$$

BLM 10 – *Star Gazer Game Sheet (1 Quadrant)*

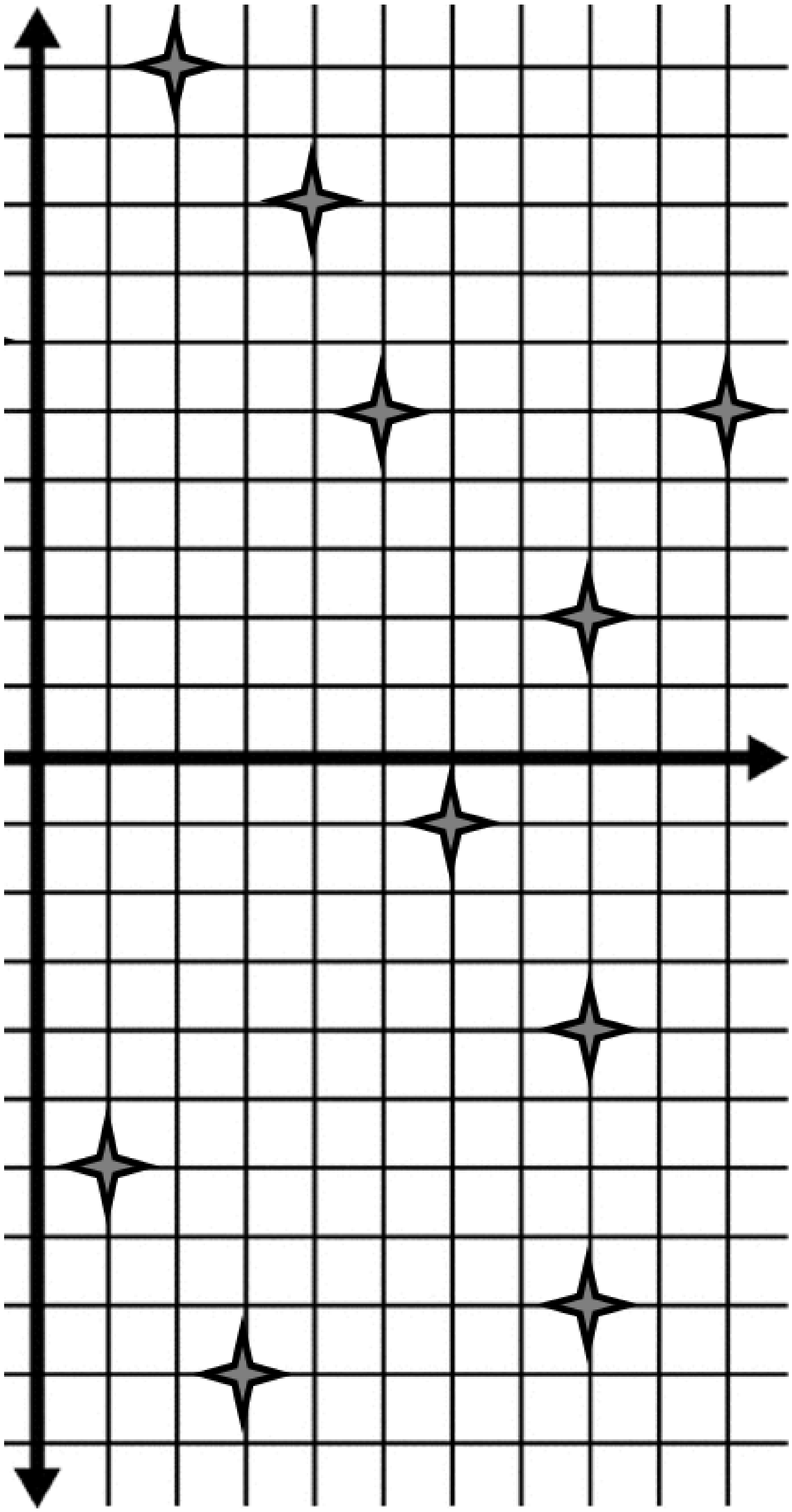
In the story, *Txamsm Brings Light to the World*, Raven scattered the stars in the sky. The goal of this game is to graph a line to connect with each of your opponent's stars. Each player selects 5 stars to connect making a constellation and marks it on their own chart secretly. Player A chooses an expression from the list to aim at the other player's stars. Both players graph the line and Player B announces if it is a hit or miss. Take turns until one player has found all the stars in the constellation of the other player.

$y = \_\_\_ + 0$



$5x$	x	$\frac{1}{2}x$	$2x$	$\frac{1}{4}x$	$3x$	$0x$	$\frac{1}{8}x$	$6x$	$\frac{1}{5}x$

BLM 11 – *Star Gazer Game Sheet (2 Quadrants)*



$y =$ ______ $+ 0$

In the story, *Txamsm Brings Light to the World*, Raven scattered the stars in the sky. The goal of this game is to graph a line to connect with each of your stars. Each player selects 3 stars to connect making a constellation and marks it on their own chart secretly. Player A chooses an expression from the list to aim at the other player's stars. Both players graph the line and Player B announces if it is a hit or miss. Take turns until one player has found all the stars in the constellation of the other player.

$5x$ x $\frac{1}{2}x$

$2x$ $\frac{1}{4}x$ $-3x$

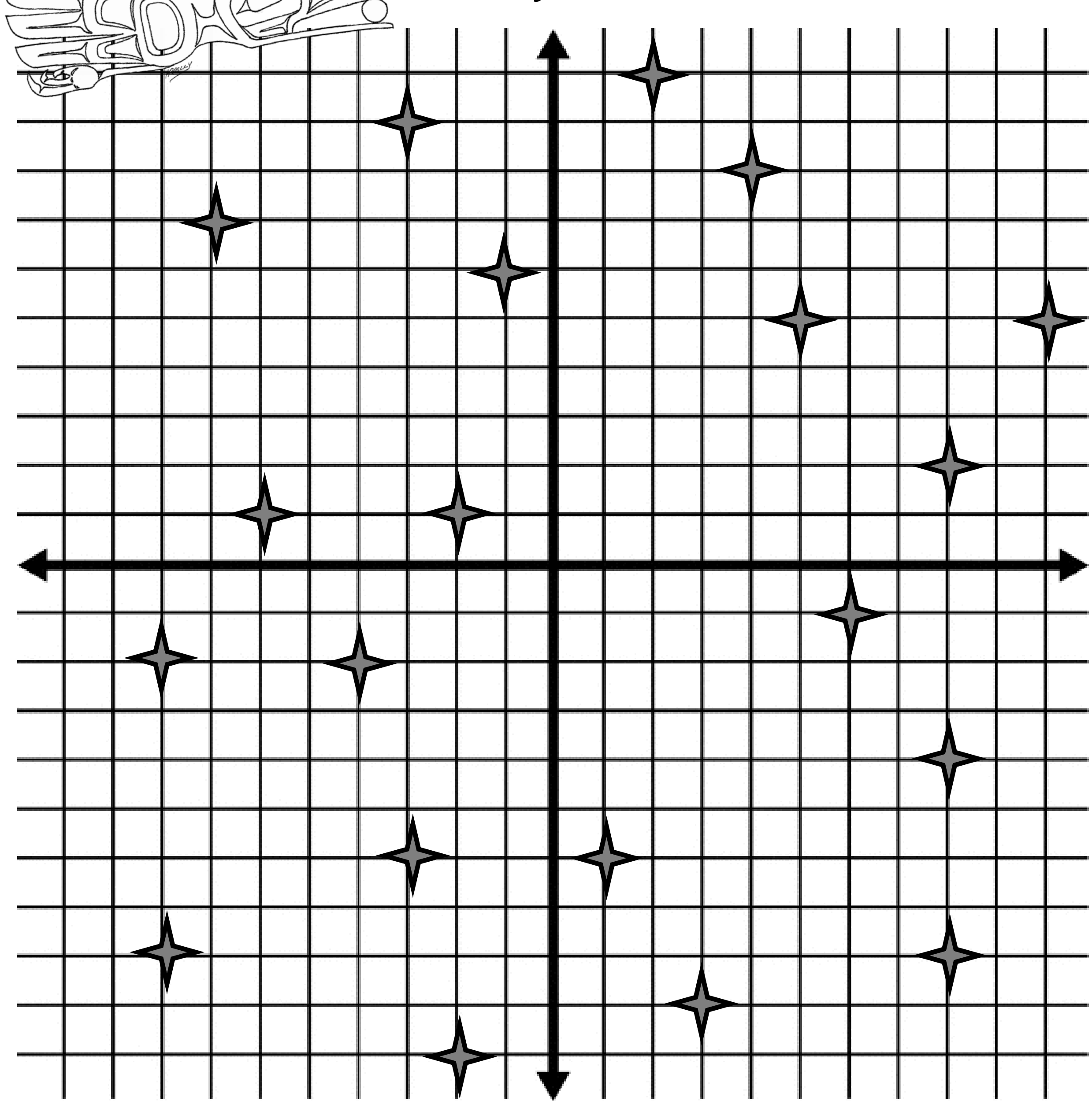
$-x$ $-\frac{1}{2}x$

$-6x$ $-\frac{1}{6}x$

BLM 12 – *Star Gazer Game Sheet (4 Quadrants)*

In the story, *Txamsm Brings Light to the World*, Raven scattered the stars in the sky. The goal of this game is to graph a line to connect with each of your stars. Each player selects 5 stars to connect making a constellation and marks it on their own chart secretly. Player A chooses an expression from the list to aim at the other player's stars. Both players graph the line and Player B announces if it is a hit or miss. Take turns until one player has found all the stars in the constellation of the other player.

$y =$ ______ $+ 0$



$5x$	x	$\frac{1}{2}x$	$2x$	$\frac{1}{4}x$	$-3x$	$-x$	$-\frac{1}{2}x$	$-6x$	$-\frac{1}{6}x$

SUSTENANCE FROM THE LAND

Multi-Grade Thematic Unit

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 identities of First Peoples. Many First Peoples have continued their intimate relationship with the land, while others still hold onto the symbolism that connects them to the land. Knowing one's way on the land can only happen when one spends considerable time on the land. Names of places in the Indigenous languages describe what was in that place (e.g., in the Gitxsan language, Gitwingax, means "People of the Place of Rabbits").

Land use and territorial allocation are important traditional concepts for all Canadian Indigenous 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. 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 Ecological Knowledge (TEK).

The intent of this lesson is to provide the opportunity for students to connect the traditional management of Indigenous territories to science and math.

Adapting this Unit for your Local Area

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 local landmarks and stories of significance to the Indigenous Peoples of your own area.

Curriculum Connections

Mini-Unit: Wayfinding – A Map of Home

Big Ideas

Math 8:	The relationship between surface area and volume of 3D objects can be used to describe, measure, and compare spatial relationships.
Math 8:	Number represents, describes, and compares the quantities of ratios, rates, and percents.
Math 8:	Discrete linear relationships can be represented in many connected ways and used to identify and make generalizations.
Math 9:	Computational fluency and flexibility with numbers extend to operations with rational numbers.
Math 9:	Similar shapes have proportional relationships that can be described, measured, and compared.

Grade	7	8	9
Curricular Competencies	• Estimate reasonably • Model mathematics in contextualized experiences • Represent mathematical ideas in concrete, pictorial, and symbolic forms • Use mathematics arguments to support personal choices		

Grade	7	8	9
Content	relationships between decimals, fractions, ratios, and percents Cartesian coordinates and graphing	Pythagorean theorem numerical proportional reasoning construction, views, and nets of 3-D objects	spatial proportional reasoning
Core Competencies	Positive Personal and Cultural Identity Social Awareness and Responsibility		

Cross-Curricular Connections

- Social Studies – mapping and significance of peoples, places, and events
- Physical and Health Education – influences on identities and relationships
- Outdoor Education – environmental awareness and stewardship
- ADST designing a canoe

Mini-Unit: Wayfinding – Crossing the River

Big Ideas

Math 8: The relationship between surface area and volume of 3D objects can be used to describe, measure, and compare spatial relationships.

Math 8: Number represents, describes, and compares the quantities of ratios, rates, and percents.

Math 8: Discrete linear relationships can be represented in many connected ways and used to identify and make generalizations.

Grade	7	8	Pre-calculus 10
Curricular Competencies	• Using reasoning and logic to explore, analyze, and apply mathematical ideas • Represent mathematical ideas in concrete, pictorial and symbolic forms • Estimate reasonably • Model mathematics in contextualized experiences		
Content	decimals 2 step equations with integer coefficients, constants, and solutions	operations with fractions Pythagorean theorem proportional reasoning (scale)	linear functions primary trigonometric ratios
Core Competencies	Critical and Reflective Thinking		

Mini-Unit: Hunting – Cultural Practice and Bow Technology

Big Ideas

Math 8: The relationship between surface area and volume of 3D objects can be used to describe, measure, and compare spatial relationships.
Math 8: Number represents, describes, and compares the quantities of ratios, rates, and percents.
Math 8: Discrete linear relationships can be represented in many connected ways and used to identify and make generalizations.
Math 9: Computational fluency and flexibility with numbers extend to operations with rational numbers.
Math 9: Similar shapes have proportional relationships that can be described, measured, and compared.

Grade	7	8	9
Curricular Competencies	• Estimate reasonably • Communicate mathematical thinking in multiple ways • Explain and justify mathematical ideas and decisions		
Content	discrete linear relations Cartesian coordinates	discrete linear relations expressions – writing and evaluating using substitutions scale	multistep 1 variable equations operations with polynomials, of degree less than or equal to 2
Core Competencies	Social Awareness and Responsibility Critical Thinking		

Cross-Curricular Connections

- Science (Classes can experiment with other factors that affect how far an arrow travels: length of arrow, number of feathers, angle of projection, etc.
- Social studies or art (Classes could build simple bow and arrows.)
- PE classes (Invite someone from an archery club to give instruction in archery.)

Mini-Unit: Cooking with Fractions

Big Ideas

Math 8: The relationship between surface area and volume of 3D objects can be used to describe, measure, and compare spatial relationships.
Math 8: Number represents, describes, and compares the quantities of ratios, rates, and percents.
Math 8: Discrete linear relationships can be represented in many connected ways and used to identify and make generalizations.

Grade	6	7	8	10 Workplace
Curricular Competencies	• Estimate reasonably • Model mathematics in a contextualized experience • Apply multiple strategies • Explain and justify mathematical ideas and decisions • Reflect on mathematical thinking • Represent mathematical ideas in concrete, pictorial, and symbolic forms			
Content	financial literacy percentages ratio/rate mixed numbers decimals	fractions discrete linear relations operations with decimals relationships between fractions ratios, decimals and percents	operations with fractions	metric and imperial measurements and conversions
Core Competencies	Social Awareness and Responsibility Critical and Reflective Thinking			

Cross-Curricular Connections

- Social Studies, Potlatch
- ADST, Food Studies/Entrepreneurship and marketing

Mini-Unit: Wayfinding – A Map of Home

Context-Setting Introductory Material for Students

(for teacher-facilitated sharing in a whole-class setting)

The Four Food Chiefs

from https://kettlevalleyexpress.com/the-guide/thompson-okanagan/the-four-food-chiefs/

In the world before this world, before there were people, and before things were like they are now, everyone was alive and walking around like we do. All Creation was talking about the coming changes to their world. They had been told that soon a new kind of people would be living on this Earth. Even they, the Animals and Plant people, would be changed. Now they had to decide how the People-To-Be would live and what they would eat. The four Chiefs were: Skimxist (Bear), Ntytikxw (Salmon), Speetlum (Bitterroot) and Seeya (Saskatoon). They held many meetings and talked for a long time about what the People-To-Be would need to live. All of the Chiefs thought and thought. "What can we give to the People-To-Be to eat that is already here on Earth?" they asked one another. "There seems to be no answer."

Finally, the three other chiefs said to Skimxist, "You are the wisest and the oldest among us. You tell us what you are going to do." Skimxist said, "since you have all placed your trust in me, he said, "I will give myself and all the animals that I am Chief over to be food for the People-To-Be." Then he said to Ntytikxw, "what will you do?" Ntytikxw answered, "You are indeed the wisest among us. I will also give myself and all the things that live in the water as food for the People-To-Be." Speetlum, who was Chief of all the roots under the ground said, "I will do the same." Seeya was last. He said, "I will do the same. All the good things that grow above ground will be the food for the People-To-Be." Chief Skimxist was happy because there would be enough food for the People-To-Be. He said, "Now I will lay myself down to make these things happen." Because he was the greatest Chief and had given his life, all the People-That-Were (The Animal People) gathered and sang songs to bring him back to life. That was how they helped heal each other in that world. They all took turns singing but Skimxist did not come back to life. Finally, Fly came along. He said, "You laid your body down. You laid your life down." His song was powerful. Skimxist came back to life. Then Fly told the four Chiefs, "When the People-To-Be are here and they take your body for food, they will sing this song. They will cry their thanks with this song." Then Skimxist spoke for all the Chiefs, "From now on when the People-To-Be come, everything will have its own song. The People-To-Be will use these songs to help each other as you have helped me." That is how food was given to our people. That is how songs were given to our people. That is how giving and helping one another was and still is taught to our people. That is why we must respect even the smallest, weakest persons for what they can contribute. That is why we give thanks and honour to what is given to us.

OR

The Plant and Animal Societies make Treaties with the First Humans

https://www.stitcher.com/podcast/april-vokey/anchored-with-april-vokey/e/59857300
(Starting at 1:58:42; note, however, that the full podcast is a valuable resource for teachers.

Listen to the Story told by La'goot (Spencer Greening) a Gitga'at Indigenous Scholar. This Ts'msyen story tells of the time when the first humans appeared on the Earth and were the most pitiful of all creatures. Each of the animal and plant societies make treaties or agreements with the first humans in order to help them survive. As a result, humans must agree to give the most thanks and honour and respect the plants and animals that give of themselves to sustain humans. He also explains after the story why practices of catch and release sit uncomfortably within this mindset.

Preparatory Notes

Knowledge of the land, and the ability to communicate location with others has been a long-held skill for most Indigenous peoples. Today, land-use decisions are based on both oral histories and other knowledge. This activity introduces students to maps, scale, and identifying their personal landmarks on topographical maps.

Connecting with the Local First Nations Community

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 like 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.

IF POSSIBLE, OBTAIN A MAP OF THE TERRITORY & MAKE IT AVAILABLE AS A DISPLAY.

Guiding Questions

- Where did, and do, First Nations people travel to around your area (e.g., berry patches, traplines, fishing areas, out to the coast, along the grease trails)?
- How did people find their way in the wilderness when they were out hunting, in the days before GPS and printed maps (e.g., landmarks, familiarity developed through time spent on the land, information passed down from hunters or other Knowledge-Keepers)?
- How can we use math to convey information about the land to others?

Applicable Blackline Masters

BLM 1 – A Map of Home

Activity 1: Setting the Context

If you have not yet done so, play the recording ***The Plant and Animal Societies make Treaties with the First Humans*** or read aloud ***The Four Food Chiefs***, found in the Context-Setting Introductory Material for Students (at the beginning of this mini-unit).

Activity 2: A Map of Home

> ***Resources and Materials***
> - blank paper
> - ruler
> - drafting compass or calipers (for measuring distances)
> - optional: materials for 3D models (modeling clay, etc.)
> - copies of BLM 1 – A Map of Home

See BLM 1 – A Map of Home provided at the end of this unit 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). Complementary outdoor activities could include going outside to map out the school grounds as an example for reference.

If you choose to assign the Questions for BLM 1, you may need to review or discuss contour maps, scale, and the Pythagorean theorem. The Pythagorean theorem can be used to determine the distance over the hill. Answers may vary. You could also have students

- create a 2D drawn map of their own
- create a 3D contour map/model of their own
- use a Minecraft virtual world with map views

Formative Assessment Strategy

Have students trade maps, and answer the question: How far is it between 2 places on the map given the scale described? Check for understanding and reasonableness of the estimation. Students can amend their maps based on student feedback.

Activity 3: A Walk Outside

Resources and Materials

- a paper or electronic map of hike/walk area
- pedometer (or assign a student to count steps)

Take students on a walk or hike in the surrounding area. Have students identify local landmarks, animals they see on their walk, and different plants they encounter. Before leaving, show the route on a paper or electronic map, and have students estimate how far the walk will be. Referents are used to measure and estimate distances out in the field. During the walk have students mark out 100 large steps. Using a measuring tape or wheel, compare 100 meters to that referent (the 100 steps). Have students re-evaluate their estimate. Point out a large object (tree or building) and have them estimate how far away it is. What referent did they use?

After the walk or hike, have students estimate how far they had gone and what they remembered most about the hike. Have students co-construct a map of the walk or hike using landmarks etc. Ask them, "How does your map reflect what you remembered? What features are important to include in a map? What was missed, if anything?"

Activity 4: Maps of Your Territory

Resources and Materials

- local map(s) found at:
  - Geography or Forestry class
  - local First Nations Band Office
  - Federal or provincial Fisheries or Land Management office
  - Regional District Office
  - Public Library
  - online (multiple sources, including https://maps.gov.bc.ca/ess/hm/imap4m/ and Google maps https://www.google.ca/maps/)
- drawing compass

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.
- 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.
- Calculate the distance of a reasonable path (around a mountain or swamp) and then use the distance formula or Pythagorean theorem to determine the shortest distance between the two points. Then check it with actual measurements and using the scale factor.

OPTIONS:

- 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). If appropriate, ask the guest how Indigenous peoples knew the land prior to Euro-western mapping methods. Ask the guest to share how they also use maps today.
- Identify a local Culturally Modified Tree (CMT) in your area. Have students determine the distance to the CMT from your school using a local map. If possible, have students walk to the CMT to experience distance and scale. Have students develop a KWL about the CMTs. In some territories, CMT's are located, tagged and cataloged to identify them for logging to avoid as a protected tree. Have students find out if this is a practice in your local area.

Strategies for working with maps as a class

- Use a computer projector, document camera, or smart board to display the map (e.g., BLM 1 – A Map of Home or any topographical map). Whatever technology you use, the idea is that you will be able to "write" on the displayed map 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.

Other activities using scale:

- Options include measuring items as opposed to buildings such as weirs, tools, or other cultural artefacts.
- Use a model replica of a building or landmark from your community and determine the scale factor.

Formative Assessment Strategy

Have students show ratio, scale, and percentages of the stewardship area (i.e., compare the territory being cared for to the area of the local reserve). Have students do a pre- and post-contact comparison and reflect on the difference in size. As a class, discuss how the sizes changed and why there are overlapping boundaries for adjacent territories. To help aid in this, you can use http://www.bctreaty.ca/map.

Extensions

If possible, access maps from local band offices or libraries to provide further information. Have students do a pre-contact and post-contact comparison and reflect on the difference in size. Hold a class discussion about how the sizes changed and why there are overlapping boundaries for adjacent territories.

Activity 5: Maps as a Story of Me

Have a class discussion on why we have maps and what makes them important. What do maps tell us about place and functionality?

> ***Resources and Materials***
>
> - student-created maps of their community

Explain the features of maps and scale. Use Google Earth to check their estimations of scale.

Have students create a story by using their maps of the community to highlight areas of their interest.

Create a legend to explain your features on the map. How does this reflect your personal identity?

Overlay the student maps on a Cartesian plane. Have students pick 2 places on their map that have differing x as well as differing y coordinates (e.g., their house and the school) and draw a line between them. Then have them assume they can only travel North/South and East/West. This will form a right triangle. What would the legs of the triangle be?

Use the preceding exercise as a basis for explaining the use of Pythagorean theorem to determine unknowns, giving 2-3 examples. How does this relate to the reality of the shortest distance?

Optional Extension

Given a set of Pythagorean triples (e.g., 3 4 5) have students develop a conjecture in their own words, to establish the theorem. Have students answer the questions: “What do you notice?” and “So what?”

Formative Assessment

Ensure that students use an appropriate scale on their map. Students can peer assess each other’s maps if they have used the same neighbourhoods. Have pairs of students check each other’s distances and routes to ensure accuracy.

Mini-Unit: Wayfinding – Crossing the River

Context-Setting Introductory Material for Students

(for teacher-facilitated sharing in a whole-class setting)

Beaver Story

This story shared with permission from a local Gitxsan Elder via Stacey Brown

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.

◊◊◊

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.

Preparatory Notes

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.

Guiding Question

- How can we calculate solutions to barriers that prevent an easy passage between areas?

Applicable Blackline Masters

BLM 2 – Crossing the River

Activity 1: Canoe Model/Crossing the River

In the Beaver story the people of the clans need to have safe crossing. In an ideal situation the canoes would be able to cross without issue. The beaver was making that impossible. The canoe model exercise is an experiment to look at the safe crossings of a river at different currents/speeds.

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 (see BLM 2 – Crossing the River).

Resources and Materials

materials needed (per group of 2-3):

- large plastic container (4 L storage bin, washtub, fish tank, wave tank from physics dept., etc.) to replicate a lake or river
- Snuhwulh Canoe template http://abed.sd79.bc.ca/wp-content/uploads/2011/12/Canoe-Coutout.pdf
- poster board or old file folders
- dull pencils or a medium ball point pen and scissors
- modeling clay
- fan (household fan or small handheld fan)
- copies of BLM 2 – Crossing the River

Experimental Procedure

1. Using a computer projector, document camera, or smart board, display the canoe image from BLM 2 – Crossing the River or draw it on the board and discuss how the Pythagorean theorem might apply. Ask: “How could we find out how far the canoe travels?” Apart from measuring with a metre stick, can we use anything we know about math? Point out the 90º angle.
2. Build the canoes from poster board and tape (Snuhwulh Canoe template provided by SD79). 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. Ballast may be needed in the bottom of the canoe to provide weight so that it will not tip over. A bit of modeling clay works well. 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.

    $a^2 + b^2 = c^2$ ➔ rearranged as ➔ $c = \sqrt{b^2 + a^2}$

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

Formative Assessment Strategy

Have students check the work of another group. Is it reasonable and well laid out? Are the calculations correct? What feedback do they have for the other group? Repeat with Group 2. Are students able to calculate the distance the canoe travelled using the measurements they observed?

Mini-Unit: Hunting – Cultural Practice and Bow Technology

Context-Setting Introductory Material for Students

(for teacher-facilitated sharing in a whole-class setting)

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.

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Revenge of the Mountain Goats

Gitxsan hunting story as told by Dr. M. Jane Smith

Life was good in the first Gitxsan Village of T'emlaxamit. 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 Sdikyoodenax (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 (Skeena River) 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 Sdikyoodenax and gave him back to the mountain.

Meanwhile, the mountain goats on Sdikyoodenax 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'emlaxamit.

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 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.

Preparatory Notes

This mini-unit looks at two aspects of hunting as practised by many First Peoples:

- the cultural practices/attitudes that emphasize respect and sustainability

  Students will look at how respect and a consciousness of immediate and longer-term needs contribute to sustainable resource management.

- the widely used traditional technology of bow and arrow (NB: guns were introduced with European contact and ever since have been used for hunting; yet today, many people — Indigenous and non-Indigenous alike — still use bows of varying sophistication for hunting and recreation)

  Students will examine 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. In terms of prior mathematics learning, students should have had instruction in solving one-step linear equations by dividing and multiplying before embarking on Activity 6.

Guiding Question

- What learning do we need to know to identify how the land sustains us?
- How do we know how much to harvest from each area?
- How do we ensure equal sharing for the families in our classroom?

Applicable Blackline Masters

BLM 3 – Moose Tracks: Inequalities and Moose Populations
BLM 4 – Moose Tracks — Answer Key
BLM 5 – Bow Hunting

Additional Resources

- https://soundcloud.com/user-56691203/lagoot-spencer-greening-on-indigenous-laws-and-stewardship
- https://www.stitcher.com/podcast/april-vokey/anchored-with-april-vokey/e/59857300 (starting at 1:50:30 a discussion on catch and release and sustainable practices/Indigenous law; starting at 1:58:42 The Plant and Animal Societies make Treaties with the First Humans)

Activity 1: Cultural Teaching

Share with students the Gitxsan stories "First Kill" and "Revenge of the Mountain Goat" provided here. Another relevant story is the Ts'msyen story, "The Plant and Animal Societies make Treaties with the First Humans" cited earlier in this theme unit (as part of the mini-unit Wayfinding – A Map of Home; check out the podcast at https://www.stitcher.com/podcast/april-vokey/anchored-with-april-vokey/e/59857300; the story starts at 1:58:42; but the full podcast is a valuable resource for teachers). Alternatively, locate and share a similar story from the local First Nations community (e.g., telling about a young person who has not followed the "rules" as to how resources should be used responsibly).

Explain to students how in First Peoples cultures everyone has a role and responsibilities. Historically this was necessary for the survival of the community. Being involved in contributing to the community keeps both the individual and community strong and enables the transmission of knowledge. When someone takes on a new role in a community, whether through inheritance, through maturity, or through their actions, a feast is held so the community can witness what has been done. (For example, 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.")

Follow up by inviting an Elder or other Knowledge-Keeper 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 whose territory?
- How is territory passed down?
- Who else hunts on the territory?
- How do clan/house groups know how many moose have been taken from a 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?

Activity 2: Hunting for Sustainability — OPTIONAL ACTIVITY

Wild game has been and still is a very important food source for many First Peoples communities. Use lead-in questions appropriate to the composition of your class (e.g., 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?)

Resources and Materials
- BLM 3 – Moose Tracks: Inequalities and Moose Populations
- BLM 4 – Moose Tracks — Answer Key

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

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

Show the inequality on a number line

Demonstrate for students how to write equations using inequalities

- If 20 salmon are the food equivalent of 1 moose and there are 260 extra salmon caught, how many fewer moose do you need?
- Use your number from the previous example as the number of moose you started with (example: 17.2 moose).
- How are we going to decrease the number of moose? (the number of extra salmon/the number of salmon that is equivalent to one moose: 260/20)
- Is the number of moose we need going to increase or decrease? (decrease)
- So how are we going to change the equation? (take away the number of the moose that would be represented by the salmon: $M \geq 17.2 - \text{extra}/20$)
- Solve the equation to determine the new number of moose needed.

Distribute copies of BLM 3 – Moose Tracks: Inequalities and Moose Populations, provided at the end of this unit. Have students work through the exercises in pairs or small groups. BLM 4 – Moose Tracks — Answer Key is also provided for your reference.

Activity 3 – Population Distribution and Dynamics

Resources and Materials

- Graham Herd Caribou habitat maps: https://www2.gov.bc.ca/assets/gov/environment/plants-animals-and-ecosystems/wildlife-wildlife-habitat/caribou/core_high_elevation_habitat_for_the_graham_herd.pdf
- ruler
- graph paper
- CBC article (https://www.cbc.ca/news/canada/british-columbia/b-c-woodland-caribou-face-extinction-despite-government-protection-study-1.3072963)

The Northern Mountain Caribou have long been a staple for food in Northern BC. Unfortunately, the numbers have dwindled significantly since 1900, and currently the population numbers around 19,000. When the herds were plentiful, less distance needed to be traveled to hunt them. Due to the low numbers a moratorium was placed on hunting. Now to find Caribou from the Graham Herd in Muskwa-Kechika, biologists and guides must go further distances. Topography can also play a role in how far the people must travel.

Read the CBC article on the decline of the caribou herds in northeastern BC. Discuss how biologists calculate the numbers of caribou left using population dynamics. What are the factors affecting the herds? How are people impacting their survival?

Have students plan a hiking route that would enable them to find caribou herds for counting. They should use one of the Graham Herd Caribou habitat maps to identify 4 widely separated spots within the range described. They should then plot a circuit that visits these spots in turn, starting and ending at the same point. They may find it helpful to obtain a more detailed (paper or electronic) topographical map of the Graham-Laurier Provincial Park area to do this. They may also find it helpful to trace their path on a graph paper overlay.

Have students use the information available to them (i.e., map scale + measured distances) to "determine" the total distance for their route. Debrief by discussing how terrain and topography might affect route decisions (i.e., the difference between easy, difficult, and impossible routes). With the help of a local trail guide, having students compare map (theoretical) routes with actual (on the ground) routes on a known hike would reinforce this point and allow for introduction of travel speed (time taken) as a measurable variable to factor in (for more on map study, see Activity 4 in the Mini-Unit: Wayfinding – A Map of Home).

Alternative: In southern BC, a similar activity could be undertaken focussing on the Southern Caribou herds.

Activity 4: Predicting Enough

Resources and Materials

- map of your local area

Indigenous people not only hunted big game, but also small game such as rabbits (typically trapped). For some, in order to have a balanced diet, rabbits were used to add a different protein from marine based food. A knowledge of place is important to increase the efficiency of snare-lines. Being able to identify the areas of rabbit trails by tracks, trails, and scat increase the probability of catching game.

Have students map out a rabbit trapline using a map of your area. Have them estimate how many snares they would need along the trapline. If each snare catches, on average, one rabbit per 3 days, have students develop a plan to provide enough rabbits to provide one rabbit per household for their classroom within a certain timeframe. Have students predict the number of rabbits that would be needed at maximum, at minimum, and to ensure sharing for larger families. Students should predict the distance needed to travel to set the snares. Have a class discussion to evaluate the reasonableness of student responses and predictions. What other factors deserve consideration (e.g., whether over-hunting is occurring and possible consequences)?

Activity 5: Parts of a Whole

Resources and Materials

- recording: https://www.stitcher.com/podcast/april-vokey/anchored-with-april-vokey/e/59857300 starting at 1:50:30 a discussion on catch-and-release and sustainable practices/Indigenous law

An animal gives its life for sustenance for us, so it is disrespectful to waste it. Listen to the end of the recording to give context to this understanding. All parts of the animal are used. If 100% of a deer (or local game) is used, what percentage of each part (hide, bones, meat, sinew, brain etc.) is used for different things (food, tools, shelter, clothing, ceremonial pieces etc.). Are there further divisions within each category? Given a specific weight, how would these percentages work out? Compare this to a chicken. What is used for what purpose? Are there wasted parts? Repeat the process outlined above. Have a discussion focussed on waste in the western world view. Optional: Go to a butcher and ask these questions.

Formative Assessment

Ensure students are able to use scale to create their maps on the graph paper.
Are students able to determine the extra distance traveled to avoid topography, or to return to an area?

Activity 6: The Shooting Range of a Bow

Resources and Materials

- archery bow (if available), or simple bow constructed from a string/elastic and a flexible stick such as willow or alder; arrows are neither required nor recommended
- 50 N force meters
- graph paper
- rulers
- BLM 5 – Bow Hunting

In terms of prior learning, students should have had instruction in solving one step linear equations by dividing and multiplying.

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, most Indigenous hunters now use guns when they go hunting.

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 copies of BLM 5 – Bow Hunting (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	20 N	30 N	40 N
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 force 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 force meter that measures in Newtons, 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: Write 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: Use 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: Extend the understanding
  If a different bow had a spring constant of 4.3 N/m
  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 were applied, what would be the draw distance?

Formative Assessment Strategy

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

- 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.

Mini-Unit: Cooking with Fractions

Context-Setting Introductory Material for Students

(for teacher-facilitated sharing in a whole-class setting)

Bannock and Me

reminiscence by Victory Harper (Teacher at Kitkatla Band School)

When I was younger, my family and I would go to my grandma's house. I knew whenever we went to grandma's house there would be bannock. The first thing she would always ask us when we entered the house was, "Are you hungry? I got some bannock." My heart would get so excited when I walked into her house and smelled the grease. I knew it was going to be a fried-bannock day, and I could hardly wait to sit down at the table and start spreading some jam on it. The best days were when she had homemade jam ready for us. "Oh! I just made some jam. Make sure you use that," my grandma would say. I loved my grandma's homemade jam. It was always better than anything that was store-bought. I remember when she would take me berry picking in the summer. I got so excited because I knew I would have some jam one day. She would always make sure we had some sort of a hot drink to go with our bannock too. When I was a kid, I would drink tea or hot coco with my bannock. Now that I'm older, I drink it with coffee. Bannock gives me a familiar feeling of home and being with my grandma.

Preparatory Notes

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."

Bannock is considered both a traditional food and non-traditional food, as it has changed over the years from the original ingredients to more contemporary wheat flour. Wheat-based bannock was not a Canadian Indigenous Traditional food prior to European contact. However, in contemporary times, bannock and/or fried bread has been widely adopted by Canadian Indigenous peoples and is now often associated with Indigenous peoples. For more information go to:

- https://www.cbc.ca/radio/unreserved/bannock-wild-meat-and-indigenous-food-sovereignty-1.3424436/bannock-a-brief-history-1.3425549
- https://www.for.gov.bc.ca/rsi/fnb/fnb.htm

Applicable Blackline Masters

- BLM 6: Converting Fractions, Decimals, and Percents (distribute this at any point during the unit for student reference)
- BLM 7: Recipes (sample recipes to be used for various activities, particularly if students are not able to bring in their own from home)

Activity 1: Measuring for a Recipe

Resources and Materials

- imperial measuring cups, measuring spoons, larger 2+ cup measurer
- recipes
- water for measuring
- BLM 7 – Recipes

If you have not already done so, have students listen to the Ts'msyen story, "The Plant and Animal Societies make Treaties with the First Humans" cited earlier in this theme unit (as part of the mini-unit Wayfinding – A Map of Home; check out the podcast at https://www.stitcher.com/podcast/april-vokey/anchored-with-april-vokey/e/59857300 ; the story starts at 1:58:42; but the full podcast is a valuable resource for teachers). Discuss how this respectful mindset might apply in the kitchen when preparing foods.

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.)

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. BLM 7 – Recipes includes a recipe for venison stew which is provided as a sample.

Formative Assessment Strategy

Challenge students to think about what units of measurements are being used in the recipes. With a partner, students could identify similarities and differences of metric and imperial systems. As a class, discuss which recipes are metric and which use imperial or other measuring systems. Ask students, "How do you know?"

Activity 2: Fractions in the Kitchen

Resources and Materials

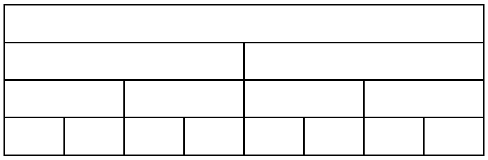
- BLM 6: Converting Fractions, Decimals, and Percents
- BLM 7 – Recipes
- Bannock Awareness by Michael D. Blackstock https://www.for.gov.bc.ca/rsi/fnb/fnb.htm

Share the recipe with your students being sure to 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:

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

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.

One good way to demonstrate dividing is to make a cake and then use it like fraction strips. Thus, 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 a fry bread or other recipe, have the students double the recipe, triple it, multiply it 10 times. (This activity can be used with any local Indigenous recipe for bannock depending on area; see the Bannock Awareness Link or elsewhere for recipes.)

Extension

Choose 2 more recipes; one is to be multiplied by 1 ½, doubled, and multiplied 5x; the other is to be divided into thirds and halves.

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

Formative Assessment Strategy

Taste Test: Have students make at least two batches of bannock from the same original recipe. Have them compare the tastes of the batch that used the original recipe and one that used a multiple of measurements from the original. What did they notice? How do they know if their math was correct or incorrect (i.e., the calculations, measurements)?

Activity 3: Eva's Jam

Resources and Materials

- ½ pint jars and lids (250 ml)
- berries
- sugar
- pectin/gelatin
- water
- heat source
- pot
- bowl
- wooden spoon

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 sugar, 5 cups of berries are needed. So, for 1 tbsp of sugar, 5 tbsp of berries is required. $\frac{1\,c = 1\,tbsp}{5\,c = 5\,tbsp}$

What is the imperial conversion for 5 tbsp of berries into cups?

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 (approx. 1 dozen medium-sized, 1 cup flour, 1 cup oatmeal, 1 cup sugar, and 1 cup butter (feeds 4)

$\frac{1\ cup = 4\ people}{x\ cup = 1\ person}$ 1 cup ÷ 4 = ¼ c per person

Expand: Give the students a variety of recipes and have them practise making recipes larger or smaller using the proportion method.

Choosing a recipe again, challenge students to

- increase all of the ingredients by 60%, 75%, and 150%
- decrease all of the ingredients by 10%, 25%, and 50%

Additional Problems

1. If 3 kilograms of clams cost $65, how many kilograms can you buy for $100?
3. One venison roast 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 your class, how many cups of berries do you need? How long will it take to pick the berries?

Formative Assessment Strategy

Use the taste test as described in Activity 3; but use the Jam Recipe. You could also have students design proportion questions and challenge each other.

Activity 4: Cam's Mussels/Sharing the Whole

During traditional food harvesting, a portion of what is taken is put aside for Elders and those not able to go out on the land due to illness or circumstance. For the purpose of this activity, we will assume that the amount set aside is 30% of all harvested foods.

Resources and Materials

- BLM 6: Converting Fractions, Decimals, and Percents

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:

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

ratio = fraction = 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.

$$\frac{\boldsymbol{part} = \%}{\boldsymbol{whole} = \mathbf{100}\%} \rightarrow \frac{\boldsymbol{part}}{\boldsymbol{whole}} = \frac{\%}{\mathbf{100}}$$

Demonstrate examples such as:

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

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 square of seaweed, 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 selling price of salmon is $32 kg. If the price was to be raised 25%, how much is the new salmon price?
5. If Cam picks 5 buckets of mussels, how many should go to the Elders?

Formative Assessment Strategy

Have the students identify a traditional food source for their area. Have the students describe how it is harvested and predict how it could be divided (using fractions) amongst the community or family, using examples. Have students explain their reasoning.

Activity 5: It's All About the Fry Bread (or Bannock)

> ***Resources and Materials***
> - recipe
> - Foods/Culinary Arts classroom

Share with students the reminiscence provided at the beginning of this mini-unit ("Bannock and Me"). Have students investigate different fry bread/bannock recipes in BC. Help them learn the difference between Fry Bread and Bannock, and why the use of these two foods were used by First Peoples (see the Preparatory Notes for this mini-unit). Have students try each recipe and choose their favourite.

Have students identify and calculate the overall cost of ingredients in their recipe. Introduce the idea of social entrepreneurialism and have students choose a charity together. Challenge students to create a business model and set a goal to fundraise for the cause. Students could apply their mathematics skills to

- figure out by how many times they need to increase their recipe to meet the need for sale
- determine the cost to make an individual fry bread and set a profitable price
- use percentages to meet projections of ingredients used and fry bread sold. (This can be used as a marker for the success of their business model.)

Formative Assessment Strategy

Does the fry bread taste good? (implies good measuring and calculations)
Did students meet their target profit goal? Did they estimate appropriately?

Optional Extension Activity

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

Choose a local Indigenous food and apply the activities to that food. How does the place we live offer differences in our diets and available resources? Talk to an Elder or Knowledge-Keeper about how diets have changed over time. How do we know how much is needed?

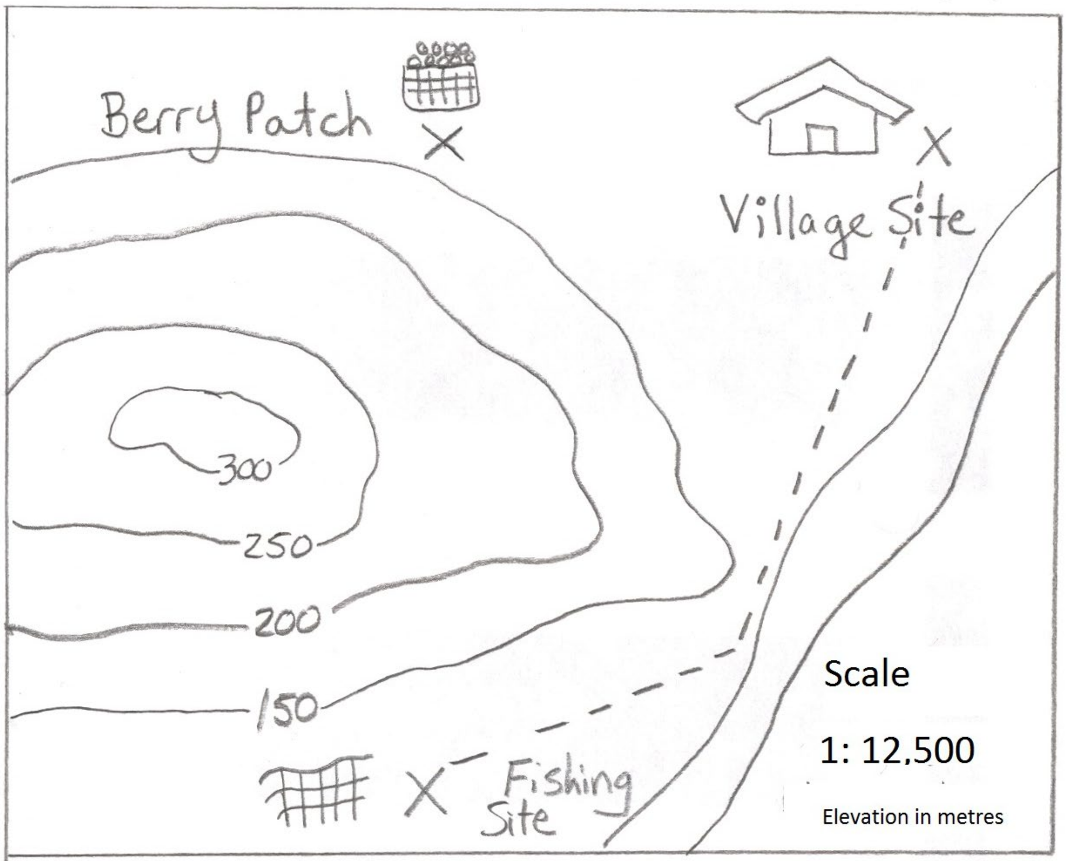
Extension Questions

- What is a local Indigenous food in your community? What food would be shared during feasting?
- What amount of waste is in your own home?
- Track the amount of food that you eat vs waste. How can you minimize your waste footprint?
- How does the season affect the harvesting of certain foods? How is harvesting affected by seasonal change?
- How does this mathematical knowing reflect mapping using current technology such as a GIS?

BLM 1 – *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).

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

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).

$$\_\_\_\_\_\ cm \times \frac{1m}{100\ cm} = \_\_\_\_\_\_m$$

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, as in the previous two examples. Write a sentence sharing your 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?

BLM 2 – *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

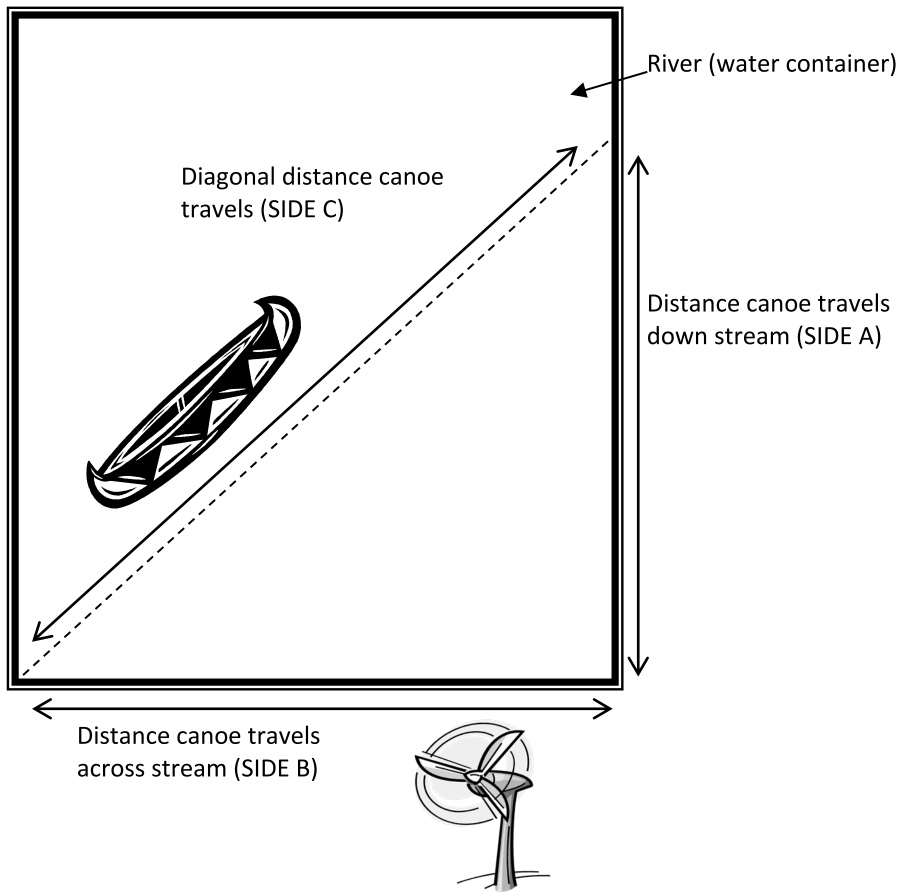
- I found this class/experience interesting because _____.
- Large plastic container (your river or lake) filled with water
- Model canoe that you made
- Erasable marker
- Fan (the current or wind)
- Metre stick or measuring tape

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^{o} corner) is called the

____.



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 them 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.)

BLM 3 – *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 percentage for forest cover that will make biologists' estimates more accurate.

____

v) Suggest one possible for forest cover that will make biologists' estimates 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 Elders and hunters in your First Nations communities how they know about the moose population on their 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 the territories?

BLM 4 – *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

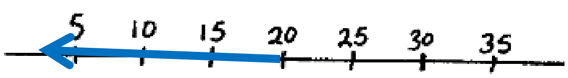
Inequality Example 1: Moose Populations and Wolves

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)



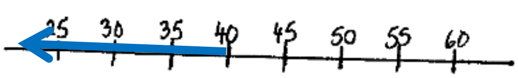
$m \leq 20$

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. Answer: $f <$ 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).

BLM 5 – *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?

BLM 6 – *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.

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

A decimal to a percent

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

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

A percent to a fraction:

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

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

BLM 7 – *Recipes*

Venison Stew (for Slow Cooker)

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.

No-Cook Raspberry Jam

2 cups prepared fruit
4 cups of sugar
1 pouch liquid Certo
2 tablespoons lemon juice

Crush raspberries, one layer at a time. Sieve half the pulp to remove seeds, if desired. Measure exactly 2 cups prepared raspberries into large bowl. Add sugar; mix well. Let stand 10 min., stirring occasionally. Add pectin and lemon juice; stir 3 minutes or until most the sugar is dissolved and no longer grainy (a few sugar crystals may remain). Pour into clean containers, filling up to 1/4 inch from rims. Cover with lids. Let stand at room temperature 24 hours or until set. Refrigerate or freeze until ready to use.

Food Facts (Keeping it Safe)

- No-cook jams can be refrigerated up to 3 weeks or frozen up to 8 months.
- This recipe will yield 4 (1-cup/250-mL) containers of jam plus a partially filled container. Refrigerate the partially filled container immediately and use within 3 weeks.

THE BUILT ENVIRONMENT

Multi-Grade Thematic Unit

The Nisga'a are a nation of First Peoples situated around the Nass River (Nass Valley). Their traditional style of shelter constitutes one of many examples of longhouse/bighouse construction within BC First Nations. The location (or dwelling place) and structure of these shelters were influenced by the local climate, resources, environment, physical geography, land, seasonality, and size of family or community.

The Nisga'a style of shelter also exemplifies the close connection between dwelling place and identity. The word the Nisga'a use for house is *wilp*, which has a dual meaning. The first meaning refers to the clan from the mother's side while the second meaning refers to the house structure itself. Within the Nisga'a Nation, there are multiple *wilps* within a clan. Each *wilp* has its own *adaawak* (i.e. intellectual property) and "Nisga'a [people] have the right to only those *adaawak* that belong to their own *wilp*" (Boston, Morven & Grandison, p. 29). A *wilp* has members linked by a matrilineal ancestry. "Its members are all descended from a common female ancestor. Nisga'a become members of their mother's *wilp* when they are born. Each has its own chief" (Boston, Morven & Grandison, 1996, p. 18). Members of the *wilp* have roles and responsibilities to each other and other *huwilp* (wilp plural).

The Chief's *wilp* has a pole in the front of the house or a painted house front, which represents the *wilp*'s identity and story. A *wilp* (or family group) can have multiple longhouses/bighouses to accommodate *wilp* members. At the same time, a single longhouse/bighouse can house multiple nuclear families. The housing structures, location, and social system will vary per First Nations community. We encourage you to investigate local housing practices in the traditional and contemporary contexts in BC.

Boston, Thomas, Morven S. and Grandison, M. (1996)
From Time Before Memory: The People of K'amligihahlhaahl.
School District No. 92 (Nisga'a). New Aiyansh, BC.

Two examples of traditional Indigenous housing structures in BC are considered in this learning resource.

Longhouses/Bighouses

The term *longhouse* or *bighouse* refers to a large plank dwelling usually constructed from Pacific Red Cedar and built for specific use by First Nations. First Nations of the Lower Mainland, South and Southeast Coast of Vancouver Island often use the term longhouse. First Nations from the Central to the Northern Coast commonly use the term bighouse when referring to the large plank dwelling. Please note, sometimes the term longhouse is also used by First Nations to refer to the bighouses in the Central and Northern Coastal regions.

The smoke hole is located directly above the fire pit, which is situated inside at the centre of the longhouse/bighouse. The fire pit is surrounded by different levels (which includes a level dug underground and levels of wood plank platforms above ground) around the perimeter of the house. Plank levels can be partitioned with cedar mats. Each space serves its own purpose. For example, the third level of the house is designed for sleeping and sectioned off for each family. The chief sleeps at the front of the house. Other activities that could occur inside the house include storytelling and feasting. Today, many modern communities were established on previous longhouse or bighouse sites and First Nations continue to build longhouses/bighouses as places for ceremonial and community events.

Circle Dwellings

Within many First Peoples cultures, the circle has functional importance as well as spiritual significance. For example, the Inuit *igloo* is a traditional structure whose design and construction are based on the circle. Likewise, the *kekuli* or pit house used by the First Nations from the Southern Interior of British Columbia is a traditional dwelling that is laid out on a circular floor plan.

Kekuli or pit houses were well insulated by an earth covered roof typically 8-10 metres in diameter and 1.5 metres deep. A larger kekuli or pit house could accommodate up to 30 people. They were built with logs, tule, dirt, grass, and other materials half into the ground and half above ground. Most kekuli or pithouses contained a small fire pit, a notched pole ladder entrance extending through the smoke hole in the roof, and a side hatch used to bring in firewood as well as an emergency exit. You can still find historical kekuli or pit houses throughout the Thompson and Okanagan areas.

Curriculum Connections

Mini-Unit: The Longhouse/Bighouse

Big Ideas

Math 7:	Properties of objects and shapes can be described, measured, and compared using volume, area, perimeter, and angles.
Math 8:	The relationship between surface area and volume of #D objects can be used to describe, measure, and compare spatial relationships.
Math 9:	Similar shapes have proportional relationships that can be described, measured, and compared.
Workplace 10:	3D can be examined mathematically by measuring directly and indirectly length, surface area, and volume.

Grade	6	7	8	9	Workplace 10
Curricular Competencies	• Model mathematics in contextualized experiences • Develop, demonstrate, and apply mathematical understanding through play, inquiry, and problem solving • Explain and justify mathematical ideas and decisions • Connect mathematical concepts to each other and to others' areas and personal interests • Estimate reasonably and demonstrate fluent, flexible, and strategic thinking about number • Develop, demonstrate, and apply conceptual understanding of mathematical ideas through play, inquiry, and problem solving • Explain and justify mathematical ideas and decisions in many ways • Connect mathematical concepts to each other and to others' areas and personal interests				
Content	perimeter of complex shapes area of triangles, parallelograms, and trapezoid volume and capacity	volume and rectangular prisms and cylinders Cartesian coordinates and graphing	surface area and volume of regular solids, including triangular and other right prisms and cylinders construction, views, and nets of 3D objects Pythagorean theorem	spatial proportional reasoning	surface area and volume
Core Competencies	Positive Personal and Cultural Identity Social Awareness and Responsibility Critical and Reflective Thinking				

Mini-Unit: Circle Dwellings

Big Ideas

Geometry 12: Diagrams are fundamental to investigating, communicating, and discovering properties and relations in geometry.
Geometry 12: Geometry involves creating, testing, and refining definitions.
Geometry 12: Geometry stories and applications vary across cultures and time.

Grade	Geometry 12
Curricular Competencies	• Engage in spatial reasoning in a dynamic environment • Model with mathematics in situational contexts • Think creatively and with curiosity and wonder when exploring problems • Visualize to explore and illustrate geometric concepts and relationships • Represent mathematical ideas in concrete, pictorial, and symbolic forms • Use geometric vocabulary and language to contribute to discussions in the classroom • Use mistakes as opportunities to advance learning

Content	• parallel and perpendicular lines:
	   ◦ circles as tools in constructions
	   ◦ perpendicular bisector
	• circle geometry
	• constructing tangents

Core Competencies	Social Awareness and Responsibility Critical Thinking Creative Thinking

Cross-Curricular Connections

- BC First Peoples 12
- Drafting 10-12
- Woodwork 10-12
- ADST 6-9 (Drafting and Woodwork)

Mini-Unit: The Longhouse/Bighouse

Context-Setting Introductory Material for Students

(for teacher-facilitated sharing in a whole-class setting)

Multi-Media Resources: Traditional Housing Arrangements

- Nisga'a *Wilp*: http://www.nisgaanation.ca/wilp-houses and https://www.nisgaanation.ca/wilp-family-unitsclans
- Nisga'a Clan System: http://www.nisgaanation.ca/about-0 and http://gingolx.ca/nisgaaculture/nisgaapoles/index.html
- *Ancient Villages of the Nass Valley* (explore the ancient villages, the huwilp and learn the stories of each pole): http://www.gingolx.ca/nisgaaculture/ancient_villages/index.html
- SFU: Engaging the World, The Bill Reid Centre. *Explore the Village Galleries:* http://www.sfu.ca/brc/virtual_village.html
- *Building A Pit House* (UNBC FNST 161): https://www.unbc.ca/image-galleries/34697/fnst-161-building-pit-house
- *UNBC Students Building the Pit House* (video): https://www.youtube.com/watch?v=s6gbm8Z2xfw
- Pit House Diagram: https://royalbcmuseum.bc.ca/exhibits/bc-archives-time-machine/galler07/frames/int_peop.htm
- Haida House Argillite Model made by Charles Edenshaw https://www.historymuseum.ca/cmc/exhibitions/aborig/haida/havho06e.html
- *Canadian Encyclopedia*: "Architectural History of the Indigenous Peoples of Canada." https://www.thecanadianencyclopedia.ca/en/article/architectural-history-early-first-nations
- Museum of Anthropology, Background Information: First Nations of British Columbia https://moa.ubc.ca/wp-content/uploads/2014/08/SchoolProgram-BackgroundInfo.pdf

Preparatory Notes

This mini-unit gives students a chance to take a closer look at traditional and contemporary housing and understand that housing and place can represent one's identity. Mathematical concepts include perimeter, area, and surface area, but may also include concepts of polynomials, capacity, and volume. The learning activity in this mini-unit involves aspects of Design Thinking and Maker Space as students will design and build a longhouse/bighouse that would accommodate their family up to three generations. To avoid a "trivializing," crafts-focussed approach to this undertaking, please review the material on "Permissions, Protocols, and Respectful Practice" in the Foundations section of this guide. As part of this mini-unit, students can learn more about their family, self, and sense of place in the design and construction of a longhouse/bighouse (or *wilp*) along with their family tree.

Applicable Blackline Masters

n/a

Activity 1: Longhouse/Bighouse Floor Plan

Resources and Materials

- paper
- pencils
- online access, books, or local resources on longhouses/bighouses or traditional and contemporary housing
- popsicle sticks or corrugated cardboard and glue
- outdoor materials (for extension)

Students will investigate different longhouses/bighouses and floor plans. Students are to look for similarities and differences among these floor plans and structures. Discuss reasons for the existence of various types of floor plan (e.g., considering the land, the environment, the building materials available, and the needs of family members). Have students choose and sketch out one of the floor plans and label specific areas (sleeping areas, gathering areas, fire pit, etc.) with dimensions. They should then discuss with a partner why they believe this particular longhouse/bighouse design was important to the family or community. Students may visit a local longhouse/bighouse (if available) to gather dimensions of longhouses/bighouses and determine (or hypothesize) how longhouses/bighouses are constructed. Have them

- question a local Indigenous Knowledge-Keeper (if possible) about construction processes and techniques as well as about the importance of the longhouse/bighouse with respect to community and identity
- compare what they have researched about longhouses/bighouses to what they are experiencing and observing.

Formative Assessment

Students in small groups can collect and share information about what makes a longhouse/bighouse and research dimensions of longhouses/bighouses in terms of length, width, and height and the number of people the longhouse/bighouse accommodated. They can share this information as a class, comparing and contrasting the findings from each group. The larger the gathering, the larger the fire would need to be. Have students

- investigate what the longhouse/bighouse was used for
- estimate the sizes of fire needed, given how many people would participate in each of those events or activities.

Activity 2: My Family Tree

Students will create a family tree of up to three generations of their family, if possible. Students can talk with family members to construct this family tree or investigate the family tree of another individual of interest (with permission). In constructing this family tree, students must make connections between members within the family tree, who they are, and how they are related. Names, photos of individuals (or sketches) birthdates, places where they were born, or where each currently lives in can be included into this family tree. Students can write a story about the family tree and where these people are from. What role do place and family play in one's identity? They can also reflect on how knowing this family tree information influences their understanding of self, sense of place, and personal values. They may see connections from this tree.

Formative Assessment

Students are able to complete the family tree and compare their trees with those of other students in the class to describe something about the individuals within their family tree and describe how they are related.

Activity 3: Designing Your Longhouse/Bighouse

Students must consider place (i.e., location, climate, geography), identity of self, and number of people in their family tree (see Activity 2) when designing a longhouse/bighouse. Students will create a floor plan of their longhouse/bighouse and the different levels it may have. They should label designated areas with dimensions. For example, they may want to map out the *excavation area* that surrounds the fire pit at the centre of the longhouse/bighouse. Drawings are to be produced to scale (e.g. 1 cm = 2 m; or 1" = 3 ft).

Excavation area

Students will determine the length and width dimensions of the fire pit and excavation area based on their floor plan design. Similarly, dimensions for the entire floor plan will be based on what they have learned in previous activities about longhouses/bighouses and the number of families from the family tree.

Students will take this further and draw front, back, left, right, and top views of their longhouse/bighouse. This is where students can indicate the smoke hole on the roof, location of front and back doors, and design a painted house front or house pole to be situate at the front of the house. This is where students can personalize their floor plans and longhouse/bighouse designs that are reflective of who they are.

Formative Assessment

Are the floor plan and view drawings of the longhouse/bighouse lined up so that the dimensions of one view correlate with those of another view and the floor plan design? What details were included in the floor plan in view drawings? Why was this important to include? What would you do differently? Where would the longhouse/bighouse be located? What direction is your longhouse/bighouse facing? How does your longhouse/bighouse address weather conditions and location?

Activity 4: Preparing for Longhouse/Bighouse Construction

Students can take the opportunity to engineer the initial construction of their longhouse/bighouse design by outlining the floor plan using scale and rope and sticks. This can be achieved using small groups, individually, or as a class depending on available space and materials. Students can also use the Pythagorean theorem (or 3-4-5 Pythagorean Triple) to check to see if walls of their design are square. Students can reflect on size and capacity and how many family members can fit into a longhouse/bighouse.

Adaptation: Students can scale down the dimensions of their longhouse/bighouse to fit the space available.

Extension – to design a community: How many longhouses/bighouses are there within a village? Students as a class will design a village that would accommodate multiple longhouses/bighouses. Students will have to consider location, resources, and other variables that would influence the design of a village and justify their design decisions.

Formative Assessment

Have students talk about their longhouse/bighouse (e.g., describe the design of their longhouse/bighouse and reasons why they made those design choices). This type of conversation could also be applied to the village design activity (Extension). How might proximity to rivers, shorelines, or forests influence the design of their longhouse/bighouse and/or village.

Extensions

Students can investigate other Indigenous housing or architecture, traditional or contemporary that is local to their area or province. Students can design and build this housing structure noticing the similarities and differences to longhouses/bighouses, local Indigenous art, or shape forms. Students can also be challenged to build an outdoors housing structure that was inspired by what they have learned and possibly stay overnight in this structure. Students can reflect on their mathematical thinking and wonder what made the house structure effective, what needed improvement, and what they would do differently next time. Students can work with an Elder or skilled craftsman from the local Indigenous community to co-create and/or co-construct this housing structure and learn why this structure was important to the community, one's identity, and sense of place. This may include reference to local materials, weather, geography, size, number of people accommodated, effectiveness of the build, etc.

Mini-Unit: Circle Dwellings

Context-Setting Introductory Material for Students

(for teacher-facilitated sharing in a whole-class setting)

Field Study or Video

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, and there are several in the Kootenay, Chilcotin, and Southern Interior areas of BC. Both the Kelowna Museum and the Royal BC Museum in Victoria have a *kekuli* or pit house to visit. When visiting a *kekuli* or pit house, be aware of, and observe, the local customs associated with them.

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. Check out

- http://www.youtube.com/watch?v=THxvqceF-Sg: includes an explanation of traditional pit house construction; features a group of Sinixt students from School District #20-Kootenay Columbia
- http://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
- https://www.youtube.com/watch?v=xHSYg_26eIE: the pit house at the Royal BC Museum in Victoria
- https://www.nfb.ca/film/stories_from_our_land_how_build_igloo/: National Film Board of Canada video of the creation of an igloo
- https://thecanadianencyclopedia.ca/en/article/pit-house & http://www.firstpeoplesofcanada.com/fp_groups/fp_plateau2.html: *Canadian Encyclopedia* articles

Conversations about the different types of circle dwellings and the construction of these structures would be beneficial as a starting point to this unit.

Preparatory Notes

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. To avoid a "trivializing," crafts-focussed approach to building the model, please review the material on "Permissions, Protocols, and Respectful Practice" in the Foundations section of this guide.

Helpful online resources that can be referred to when completing unit activities include the following:

- http://www.mathopenref.com/ (definitions and illustrations of circle geometry terms and concepts; under Plane Geometry, select "Circles and Arcs")
- www.learnalberta.ca (for help with tangents, at the Home Page, select "Resource Search," refine search parameters by checking mathematics, and search "tangent"; sign-in is required)

Applicable Blackline Masters

BLM 1 – Circle Terms Dominos
BLM 2 – Circle Dwelling Project Instructions
BLM 3 – Geometry Theorems
BLM 4 – Template for Top View
BLM 5 – Template for Side View
BLM 6 – Circle Dwelling Plan - Assessment Master
BLM 7 – Circle Unit Answer Key

Activity 1: Review of Terms

> ***Resources and Materials***
> - BLM 1 – Circle Terms Dominos

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.

Activity 2: Introducing Tangents

> ***Resources and Materials***
> - BLM 2 – Circle Dwelling Project Instructions

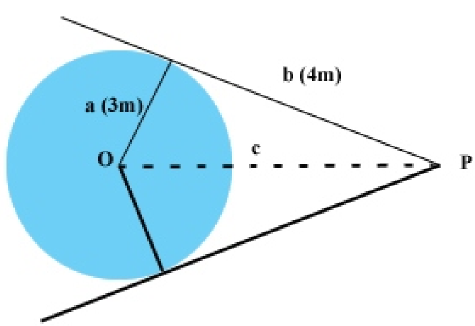
Introduce the Circle Dwelling Project using BLM 2 – Circle Dwelling Project Instructions. These instructions assume prior familiarity with some or all of the Context-Setting Introductory Material for Students.

Explain that in order to plan and complete their Circle Dwelling Project, students will find it helpful to understand some important circle geometry concepts, including tangents, inscribed angles, and chords. 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 way to illustrate this 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 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.)"



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

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

Use www.learnalberta.ca, or another similar site to help explain and visualize the process (from the Home Page for www.learnalberta.ca, select "Resource Search," refine your search parameters by checking mathematics, and search "tangent"; sign-in is required).

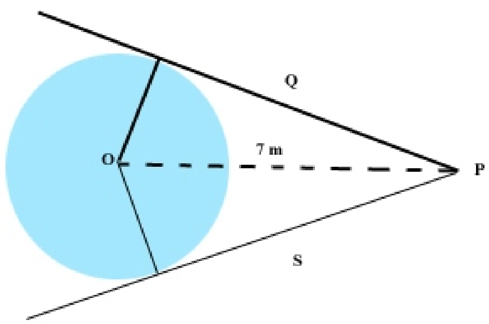
- "Find a second radius that is at a symmetrical angle to your first radius (at equal degrees away from the newly created triangle). Create another triangle that uses a tangent to the second radius as one side and whose third side (hypotenuse) is the same as the third side (hypotenuse) of the first triangle. This creates a quadrilateral with a common point outside the 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 and contributes to reducing heat loss in the winter or gain in the summer. It also 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 1.68 m 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?"



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

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

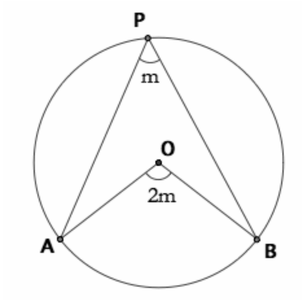
When students carry out the calculations, they will find that given the radius of 3 m, if they measure 1.68m back along tangent Q or tangent S they will end up creating a new right-angle triangle (90° where it meets OP) with a base that is 0.75 m. By doubling that to 1.5 m (using both tangent-based triangles) 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 video of building a circle dwelling, such as http://www.youtube.com/watch?v=k1WrOc9vRR8.

Activity 3: Inscribed Angle Theorem

> ***Resources and Materials***
> - BLM 3 – Geometry Theorems
> - video showing the construction of a pit house roof at Thompson Rivers University (http://www.youtube.com/watch?v=1bZhvjY9qBk)

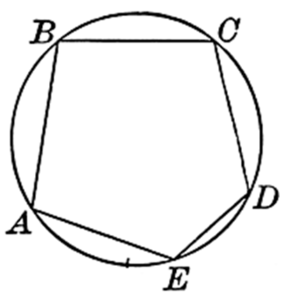
Students will need to understand the **Inscribed Angle theorem** (#3 on BLM 3 – Geometry Theorems) to figure out where on the outer arc to place the beams that support the roof of their circle dwelling. If you haven't done so already, explain to students how paired beams are arranged to support a circular roof: use the time-lapse video showing the construction of a pit house roof at Thompson Rivers University (http://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 one or more illustrative websites as suggested here. 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.

Activity 4: Chords

Resources and Materials

- BLM 3 – Geometry Theorems

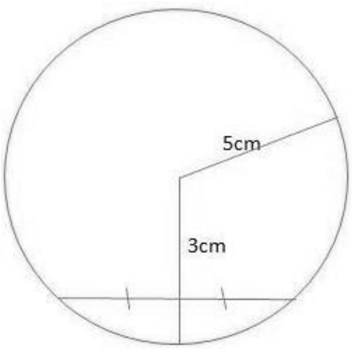
Students will need to understand the properties of chords and be able to combine this understanding with their knowledge of Pythagorean theorem to figure out

- 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 BLM 3 – Geometry Theorems) 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 5 cm and bisected by a segment 3cm long. (Encourage them to always draw the diagram first, when dealing with this sort of challenge!)

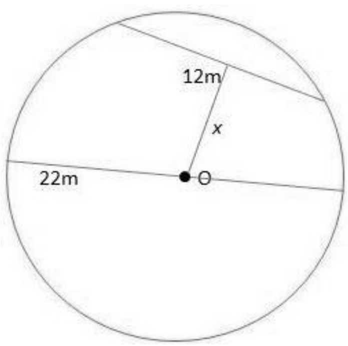


Demonstrate how to draw in the missing side to form a right triangle and use Pythagoras to determine the missing side. From there, simply multiply by 2 to determine the length of the chord. Therefore, the length of the missing side is 4cm, and the entire chord length must be:

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.

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

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 1 m away from the wall).

Optional Extension Activities

- Visit a kekuli or pit house: Take your class to a local kekuli or pit house to have them experience and see firsthand how the chords and triangles create a circular structure. Point out the structures that represent the inscribed lines and tangents. Ask students to hypothesize how the traditional knowledge was acquired and passed on without the use of Greek trigonometry.

- Have students, in small groups, research circle dwellings and create the base of the circle dwelling outside using "non-math" equipment (i.e. other resources like string, foot steps, etc. as referents) to measure the entrance to the circle dwelling. Check for reasonability. How did the First Peoples build circle dwellings without the use of modern technology? What do you think they had noticed?

Formative Assessment:

- Have students summarize the geometry rules and definitions using their own words and diagrams.
- Use computer assisted design technology (CAD) to design their own circle dwelling with dimensions.

Project Completion and Assessment

Resources and Materials

- BLM 2 – Circle Dwelling Project Instructions
- BLM 4 – Template for Top View
- BLM 5 – Template for Side View
- BLM 6 – Circle Dwelling Plan - Assessment Master
- BLM 7 – Circle Unit Answer Key

Use BLMs 2, 4, 5, and 6 to have students complete the tasks involved in drawing and measuring the floor plan of a kekuli/pit house and/or building a model. Depending on time available, your preferences, and other factors related to student learning (e.g., their preferences), you could use any of the following approaches to complete the project:

- 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.

Note that if you print BLMs 4 and 5 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.

Assess students' work in relation to the following aspects of the project:

- Plan (e.g. measurements, labelling, etc.)
- Circle Geometry and Concepts
- Related Math Concepts (linear geometry, properties of triangles, Pythagorean theorem, etc.)
- Calculations
- Construction – Materials
- Curricular Competencies

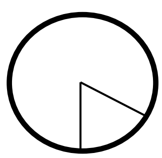
Assessment rubrics (single point or four-point rubrics) can be co-constructed with students to establish a shared set of criteria with respect to expectations, curricular competencies, and quality of product.

BLM 1 – *Circle Terms Dominos*

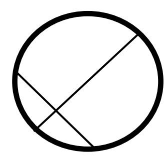
Play circle dominos to review the terminology associated with circle geometry. The rules are the same as those for regular dominos:

- 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.

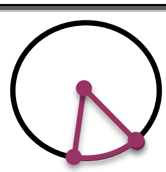
This game can be used as an individual review as well.



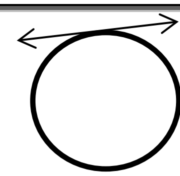
A line that runs from the centre of the circle to the outer edge



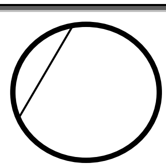
A portion of the perimeter of the circle



A line segment that joins two points on a circle



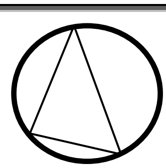
The centre of the circle



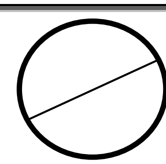
A line which cuts a line segment into two equal parts at 90°

An angle formed at the origin, involving 2 other points on/in the circle

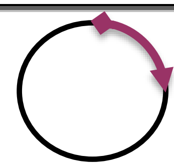
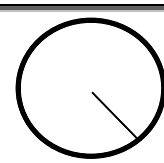
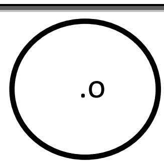
Origin



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
	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		

BLM 2 – *Circle Dwelling Project Instructions*

This project involves two related tasks:

1. designing a circle dwelling that will allow a person who is 1.82 m tall to stand comfortably, 2 m 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
2. 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; keep in mind 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; the 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 mâché. Be sure to work as close to scale as possible.

BLM 3 – *Geometry Theorems*

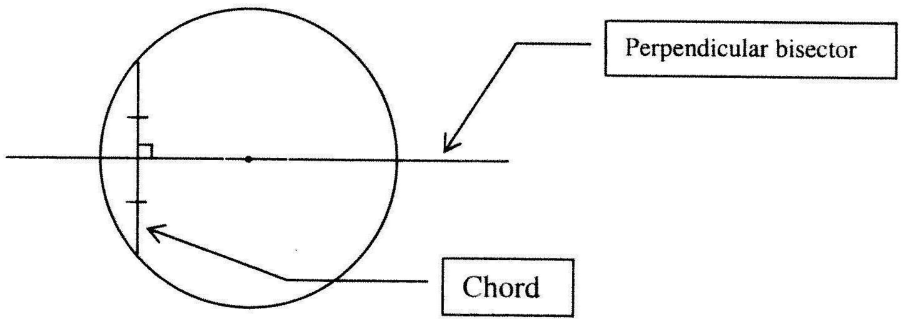
1. Chord Perpendicular Bisector theorem

   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

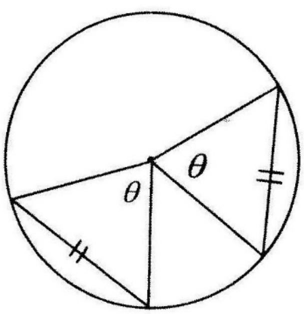
   c) the line through the centre and perpendicular (at 90°) to a chord bisects the chord (i.e., splits the chord into two segments of equal length)

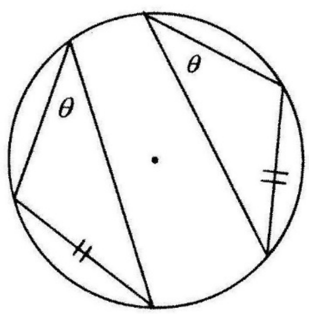


Note: there is ALWAYS a radius that will be at a right angle to the chord. Otherwise, the chord is really a diameter!

2. Equal Chords theorem

   Inscribed angles or central angles containing equal chords are equal.



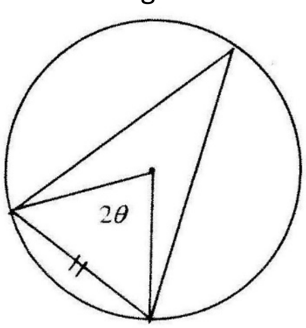


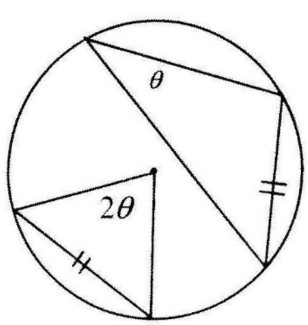
Since the chords are equal, the angles are equal ($\theta = \theta$) and vice versa.

3. Inscribed Angle theorem

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

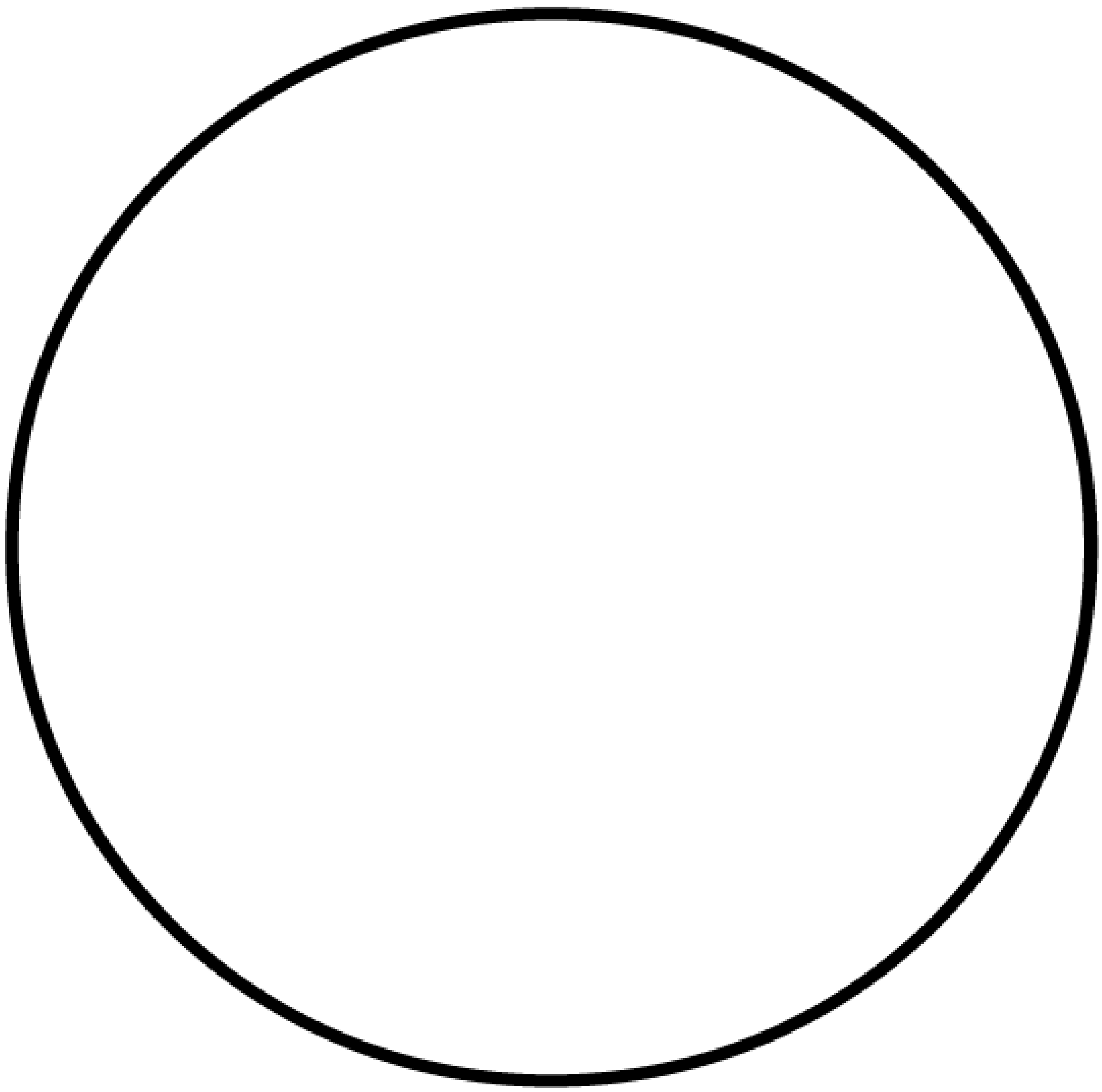
   - both angles share the same arc
   - the angles contain equal chords.





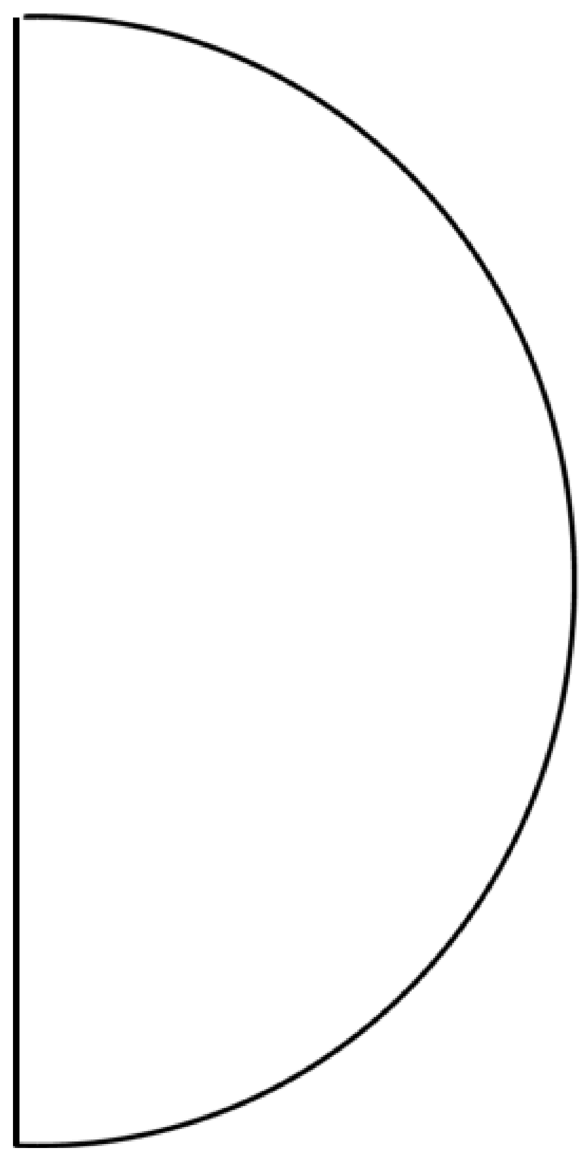
BLM 4 – *Template for Top View*

Name: ______________________

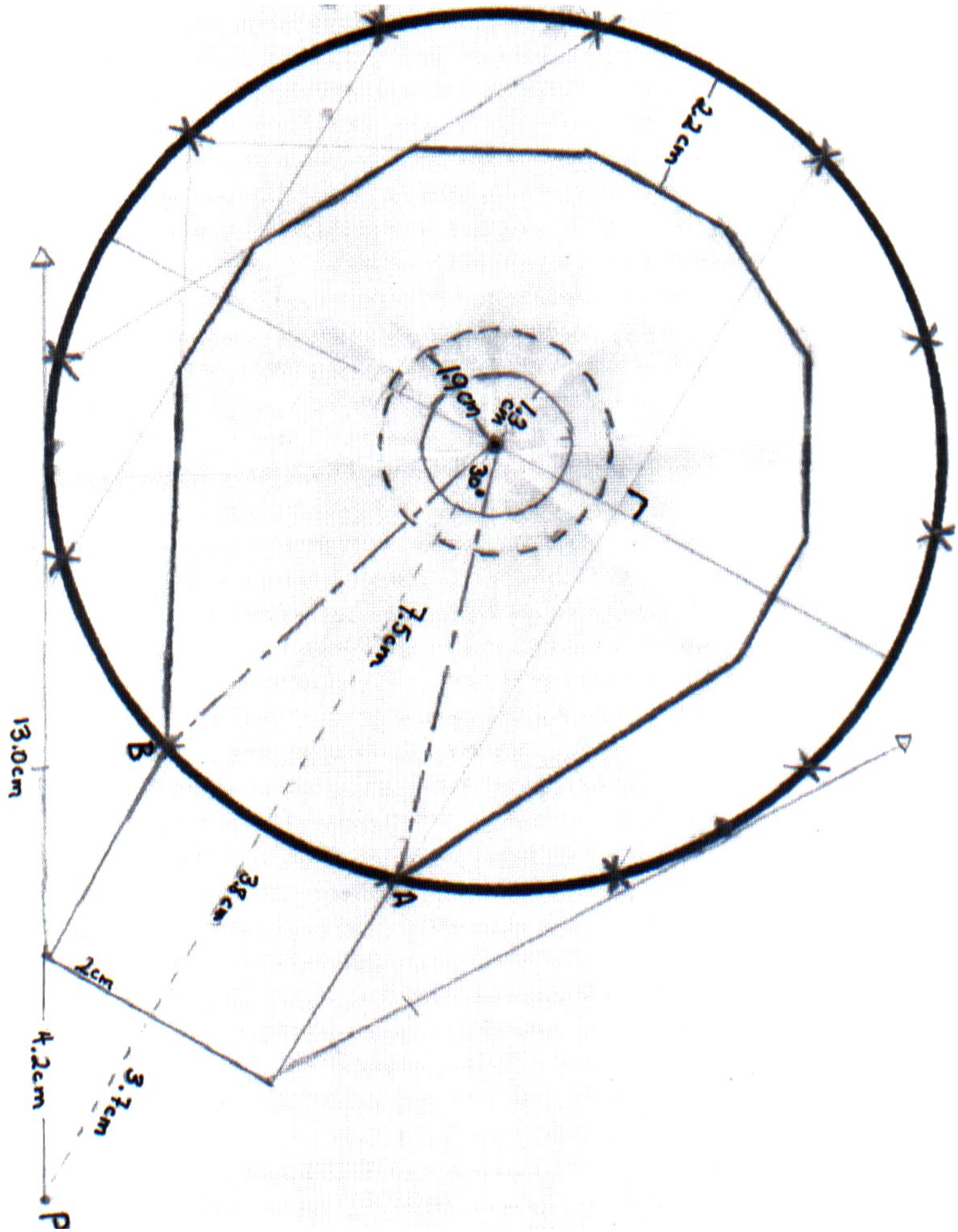


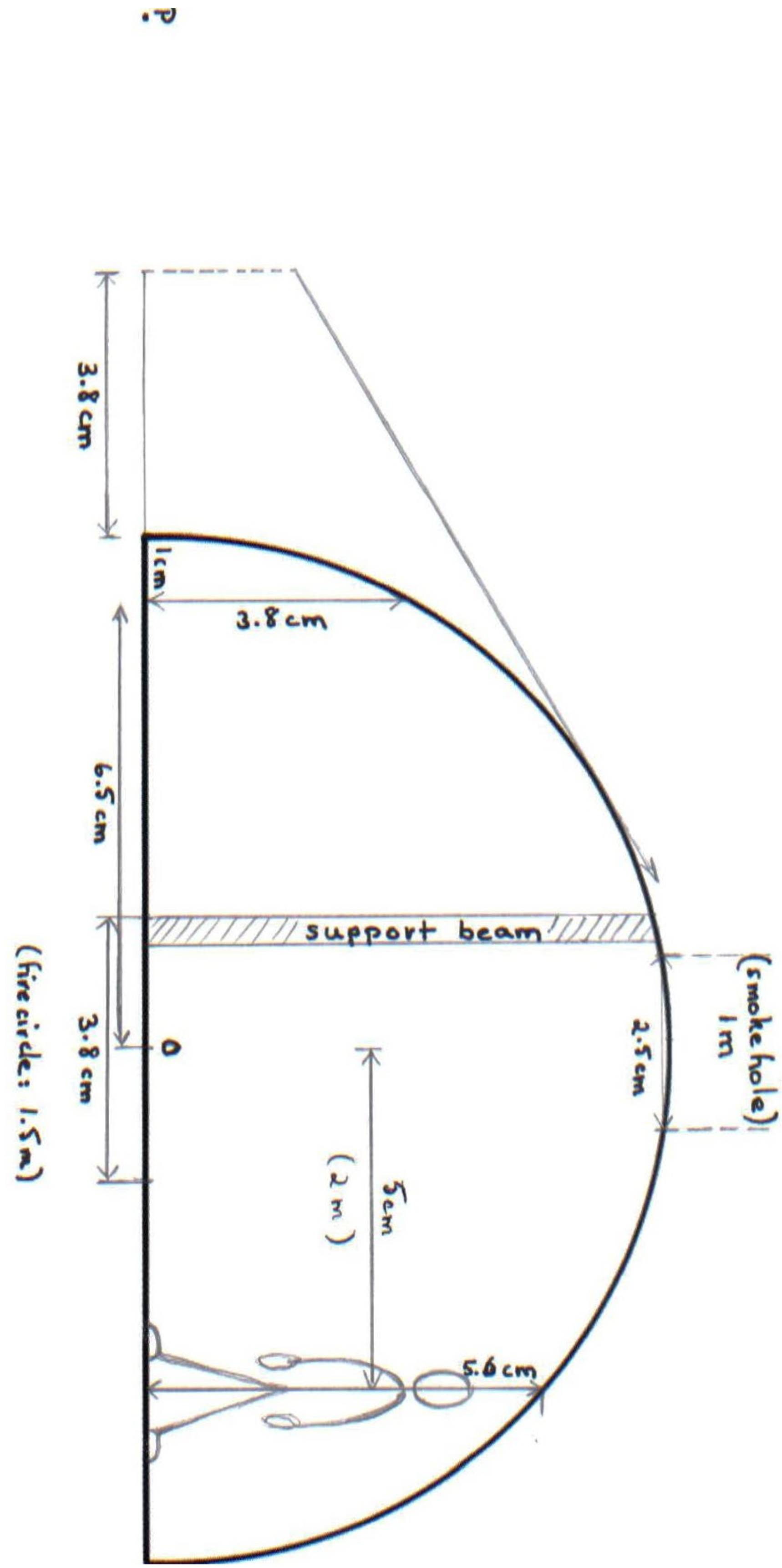
BLM 5 – *Template for Side View*

Name: ______________________



BLM 6 – *Circle Dwelling Plan - Assessment Master*




P
3.8 cm
1cm
3.8 cm
6.5 cm
support beam
(smoke hole)
1m
2.5cm
0
3.8 cm
(fire circle: 1.5m)
5cm
(2m)
5.6 cm

BLM 7 – *Circle Unit Answer Key*

Kekuli Measurement	**12 post Option**
Radius (using Pythagoras)	3 m
Diameter (r x 2)	6 m
Distance to P from Centre (given):	6 m
Length of entrance opening from circumference:	1.52 m
Width of entrance at opening:	1.60 m
Radius of fire circle:	Varies by student choice. Should be between 1-2.0 meters for optimal measuring ease of math.
Radius of smoke hole:	Varies by student choice, but is 2/3 of diameter of smoke hole • (i.e., 1 m diameter fire circle: 0.667 m smoke hole) • (i.e., 1.5 m diameter fire circle: 1 m smoke hole) • (i.e., 2.0 m diameter fire circle: 1.333 m smoke hole)
Depth of seats on circumference (chord theory, Pythagoras, subtract from radius):	0.86 m
Central angle at entrance beams:	30°
Inscribed angle:	15°
Height of central support beams:	Varies by student choice; but use Chord theory and Pythagoras (i.e., 1 m diameter fire circle: 2.95 m tall support beams; 1.5 m diameter fire circle: 2.90 m tall support beams; i.e., 2.0 m diameter fire circle: 2.83 m tall support beams)
Height of ceiling 2m from centre:	2.24 m
Height of entrance:	Varies by student choice. • If entrance is at 2.75 m, height = 1.20 m • If entrance is at 2.60 m, height = 1.50 m • If entrance is at 2.50 m, height = 1.66 m

SUSTAINING THE LAND AND WATER

Multi-Grade Thematic Unit

As in the Multi-Grade Thematic Unit: Sustenance from the Land, this unit highlights the importance of respectful harvesting and sustainable practices for First Peoples. But where “Sustenance from the Land” focussed on travel, hunting, and food preparation, this unit focuses on salmon harvesting and water use/management.

Salmon Harvesting

Salmon has been a vital resource for many of British Columbia’s First Peoples from time immemorial, and it 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.

Water Use/Management

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 Nations 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.

Curriculum Connections

Mini-Unit: Statistics and Salmon

Big Ideas

Math 6: Data from the results of an experiment can be used to predict the theoretical probability of an event to compare and interpret.

Math 9: Analyzing the validity, reliability, and representation of data enables us to compare and interpret.

Statistics 12: Statistics plays an integral role in research, decision making, and policy in society.

Grade	6	9	Statistics 12
Curricular Competencies	• Use reasoning and logic to explore, analyze, and apply mathematical ideas • Apply multiple strategies to solve problems in both abstract and contextualized situations • Use mathematical vocabulary and language to contribute to mathematical discussions • Explain and justify mathematical ideas and decision making • Reflect on mathematical thinking • Connect mathematical concepts to each other and to other ideas and personal interests • Explore, analyze, and apply statistical ideas using reason, technology, and other tools • Apply flexible and strategic approaches to explore statistical questions in abstract and situational contexts • Use statistical vocabulary and language to contribute to mathematical discussions		
Content	Single-outcome probability	Statistics in society	Extension
Core Competencies	Communication Critical Thinking		

Mini-Unit: Waterkeepers I

Big Ideas

Math 8:	Number represents, describes, and compares the quantities of ratios, rates, and percents.
Math 8:	Discrete linear relationships can be represented in many connected ways and used to identify generalizations.
Math 8:	The relationship between surface area and volume of 3D objects can be used to describe, measure, and compare spatial relationships.
Math 9:	The principles and processes in underlying operations with numbers apply equally to algebraic situations and can be described an analyzed.
Math 9:	Continuous linear relationships can be identified and represented in many ways to identify regularities and make generalizations.
Math 9:	Analyzing the validity, reliability, and representation of data enables us to compare and interpret.

Grade	8	9
Curricular Competencies	• Use reasoning and logic to explore, analyze, and apply mathematical ideas • Use tools or technology to explore and create patterns and relationships, and test conjectures • Model mathematics in contextualized experiences • Develop, demonstrate, and apply mathematical understanding through play, inquiry, and problem solving • Explain and justify mathematical ideas and decisions • Communicate mathematical thinking in many ways • Reflect on mathematical thinking • Represent mathematical ideas in concrete, pictorial, and symbolic forms • Connect mathematical concepts to each other and to other areas and personal interests	
Content	perfect squares and cubes square and cube roots numerical proportional reasoning (rates, ratio, proportion, and percent) discrete linear relations (extended to larger numbers, limited to integers) two-step equations surface area and volume of regular solids	exponents and exponent laws with whole-number exponents two-variable linear relations, using graphing, interpolation, and extrapolation multi-step one-variable linear equations statistics in society
Core Competencies	Communication Critical Thinking	

Cross-Curricular Connections

- Science 9 (ecology)
- Science 10
- Life Sciences 11
- BC First Peoples 12

<u>Mini-Unit: Waterkeepers II</u>

Big Ideas

Math 8:	Number represents, describes, and compares the quantities of ratios, rates, and percents.
Math 8:	Discrete linear relationships can be represented in many connected ways and used to identify generalizations.
Math 8:	The relationship between surface area and volume of 3D objects can be used to describe, measure, and compare spatial relationships.
Math 9:	The principles and processes in underlying operations with numbers apply equally to algebraic situations and can be described an analyzed.
Math 9:	Continuous linear relationships can be identified and represented in many ways to identify regularities and make generalizations.
Math 9:	Analyzing the validity, reliability, and representation of data enables us to compare and interpret.

<table>
<tr><th>Grade</th><th>8</th><th>9</th><th>Foundations 11</th><th>Pre-calculus 11</th></tr>
<tr><td>Curricular Competencies</td><td colspan="4">
Use reasoning and logic to explore, analyze, and apply mathematical ideas
Apply multiple strategies to solve problems in both abstract and contextualized situations
Use mathematical vocabulary and language to contribute to mathematical discussions
Explain and justify mathematical ideas and decision making
Reflect on mathematical thinking
Connect mathematical concepts to each other and to other ideas and personal interests
Explore, analyze, and apply statistical ideas using reason, technology, and other tools
Apply flexible and strategic approaches to explore statistical questions in abstract and situational contexts
Use statistical vocabulary and language to contribute to mathematical discussions
</td></tr>
<tr><td>Content</td><td>single outcome probability</td><td>statistics in society</td><td>graphic analysis
linear inequalities</td><td>linear and quadratic equations</td></tr>
<tr><td>Core Competencies</td><td colspan="4">Communicating
Social Awareness and Responsibility
Critical and Reflective Thinking</td></tr>
</table>

Cross-Curricular Connections

- Science 9 (ecology)
- Science 10
- Life Sciences 11
- BC First Peoples 12

Mini-Unit: Statistics and Salmon

Context-Setting Introductory Material for Students

(for teacher-facilitated sharing in a whole-class setting)

Salmon is Life!

Salmon is found in the Pacific Ocean and throughout the rivers of British Columbia. It is a dietary staple of many First Nations and provides an excellent source of protein and vitamins. Salmon is harvested in the spring and summer and processed by family members to be stored for the winter. The salmon feeds the family, but also the environment. Animals such as bears eat salmon. This in turn contributes to a food cycle where nutrients from the salmon feed not only the people and animals, but also the land that surrounds them. For more on the life-giving role of the salmon, see the online resources:

- https://www.indigenousbc.com/stories/the-teachings-of-the-salmon (an Elder talking about salmon; 1:43 min)
- http://www.fnha.ca/documents/traditional_food_fact_sheets.pdf (the nutrient profile of salmon)
- https://www.youtube.com/watch?time_continue=8&v=UOtkekP-sxk (David Suzuki speaks about the connection between salmon and the forest; 5:29 min)

The Cultural Importance of Salmon

Salmon is important to First Nations communities. They are celebrated with a ceremony, where each community may have different protocol and processes, to recognize the return of the salmon. Part of the ceremony involves returning the bones of the salmon back to the river or ocean. Use the following video and/or storybook resources to expand on this:

- https://www.interior-news.com/community/return-of-the-salmon/ (First Salmon Ceremony)
- *The Sockeye Mother* (2017) by Hetxw'ms Gyetxw (Brett David Hudson) & Natasha Donovan
- *P'esk'a and the First Salmon Ceremony* (2015) by Scot Ritchie

Fish Harvesting

Traditional technologies and methods are linked to place. There were different ways to harvest salmon. For example, fishers can use fish weirs, fish wheels, nets, gaffs, and spears. For more information on salmon harvesting, histories, and practices, approach your local First Nation.

Contemporary Fisheries Management

First Nations communities currently co-manage salmon resources with the Canadian Department of Fisheries and Oceans. Learn more at

- https://www.fnfisheriescouncil.ca/
- http://www.nisgaalisims.ca/fisheries-and-wildlife
- https://haidamarineplanning.com/

Preparatory Notes

This mini-unit will require approximately 8-10h of instructional time.

Applicable Blackline Masters

- BLM 1 – Factors That May Influence Data
- BLM 2 – Jennifer's Salmon Stand
- BLM 3 – Using Samples to Collect Data
- BLM 4 – Salmon Probability Game

Activity 1: The Importance of Salmon

The approaches for introducing the unit could include oral retelling/reading of a story (e.g., *The Sockeye Mother* or *P'esk'a and the First Salmon Ceremony*), screening a video (e.g., from YouTube, ERAC, or NFB), or bringing in a guest speaker (e.g., a local Elder, conservation officer, local fisher). Most school districts have an Indigenous Education department that could assist in organizing an Elder to come into your class.

No matter what resources you use to introduce this unit, it is helpful to get students to start by formulating questions about the role and harvesting of salmon (ecological, cultural, management considerations). This will enable you, in a natural and non-threatening way, to incorporate concepts such as bias, cultural sensitivity, privacy, time and timing as they pertain to understanding the importance of salmon for First Peoples in BC.

Formative Assessment

Activities that will enable you to monitor and guide students' growing understanding (especially knowledge and attitudes) include the following:

- Think-Pair-Share: students are challenged to formulate inquiry questions that are respectful and thought-provoking
- Small group discussion: how to approach or investigate answers to their questions
- Brainstorming responses to the questions above

Activity 2: Salmon Surveys

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

> ***Resources and Materials***
> - BLM 1 – Factors That May Influence Data

To introduce the activity, you can ask students to compose a set of questions, create a survey questionnaire, and poll one another on their surveys. What questions did they ask? What data did they collect? What did they learn about the questions they asked? What conclusions can they draw from this data collected?

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? What influences their data analysis?

Distribute copies of BLM 1 – Factors That May Influence Data, and discuss the information and examples given. Then have students work in small groups to rewrite the above questions.

Formative Assessment

- Ask students: How does place affect bias? What other factors form bias? (Journal Reflection)
- Choose three questions and revise them as a class or small group to make the questions "bias free"
- Exit Slips: explain why questions need to be well constructed and give an example question
- Brainstorming (small group): in light of the findings and conclusions, what other questions arise from this new information? (i.e., iterative process)

Activity 3: Samples and Populations

In this activity, students are challenged to defend the choice of sample or population when collecting data. Students must be careful to consider appropriate sizes when sampling a population, time constraints, costs, and validity.

Resources and Materials

- coloured marbles, tokens, or other manipulatives, at least 3 colours, and at least 25 of each colour for each group of students
- lidded containers or boxes, 1 per group of students
- BLM 2 – Jennifer's Salmon Stand
- BLM 3 – Using Samples to Collect Data

Distribute BLM 2 – 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 copies of BLM 3 – Using Samples to Collect Data. 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.

Formative Assessment

- Split the class in half (i.e., sample vs. population). Each takes a side and debate pros and cons.
- Non-permanent vertical surfaces (NPVS): brainstorm in small groups appropriate sample size and reasons why; follow up with students looking at each others' results (aka. museum) and discuss as a class which sample size is most appropriate and why. Class cooperatively decides which is best.
- ABCD: Students stand at each corner of the room (A=10, B=20, C=40, D=undecided) to vote which sample size is best. Students compare results in each corner and can change votes. Members in each corner report out after discussing with those in their corner why they believe this is the best choice.
- Relating back to the salmon: Which is more appropriate to collect data for salmon, sample or population? What are the limitations? What are some constraints? What are some factors that would be considered to obtain the best sample about the salmon to infer this data onto the population?

Activity 4: Salmon Statistics Project

This activity is an opportunity for students to do some field work. Students will use some of the work from previous activities in this unit to satisfy some requirements for the "Salmon Statistics Project."

Resources and Materials

- data about salmon habitats, species, characteristics, from sources such as Fisheries and Oceans Canada and Statistics Canada

The challenge is to develop a guiding or inquiry question for the statistics project that is meaningful to students. Students can refer to questions developed in Activity 2, or they can explore other creative options. The Internet is also a great resource for information and data collection. The population and sample must be determined (e.g., student body in the school) to collect data for their surveys, questionnaires, or interviews (with an emphasis on quantitative approaches).

Possible **project ideas** could include, but are not limited to:

- Collecting data about salmon habitats, species, characteristics, from resources such as
  - https://www.fnfisheriescouncil.ca/
  - https://haidamarineplanning.com/
  - https://www.nisgaanation.ca/fisheries-management

- Fisheries and Oceans Canada (e.g., http://www.dfo-mpo.gc.ca/species-especes/identify-eng.html)

- Using data about salmon in your local community and determining ways in which it matters (e.g., financial, populations, the balance between supply and demand)
- Surveying people about salmon preferences, uses, knowledge of/familiarity with salmon, etc.

To guide the Salmon Statistics Project, consider the following:

- Compose an appropriate inquiry **question** that can be answered with the data collected from surveys, interviews, or questionnaire. Students need to avoid (or minimize) bias and consider cultural sensitivity in making the survey, etc. Remind them of the information in "Factors That May Influence Data" handout.
- Choose a method for **data collection** and choice of sample or population. Students must consider cost and time involved in addition to what other resources they may require to collect and analyze the data.
- Analyze the data, display aggregate data that was useful, and infer to draw conclusions that might help answer or address the project's inquiry question.

Formative Assessment

- As a class, discuss criteria for assessing students' work. Co-create a statistics project rubric.
- Peer-assess survey questionnaire questions as reviewers or pilot testers and give feedback.
- Collect data, analyze, and display the data. Make conclusions from the data. Switch data with another person or group. Repeat process. Compare conclusions and discuss what's the same or different.

Activity 5: Probability with Salmon

Use examples such as the following to illustrate the application of probability.

Resources and Materials

- BLM 4 – Salmon Probability Game

Example 1

Probability is most commonly used in weather forecasts. For example, it is important to know the probability of things like rainfall, wind speeds, or storms when planning a fishing trip. An accurate forecast is important because the safety of the crew members could depend on it. Students may be able to talk with weather forecasters, fishers, or local Indigenous community members on how they are able to predict weather, what factors they consider as clues, and how they have honed this skill.

Weather 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. Some First Peoples continue to fish with gaffs every fall and these fishers are part of the river ecosystems just as much as the plants, eagles, sea gulls, and bears.

Sample question on probability: 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. Based on what happened last year, what is the probability that the Edwards family will catch any Coho this year?

Sample question answer: 8/20 = 40%

This sample question is an example of **Experimental Probability** because the solution is based on a past experience of the Edwards family's fishing experiences.

Sample question 2: If Jimmy Edwards had gaffed five female salmon in a row, he might guess the next salmon he catches will be a male. The gender of each salmon caught is based on **Theoretical Probability**, because the gender of salmon is either female or male, a 50% chance or a .5 probability of catching a male.

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

Formative Assessment

- Create a spinner (with equal or different probabilities). Determine the theoretical probability of each outcome and compare to the experimental probability using sample sizes of 10, 20, and 40. Record and compare outcomes. Were the results between the theoretical and experimental probability similar? …the same? …different? What do you notice? Are there any differences in probability between the different sample sizes? If so, what are they? Why do you think these differences, if any, exist?
- The above formative assessment can also be achieved rolling a die or flipping a coin.

Activity 6: Design an Experiment OPTIONAL or Statistics 12 Extension

Resources and Materials

- BLM 1 – Factors that may Influence Data

Design and implement an ethical experiment with respect to salmon (in your community). Inquire with a university or school district about ethics and ethic application given the context of the experiment. Salmon must not be harmed or killed to engage in or complete this activity. Furthermore, contact your local First Nations about the local salmon, accessing and entering the territory, and potential concerns they may have about the salmon. The experiment may also focus on environmental factors related to the salmon, such as water quality or temperature.

Test pilot the experiment and make any revisions to the design and procedures before actually performing the experiment. From the experiment, students will collect data given an appropriate sample. They will analyze the data and make inferences and recommendations based on the inquiry, hypothesis, and work done. Ensure that aspects of the designed experiment meet the criteria as highlighted in previous activities in this unit.

Formative assessment

- Are students able to formulate questions that minimize the influencers of data? Is their plan doable?
- Were students able to answer their question based on the data collected?
- Based on the evidence, are the inferences and recommendations viable for potential action?
- Would students want to make changes in their experiment design based on their first trial of their experiment? Why would they make these changes? Will they do it again? (Design thinking)

Mini-Unit: Water-Keepers I

Context-Setting Introductory Material for Students

(for teacher-facilitated sharing in a whole-class setting)

Coyote Takes Water from the Frog People

Source: Kalapuya Told by Barry Lopez in 1977
http://www.angelfire.com/ca/Indian/CoyoteTakesWater.html

Coyote was out hunting, and he found a dead deer. One of the deer's rib bones looked just like a big dentalia shell, and Coyote picked it up and took it with him. He went up to see the frog people. The frog people had all the water. When anyone wanted any water to drink or cook with or to wash, they had to go and get it from the frog people.

Coyote came up. "Hey, frog people, I have a big dentalia shell. I want a big drink of water--I want to drink for a long time. "Give us that shell," said the frog people, "and you can drink all you want."

Coyote gave them the shell and began drinking. The water was behind a large dam where Coyote drank.

"I'm going to keep my head down for a long time," said Coyote, "because I'm really thirsty. Don't worry about me."

"Okay, we won't worry," said the frog people.

Coyote began drinking. He drank for a long time. Finally one of the frog people said, "Hey, Coyote, you sure are drinking a lot of water there. What are you doing that for?"

Coyote brought his head up out of the water. "I'm thirsty."

"Oh."

After a while one of the frog people said, "Coyote, you sure a drinking a lot. Maybe you better give us another shell."

"Just let me finish this drink," said Coyote, putting his head back under water.

The frog people wondered how a person could drink so much water. They didn't like this. They thought Coyote might be doing something.

Coyote was digging out under the dam all the time he had his head under the water. When he was finished, he stood up and said, "That was a good drink. That was just what I needed."

Then the dam collapsed, and the water went out into the valley and made creeks and rivers and waterfalls.

The frog people were very angry. "You have taken all the water, Coyote!"

"it's not right that one people have all the water. Now it is where everyone can have it."

Coyote did that. Now anyone can go down to the river and get a drink of water or some water to cook with, or just swim around.

Preparatory Notes

Using a compilation of self-paced interactive learning materials (originally designed to train on-site community water system personnel), this mini-unit allows students to explore the application of 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 FNESC website), 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 as part of the interactive electronic resource 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

- *Math First Peoples Water Keepers* digital content, available on the FNESC Resource website: http://www.fnesc.ca/math-first-peoples/. The digital content comprises various components:
    - *Small Water Systems* — 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 for students to use as part of the unit procedure

  To access the digital content, you will require **Adobe Flash Player**. The procedure for downloading and accessing the needed files is as follows:
    - At the bottom of the page under Additional Resources, click on the *Math First Peoples Water Keepers* digital content zip file (116MB), highlighted in blue.
    - In the new window, click on the download button (upper right). You may want to create a directory of your choosing as a location for the download.
    - In the downloaded .zip folder, click on the *Start_CD.exe* file. You will be prompted to extract the files.
    - Click on *Extract all files* (this is required for the applications to run properly).
    - Once all files are extracted, click on the *Start_CD.exe* file to run the *Small Water Systems* application. This application was originally designed as a self-contained training resource for water keepers (individuals involved in the operation and maintenance of a stand-alone water system in a remote or self-dependent First Nations community). A menu will allow you or your students to focus on
        - the Introduction (which establishes a context for the needed skills and knowledge and identifies the applicable mathematical concepts needed to understand small water systems)
        - a Treatment, Sampling & Testing component that builds on the basics developed in the Introduction
        - a Storage & Distribution component that focuses on system planning considerations.
    - Access the Safe Water Challenges, by clicking on the separate *Start_CD.exe* file within the SafeWater directory. The Safe Water Challenges are a separate resource, designed to focus on practicing job-specific skills for Water Keepers (they have a strong assessment and accountability emphasis).
    - Look in the root directory of your Extracted files to locate the Excel files called for in the Mini-Unit: Water-Keepers II. (A separate directory contains pdf versions of these Excel files.)

Applicable Blackline Masters

BLM 5 – 100 Grids
BLM 6 – What is Ratio?
BLM 7 – Using Excel to Create Graphs

Activity 1: The Importance of Water

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

> ***Resources and Materials***
> - the *Math First Peoples Water Keepers* digital content, available on the FNESC Resource website: http://www.fnesc.ca/math-first-peoples/

Alternately, begin by sharing the story provided at the beginning of this mini-unit, "Coyote Takes Water from the Frog People." Then have 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 operation of the media resource, Small Water Systems, until it's clear that students understand the format and what's expected of them (see the Preparatory Notes for details on access).

Have students complete the Introduction of the "Small Water Systems" resource up to 1.9 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 or with a class set of devices
- 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 questions, they should make note of them.

Formative Assessment

After all students have completed sections 1.1 – 1.9, 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?

Activity 2: Clean Water as a Human Right

Have students read the CBC article on water quality issues on Reserve. Discuss the issues around having poor water quality and the need for clean drinking water. Use BLM 5 – Good Water Consequence Tree as the start point for having students develop their thinking about the importance of having a supply of clean, safe, water in a community. Space has been left on the right for students to add an additional row of consequences, if needed.

> ***Resources and Materials***
> - https://www.cbc.ca/news/indigenous/david-suzuki-foundation-first-nations-water-report-1.4525456
> - BLM 5 – Good Water Consequence Tree

Activity 3: Math Concepts Related to Water Management

> ***Resources and Materials***
> - the *Math First Peoples Water Keepers* digital content, available on the FNESC Resource website: http://www.fnesc.ca/math-first-peoples/
> - BLM 6 – 100 Grids
> - BLM 7 – What is Ratio?

Incorporated within the "Small Water Systems" resource are simple illustrated explanations of various mathematical concepts – many of which will already be familiar to students (see sections 1.10-1.17 of the resource, as well as sections 2.4-2.5, 3.2-33, and 3.6-3.7). Depending on your students' existing levels of knowledge, you could use these explanations as review work or as a springboard to follow-up instruction. Students could be asked to

- complete all this review work independently in pairs or small groups, as in Activity 1 (i.e., keeping track of any questions they have about the math concepts raised), or
- work in pairs or small groups on a single concept/operation, which they are then assigned to explain verbally to the rest of the class.

Debrief by addressing any questions raised or difficulties students have encountered. The "Small Water Systems" resource focuses especially on the ability to easily convert amongst fractions, decimals, and percentages and appreciate how this informs the ability to handle ratios and proportions. Accordingly, you may wish to have students work their way entirely through Part 2 of the resource (Treatment, Sampling & Testing) as a basis for extra work on roots, ratios, and proportions. You can then follow up by reinforcing their ability to understand and work with squares and square roots. 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 copies of BLM 6 – 100 Grids (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 BLM 7 – What is Ratio? provided with this unit to review ratios and equivalent amounts.

Formative Assessment

Have students

- go to www.arcademicskillbuilders.com/ to practice ratios, equivalent fractions and proportions in individual and team games.
- 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.
- go to www.mathplayground.com/percent_shopping.html (level 1 and level 2) to practise using percentages.

Provide an opportunity for class debrief on students' experiences with the digital resource (i.e., the "Small Water Systems" resource Part 2) before moving on.

Activity 4: Analysing Real-World Data

As Canada's population grows, access to freshwater 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.

Resources and Materials

- the Safe Water Challenge from the Water Keepers media resource collection
- BLM 6 – 100 Grids
- BLM 7 – What is Ratio?

Have students access the Statistics Canada data for "population served by drinking water plants, by source water type and drainage region — surface water" (https://www150.statcan.gc.ca/n1/pub/16-403-x/2013001/t014-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 Yukon2	2,315,837	2,345,382	2,371,455
Fraser-Lower Mainland3	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. Add the current data to the above table and the graph. Be sure to point out the need for scale, and proper labeling of axis. Use the graphs to answer the following questions:

- What does your graph show?
- What are the trends in population relying on surface water over time?
- Is the difference between the regions consistent over time, or is one growing more than others?
- What might be some reasons for the gap between regions?
- Using the data given, and extrapolating from the trends shown, what would be a good prediction of population using surface water for each region in 2025?

Now have students access the data for "population served by drinking water plants, by source water type and drainage region — ground water" from the same resource. 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 2025 change?

How does this water data reflect the water sharing idea held by Coyote in the context-setting story? Is there a way to equitably share the water between areas?

Formative Assessment

Use the following key to discuss students' work producing and analysing their line graphs:

- Graphs should show a general upwards movement.
- There is an annual increase in the number of people who use surface water as their main water source.

- 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.
- Reasons could include (but are not limited to) increased population growth due to job increases (oil and gas industry), urbanization, and immigration to province.
- Approximate figures could be:
  - Pacific Coastal/Yukon: 2 580 000
  - Fraser Valley: 935 000
  - Okanagan-Similkameen: 251 000
  - Columbia: 108 500

ACTIVITY 5: Safe Water Challenge

Have students complete the Safe Water challenge, as per the Water Keepers media.

Resources and Materials

- the Safe Water Challenge from the *Water Keepers* media resource collection

Activity 6: Using Software Tools

Review with the class how to read a co-ordinate point graph, and how to create and plot a table of values. Then, using the Excel file, *Grade 8 – water_sampling_exercise.xls*, included with the digital *Water Keepers* resource, pose the hypothetical situation 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.

Resources and Materials

- BLM 8 – Using Excel to Create Graphs
- the Excel file, *Grade 8 – water_sampling_exercise.xls*, included with the digital *Water Keepers* resource
- computers able to run the spreadsheet software (*Excel*) files included with the *Water Keepers* digital media resource
- Part 3 of the “Small Water Systems” component (Storage and Distribution) within the digital *Water Keepers* resource, available online at FNESC Learning First Peoples

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 copies of BLM 8 – Using Excel to Create Graphs to help guide them through this process.

Have students complete Part 3 of the “Small Water Systems” component (Storage and Distribution) within the digital *Water Keepers* resource (as per Parts 1 and 2). Again, ask them to keep track of any questions they have about the math concepts raised.

Formative Assessment

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

Activity 7: Math Concepts — Cylinders

Resources and Materials

- several cylindrical objects (various food & drink cans, water bottle, film canister, Dutch oven, cookie tin, etc.) for students to use in making measurements
- measurements from several 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)

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.

Formative Assessment

- Students construct their own cylinder and measure and/or calculate the dimensions outlined above. Have students challenge 2 other people and compare their results.
- Is a line graph the best representation of the relationship between surface area and volume? Would a different graph type be better? Why or why not?

Mini-Unit: Water-Keepers II

Context-Setting Introductory Material for Students

(for teacher-facilitated sharing in a whole-class setting)

Follow up

This mini-unit uses the same Waterkeepers resource used for the preceding mini-unit and builds off the same context.

Applicable Blackline Masters

BLM 8 – Using Excel to Create Graphs
BLM 9 – Average Water Usage

Activity 1: Reviewing Order of Operations

Review the Water Keepers content that deals with order of operations (section 1.15 in the Introduction section of the "Small Water Systems" component). 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.

Resources and Materials

- the *Math First Peoples Water Keepers* digital content, available on the FNESC Resource website: http://www.fnesc.ca/math-first-peoples/

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)

Illustrative Example

To illustrate how different results will be achieved using the correct vs. the incorrect order of operations, demonstrate using the equation, $3^2 - 3 \times (8 - 6) = ?$ Using BEDMAS, we do the brackets first, then the exponent, then the multiplication, then the subtraction:
$3^2 - 3 \times (8 - 6)$ (perform within brackets or parenthesis)
$= 3^2 - 3 \times 2$ (evaluate the exponent)
$= 9 - 3 \times 2$ (perform multiplication)
$= 9 - 6$ (perform subtraction)
$= \mathbf{3}$

If, however we simply perform the operations from left to right, ignoring the order-of-operations rules, we end up with a very different result:
$3^2 - 3 \times (8 - 6) = ?$
$= 9 - 3 \times (8 - 6)$
$= 6 \times (8 - 6)$
$= 48 - 6$
$= \mathbf{42}$

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:
$3^2 – 3 \times (8 – 6) = ?$
$= 9 – 3 \times (2)$
$6 \times (2)$
$= \mathbf{12}$

Follow-up

Emphasize for students that although most calculators are now programmed to factor in BEDMAS, it is important to "know the math" rather than relying on a calculator. It is reasonable to use calculators to solve a problem like this one, so long as they recognize the significance of performing operations in the correct order.

Provide additional exercises such as the following for students to practice:
$12 + (6 \div 2)$
$12 \div 2 \times (8 \div 2)$
$4 + 4^2$
$(3 - 2)^2 \times 9 \times 10$
$(3^2 - 3) \times (5 + 10)$

Finish by having students complete *Water Keepers* Part 2 as per Part 1 (digital content, available on the FNESC Resource website: http://www.fnesc.ca/math-first-peoples/). Again, ask them to keep track of any questions they have about the math concepts raised.

Formative Assessment

- Challenge students to create their own order of operations problems for each other and then check each others' work on solving them.
- Provide an opportunity for a class debrief of students' work on *Water Keepers* Part 2 before moving on.

Activity 2: Linear Equations and Linear Inequalities

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.

Resources and Materials

- BLM 9– Average Water Usage
- the *Math First Peoples Water Keepers* digital content, available on the FNESC Resource website: http://www.fnesc.ca/math-first-peoples/

Have students research average household water usage for the local community. Alternatively, provide them with copies of BLM 9 – 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 (15 L x 6=90 L). Have students determine the formula and amount of water used in one week given the same amounts (90L x 7=630 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 is 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 15 L of water? (No displacement (15 L x 6 = 90 L) (90 L x 7 = 630 L) With displacement (15 L-1.13 L) x 6 = 83.22 L then (83.22 L x 7 = 582.54 L). What would the difference be using the same parameters over a given week? (630 L – 582.54 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 online FNESC Resource. Alternatively, have your class create their own spreadsheet and graphs using their own numbers for displacement or low flush options. What do they notice about the trends in the graphs?

Have students complete the *Safe Water Challenge*, as per the Water Keepers media resources.

Formative Assessment

Provide an opportunity for a class debrief of students' work on the Online resource at FNESC Learning First Peoples media resource, *Safe Water Challenge* before moving on.

Activity 3: Data Collection Project

Review the questions students 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).

> ***Resources and Materials***
> - the Excel file, *Grade 9 – water_use_in_schools.xls*, included with the digital *Water Keepers* resource
> - computers able to run the spreadsheet software (*Excel*) files included with the *Water Keepers* digital media resource
> - BLM 1 – Factors That May Influence Data (optional)
> - BLM 8 – Using Excel to Create Graphs

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. If needed, refer to BLM 1 – Factors That May Influence Data.

Provide time for students to conduct their surveys, tabulate the results (using the Excel file, *Grade 9 – water_use_in_schools.xls*, included with the digital *Water Keepers* resource), and present them to the rest of the class. BLM 8 – Using Excel to Create Graphs (provided at the end of this unit) may assist students if they choose to use Excel to represent their survey results graphically.

Formative Assessment

- Conduct a pilot test with 5 classmates to determine the quality of the questions in the survey. Make changes as needed.
- What are students attempting to communicate in the tables and graphs presented? Is this appropriate and the best form of display of the data?

Optional Extension Activities

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.

Summative Assessment Suggestions

Depending on the results and final conclusions, students may decide to write a report with recommendations to the municipality and/or provincial government.

BLM 1 – *Factors that May Influence Data*

Bias

A predisposition or bias is likely to influence a person to respond in a certain way.

Example of a biased or "loaded" question: "Do you think salmon tastes too fishy?" This person obviously has a bias against the taste of salmon and has built the presumption that the taste of salmon is unpleasant right into the question. A more appropriately phrased (neutral) question would ask what they think salmon tastes like (if answers are being recorded in a way that allows for open-ended responses) or perhaps offer different potential choices (if a closed-ended multiple-choice approach is being used).

Use of Language

A questioner's language can affect people's answers by influencing them.

Example (a leading question): "Do you agree that the price of salmon is way too high?" People may be led to say yes because the current phrasing suggests there is only one option really worth considering (unless one says no), that it is reasonable to expect the cost of salmon to be lower than it is, and that most people already believe salmon is overpriced. A question that asked instead whether the cost of salmon seems fair, inexpensive, or too high would encourage people to choose from three different responses without suggesting a "best" or "most popular" answer. It would be fairer and much less likely to skew results.

Ethics

The data collected must only be used for the purpose of study that respondents agree to.

Example: A study asks members of an Indigenous community for their opinions about the best methods for catching salmon. Without saying so, those conducting or supporting the study intend to use the results to develop a strategy for marketing the sale of fishing gear in the community. In this instance, the data collector should be more open and honest and 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. For example, studying a small salmon stream may cost thousands of dollars and consume many hours. This investment may not be worthwhile if the purpose is purely to satisfy curiosity. It might, however, be worthwhile if the intended purpose is to guide the allocation of further resources that will improve the stream for future use.

The data collection method must also be considered. For example, when gathering community opinions, an electronic survey may seem very cost-effective. It will, however, eliminate people without access to a computer. A telephone survey might also seem appropriate; but it involves the challenge of getting listings that properly represent the community. Only those able and willing to answer will actually be counted. Similarly, 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 Indigenous people love eating salmon. It may offend the Elder because you have made a generalization that all Indigenous 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.

Summary

When designing a survey, remember to ask yourself:

- 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?

BLM 2 – *Jennifer's Salmon Stand*

Jennifer was planning to raise money for a school trip. She had an opportunity to set up a food sale at a school track and field event. Her grandfather, a fisherman, suggested that she should offer different 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 her plan and her need to find out how her classmates might respond. Because her school had several grades and many students (**the population: the whole group you are interested in**), she decided to do a survey in her own classroom (**a sample: counting part of the population**) to help her answer her questions. A census **(a census: counting 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?

BLM 3 – *Using Samples to Collect Data*

Name: ____________________ Date: ___________________

Each group will need 50 marbles to represent a population of fish. One colour of marbles will represent male salmon and the other colour 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 more than 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?

BLM 4 – *Salmon Probability Game*

Goal: to use experimental probability to estimate the numbers of species of salmon in a “fish tank”

Materials Needed: a box or lidded bin (the “fish tank”), as well as at least 30 marbles or tokens in each of three colours (each colour represents a type of salmon)
Red: Sockeye
Green: Chum
Black: Spring

Number of Players: 4

Rules of Play

1. Choose one player to be the fisheries manager. The fisheries manager selects any 30 marbles/tokens from a selection of marbles/tokens in three different colours. A possible example: the fisheries manager 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 colour are selected. The fisheries manager places the 30 “fish” in a **covered** “fish tank” (e.g., box or lidded bin container) from which samples will be drawn.
2. Each of the other players uses a Recording Table (3 copies supplied on the next page) to record 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 fisheries manager must make sure the players cannot see what is in the container as they make their selection). 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 marbles/tokens selected.
5. Repeat Steps 3 and 4 two more times.
6. The fisheries manager now reveals exactly what is in the “fish tank” 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 # 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 fisheries manager. Share your strategies with the other players. Whose strategy worked best?

Recording Tables

	First Guess (guess the number of each species)	**Estimates** (re estimate after every round of pulling 10 marbles/tokens)			**Number of marbles/ tokens pulled** (pull 1 at a time & return it to the "tank"; do this 10 times)			**Final Estimate** (after 3 rounds, make a final estimate)	**Actual Number of marbles/ tokens** (in the "fish tank")	**Points** (difference between actual number of tiles and your Final Estimate)
		Round 1	**Round 2**	**Round 3**	**Round 1**	**Round 2**	**Round 3**			
Sockeye										
Chum										
Spring										

	First Guess (guess the number of each species)	**Estimates** (re estimate after every round of pulling 10 marbles/tokens)			**Number of marbles/ tokens pulled** (pull 1 at a time & return it to the "tank"; do this 10 times)			**Final Estimate** (after 3 rounds, make a final estimate)	**Actual Number of marbles/ tokens** (in the "fish tank")	**Points** (difference between actual number of tiles and your Final Estimate)
		Round 1	**Round 2**	**Round 3**	**Round 1**	**Round 2**	**Round 3**			
Sockeye										
Chum										
Spring										

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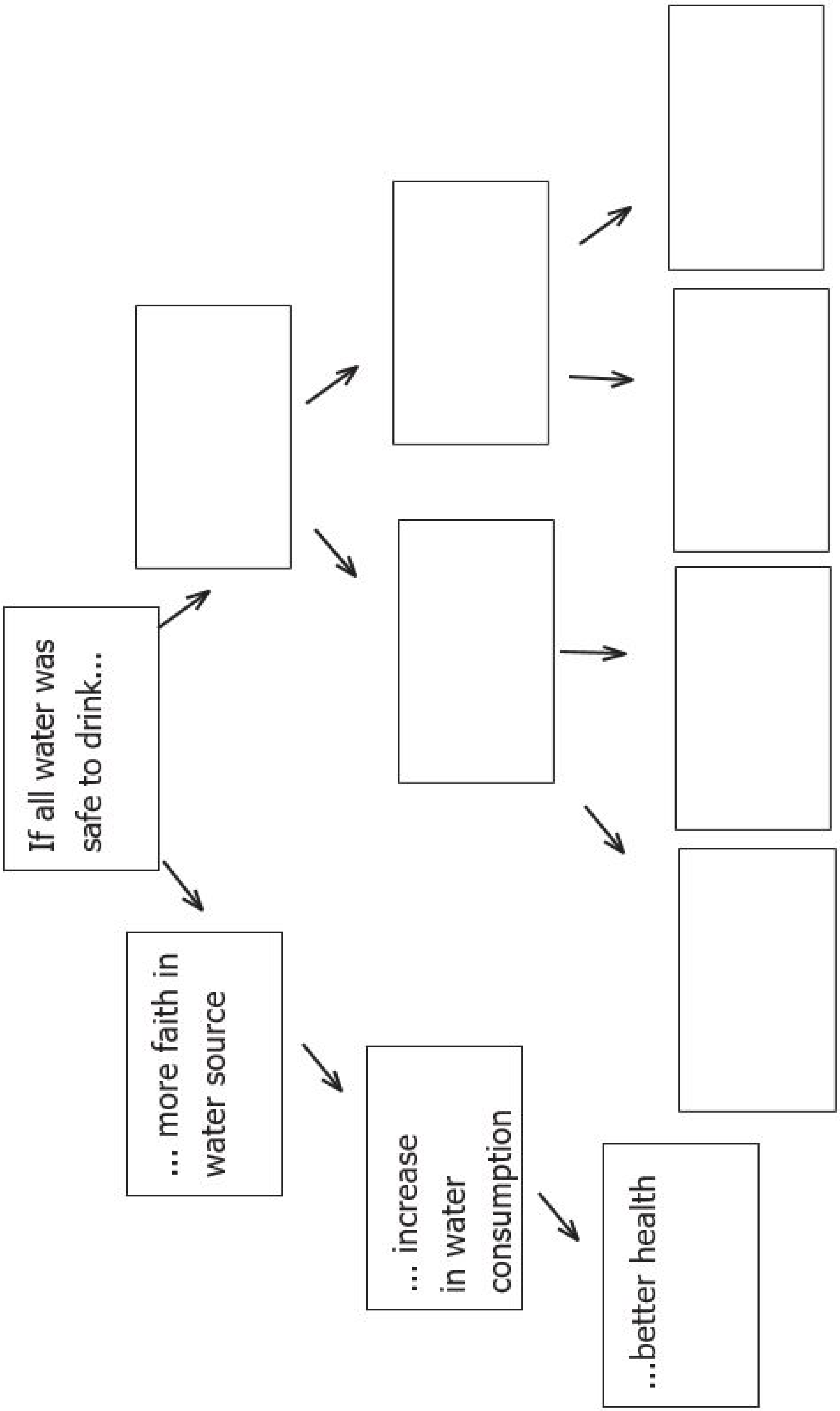
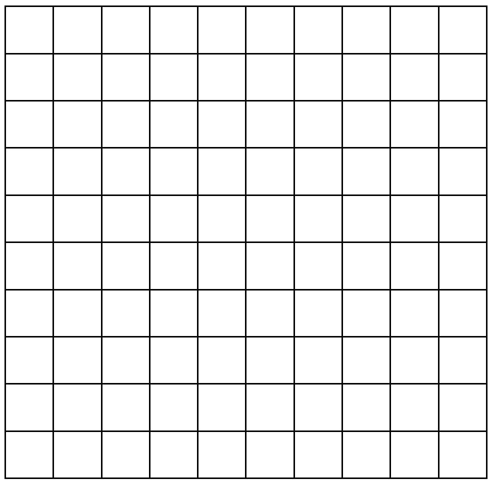
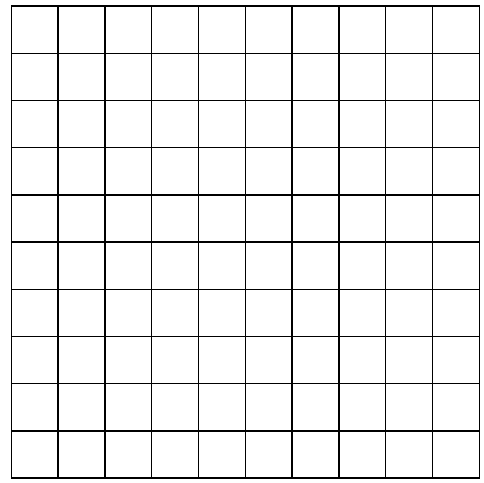
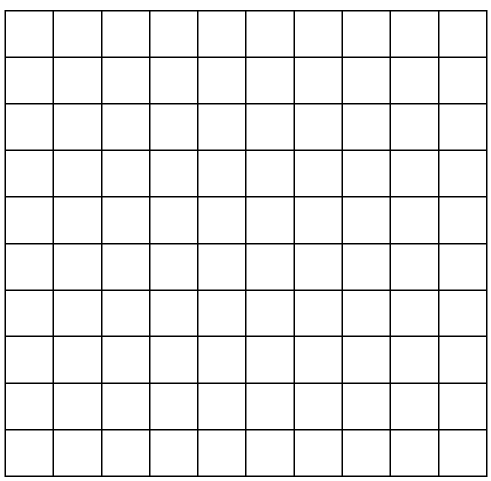
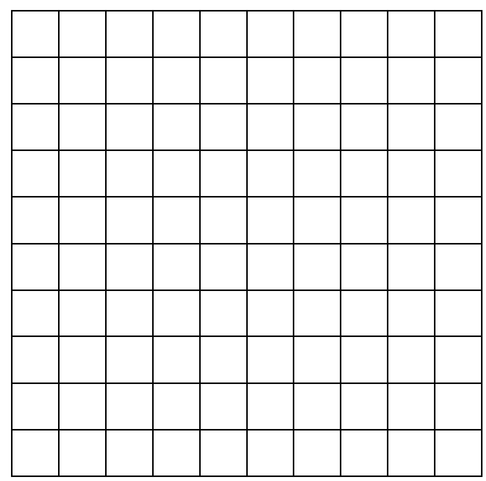
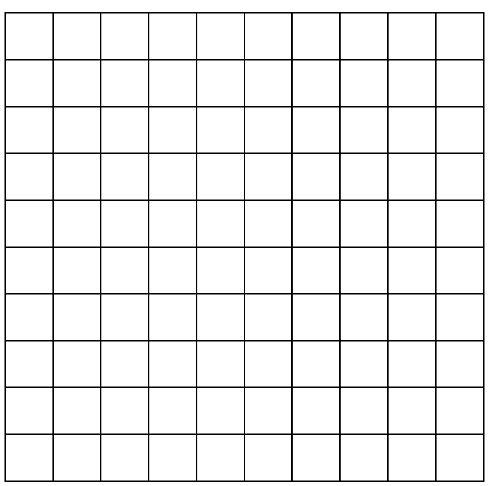
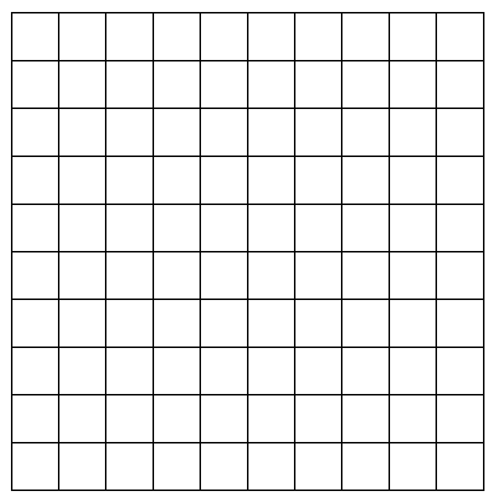
		Round 1	**Round 2**	**Round 3**	**Round 1**	**Round 2**	**Round 3**			
Sockeye										
Chum										
Spring										

BLM 5 – *Good Water Consequence Tree*



BLM 6 – *100 Grids*

BLM 7 – *What is Ratio?*

Ratio is a way of comparing amounts of something. It shows how much bigger one thing is than another. A ratio can be used to describe the number of parts to a mix. For example, a 2-stroke boat motor uses mixed fuel in which the specified mix is 51 parts, with 50 parts gas and 1 part oil. 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. No matter how much total fuel you need, the mix must remain the same. The ratio must be maintained, and the order in which this (or any) ratio is stated is important.

To maintain a constant ratio, the amounts of gas and oil need to 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

To make ratios easier to compare and use, we can often make the numbers in ratios smaller. You do this by dividing each side of the ratio by the same number, the highest common factor. This is called **simplifying.** For example, suppose the ratio of female to male members in a class is 12:18. Both 12 and 18 can be divided by 2:

$12 \div 2 = 6$
$18 \div 2 = 9$

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

This ratio can be made simpler again, since we can divide both 6 and 9 by 3:

$6 \div 3 = 2$
$9 \div 3 = 3$

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:

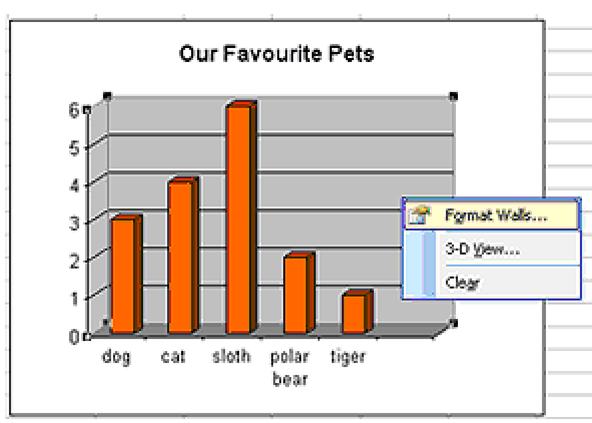
12:18 ➔ 6:9 ➔ 2:3

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.

BLM 8 – *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.



BLM 9 – *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

This information was taken from the Metro Vancouver: Services and Solutions for a livable Region website (www.metrovancouver.org).

GAMES

Multi-Grade Thematic Unit

Whether it's crossing our fingers for good weather when we plan an outdoor event or flipping a coin to make a decision, we have all at some time or another found ourselves hoping that upcoming events will unfold in a favourable way. 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, Indigenous guessing games offer a fresh, entertaining, and culturally relevant means of teaching probability. 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. Accordingly, they can offer a good opportunity to build connections between the mathematics class and the local First Nations communities.

Curriculum Connections

Mini-Unit: Playing and Learning from Lahal

Big Ideas

Math 6:	Data from the results of an experiment can be used to predict the theoretical probability of an event and to compare and interpret.
Math 7:	Number represents, describes, and compares the quantities of ratios, rates, and percents.
Math 7:	Analyzing data by determining averages is one way to make sense of large data sets and enables us to compare and interpret.
Math 8:	Computational fluency and flexibility extend to operations with fractions.
Math 8:	Decimals, fractions, and percents are used to represent and describe parts and wholes of numbers.
Math 8:	Computational fluency and flexibility with numbers extend to operations with integers and decimals.
Math 9:	Analyzing the validity, reliability, and representation of data enables us to compare and interpret.
Foundations 12:	Probabilistic thinking informs decision making in situations involving chance and uncertainty. (This can be adapted to Math 6,7,8 if looking at single events.)

Grade	6	7	8	9	Foundations 12
Curricular Competencies	• Use logic and patterns to solve puzzles and play games • Use reasoning and logic to explore, analyze, and apply mathematical ideas • Develop, demonstrate, and apply mathematical understanding through play, inquiry, and problem solving • Explain and justify mathematical ideas and decisions in many ways • Use mathematical arguments to support personal choices • Develop thinking strategies to solve puzzles and play games • Explore, analyze, and apply mathematical ideas using reason, technology, and other tools				
Content	single outcome probability, both theoretical and experimental	experimental probability with two independent events operation with decimals	theoretical probability with two independent events operations with fractions	statistics in society	odds probability expected value
Core Competencies	Communicating Social Awareness and Responsibility Critical and Reflective Thinking				

Cross-Curricular Connections

- BC First Peoples 12
- Physical Education 8-9

<u>Mini-Unit: Other Games</u>

Big Ideas

Math 6: Data from the results of an experiment can be used to predict the theoretical probability of an event and to compare and interpret.
Math 7: Number represents, describes, and compares the quantities of ratios, rates, and percents.
Math 7: Analyzing data by determining averages is one way to make sense of large data sets and enables us to compare and interpret.
Math 8: Computational fluency and flexibility extend to operations with fractions.
Math 8: Decimals, fractions, and percents are used to represent and describe parts and wholes of numbers.
Math 8: Computational fluency and flexibility with numbers extend to operations with integers and decimals.
Math 9: Analyzing the validity, reliability, and representation of data enables us to compare and interpret.
Foundations 12: Probabilistic thinking informs decision making in situations involving chance and uncertainty.
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Grade	6	7	8	9	Foundations 12
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Content	single outcome probability, both theoretical and experimental	experimental probability with two independent events operations with decimals	theoretical probability with two independent events operations with fractions	statistics in society	odds probability expected value
Core Competencies	Communicating Social Awareness and Responsibility Critical and Reflective Thinking				

Cross-Curricular Connections

- BC First Peoples 12
- Physical Education 8-9

Mini-Unit: Playing and Learning from Lahal

Context-Setting Introductory Material for Students

(for teacher-facilitated sharing in a whole-class setting)

Gatherings

Pacific Educational Press, Faculty of Education, UBC. *B.C. First Nations Studies* (2004; BCFNS 12 text)
B.C. Ministry of Education, p. 55 ("Sharing the Land and Resources").

Throughout the province, people gathered together at central locations to trade goods and ideas. Some gatherings were meetings of family groups who were related to each other, others brought together people from different nations. Gatherings were important socially and economically and were usually festive and greatly anticipated throughout the year. Competitions were often held at these gatherings, including challenges of physical strength and races. Gambling was a major component. Lahal was the almost universal gambling game played. But the opportunity to exchange resources and objects and to share ideas and knowledge was most important. These interactions gave young people the opportunity to meet each other and seek out future mates.

◊◊◊

Consider inviting a local Elder or someone from the Aboriginal/Indigenous Education department in your school district who is able to demonstrate the game (or invite someone from your local community if you are in a First Nations school). If such a person is not available, you could have students watch a short video of the game (https://www.youtube.com/watch?v=_BBHge8wzR0) and research the game online using sources such as the following:

- https://indigenouseducation.comoxvalleyschools.ca/apps/pages/index.jsp?uREC_ID=1064876&type=d&pREC_ID=1357977
- http://secwepemc.sd73.bc.ca/sec_village/sec_lahal.html

Preparatory Notes

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 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.

Guiding Question

What is the probability of winning Lahal? What factors influence winning? Can you verify that certain strategies improve your chances?

Applicable Blackline Masters

BLM 1 – Lahal Tally Sheet
BLM 2 – Probability Terminology
BLM 3 – Playing the Stick Game
BLM 4 – Theoretical Probability
BLM 5 – Stick Game Tally Sheet
BLM 6 – What's Fair?

Activity 1: Learning the Game

Whether or not your students are familiar with Lahal, 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/Indigenous Education department in your school or 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 Indigenous and non-Indigenous 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 no one is available to demonstrate the rules of the game, use the video at https://www.youtube.com/watch?v=_BBHge8wzR0, as cited in the Context-Setting Introductory Material for Students.)

Formative Assessment

- Playing the game successfully with rules intact by both teams. Have a class tournament.
- Are the students able to remember the rules and point value? Do students understand how to tally points to keep track?
- What strategies are you using to reduce the probability of your opponent from winning the game?

Activity 2: Playing the Game

This activity enables students to derive an understanding of experimental probability.

> ***Resources and Materials***
> - BLM 1 – Lahal Tally Sheet

Once they understand how the game works, have students 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 experimentally the probability for each outcome (see BLM 1 – Lahal Tally Sheet).

As an alternative, you could 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.

Formative Assessment

- Completion of the data sheet and data analysis. What is the experimental probability of guessing the correct position of two, one, or none of the solid bones? Compare your data with others.
- Class discussion: Combine class data. What is the experimental probability of each outcome?

Activity 3: Finding the Probability in Lahal

> ***Resources and Materials***
> - BLM 2 – Probability Terminology

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.

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) =	$\frac{number\ of\ ways\ event\ A\ can\ occur}{total\ number\ of\ possible\ outcomes}$

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) X 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; 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 and B) = P(A) X P(B)

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

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.

Formative Assessment

- Calculate the theoretical probability of Lahal. How close or different is the experimental value?
- Class discussion: What do you notice when you compare the results of the data collected from your class experimental value to the theoretical probability value? Why are they the same or different?

Activity 4: Non-Mathematical Factors in Lahal (Class Discussion)

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.

Although Lahal seems to be a very simple 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 aspects students can explore:

- **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 analyze result records that note whether guesses take less than five seconds, five to ten seconds, etc.

Formative Assessment

- Exit Slip: After the class discussion, ask students to write down the three top factors that influenced them the most in choosing one, two, or no bones during the game and explain why the thought so.

Activity 5: Collecting, Displaying, and Analysing Data

Resources and Materials

- BLM 4 – Theoretical Probability
- BLM 6 – What's Fair?
- software graph generators: online resources (e.g., www.nces.ed.gov/nceskids/createagraph/) or spreadsheet programs such as Excel

The collecting and organizing of data are important aspects of statistics. 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 software spreadsheets/graph generators. Discuss with them the advantages and disadvantages of each form of data graphing for the data they have gathered.

Formative Assessment

Students produce different graphs that depict the data collected by hand or via technology. Ask students to compare their graphs with others in the classroom to see how they compared. Students can discuss in small groups or as a class which type of graph best depicts the data and why.

Activity 6: The Stick Game Alternative

Resources and Materials

- BLM 2 – Probability Terminology
- BLM 3 – Playing the Stick Game
- BLM 4 – Theoretical Probability
- BLM 5 – Stick Game Tally Sheet
- BLM 6 – What's Fair?
- online descriptions of some other First Peoples' games of chance (e.g., see http://www.mathcentral.uregina.ca/RR/database/RR.09.00/treptau1/index.html)

Beyond Lahal there exist other First Peoples' games of chance that can be used as a basis for teaching probability, including the Stick game described here, which could be used as an 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 Indigenous societies throughout North America that can be used to teach probability. 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 (e.g., at http://www.mathcentral.uregina.ca/RR/database/RR.09.00/treptau1/index.html), forming groups of three and having each group play the game, record their outcomes, and calculate scores using BLM 3 – Playing the Stick Game.
- reviewing BLM 2 – Probability Terminology 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 BLM 4 – Theoretical Probability and on BLM 5 – Stick Game Tally Sheet and then discussing the concepts, as suggested earlier in relation to Lahal
- challenging students to draw conclusions from their sticks games by responding to BLM 6 – What's Fair?

Optional Extension Activities

To reinforce students' understanding of probability calculations (or conduct assessment of their learning), challenge them to apply their understanding to other probability situations with First Peoples relevance. Examples include

- the likelihood of catching a specific species of salmon in a river that supports multiple species (e.g., provide students with a ratio or percentage of each species in a river and ask students to determine probabilities not only of catching a Coho, but of catching five Coho in a row – independent events).
- the birth of baby animals in the wild (e.g., 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 (e.g., 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").

Summative Assessment Suggestions

Have a Lahal tournament with the class and community members. Students form teams with community members and discuss strategy with team members on how best to play the game to win based on their knowledge of probability and other factors that may influence decision-making during the game. Students will confer with team members about best strategy, verified by their understanding of the math and game.

Students will submit their team strategy to the teacher (or tournament official) before the tournament begins. The class will engage in the tournament. Afterward, the class can discuss and reflect on "best strategies" and analyze if their strategy was the best and why (based on the outcome of the tournament).

Mini-Unit: Other Games

Context-Setting Introductory Material for Students

(for teacher-facilitated sharing in a whole-class setting)

The Beaver and the Frog Woman

http://www.angelfire.com/ca/Indian/BeaverandFrogWoman.html

Once in the long ago, Skel'aw' (beaver) had a large family of young men and not far from the beaver house, there lived a lone woman, Waxes was her name. It was during the wintertime, so it was very cold, and all the land was covered with snow. The ice was very thick on the waters.

Skel'aw called all of his children and he said to them, that they must go and gamble against the Iceman. I want you all to play hard and don't stop until you have defeated him. So, the young men went to gamble against Iceman. They continued playing very hard for two days and two nights without a break, so on the second night Skel'aw went to the home of the Frog Woman and told her that he wanted her for his wife.

She became very angry and she bitterly called him down. She struck him and told to get out. Skel'aw' becomes very sad and he began to cry, saying, "caha caha," and on his way home he could hear the voice of all his boys singing over their gambling. The chorus of their song was, "ice break open, ice break open". This they kept repeating as they continued playing and final the ice began to groan and crack. By the morning the water is open, and all the ice is gone.

When Beaver seen the open water, he dives into it and he swims around and leaps like a salmon. Soon the rains begin to fall, increasing in violence as Skel'aw' leaps and sings. In a short time, the water rises and enters the house of Frog Woman, who became, greatly alarmed for her safety. In her fright, she calls out to the Beaver. "I consent, Beaver, I consent, yes Beaver, I consent," she screamed.

The only notice Beaver takes of her now is to call back and say "Co! Co!" I am not such a bad fellow, after all, hey! you would like to marry me now, would you? The Frog's trying to reach the top of the roof. Beaver continues his plunging, leaping and singing. The water is just about to wash her (frog) off the roof top when a drifting log comes by. She immediately grabs the log, leaps upon it and is carried away.

After she was drifting around for some time, the log is finally beached; she sees a large house. She approaches the house and secretly peeps in. And in the house, she sees a man lying on the bed. He had a very round head and a big white face. This man was the Moon Man.

She enters the house and seats herself on the side of the fire farthest away from the Moon Man. The Moon Man said to her, "Come and sit at the foot of my bed." She answered him by saying, "Do you think I came here to sit at the foot of your bed?" Then the Moon Man said, "Come and sit on my lap." "Do you think that I came here to sit on your lap?" she replied. He then said, come then, and sit on my breast, perhaps that would satisfy you." "I never came here for that purpose either," was her reply to the invitation. "Well then, come and sit on my forehead," he said.

And to that invitation she gladly responds and quickly she jumped up on his forehead, where she has remained ever since. So ends the story of the Frog Woman.

Guiding Question

What is the probability of winning this game?

Applicable Blackline Masters

BLM 7 – Hubbub Rules
BLM 8 – Rules for Sticks in Hand

Hubbub

Hubbub, the bowl game, is a probability game played in the Okanagan. The objective of the game is to obtain the most points, while distracting or intimidating the other team. It is usually played at large gatherings with teams in a tournament style. This game can be played with pennies or rocks, but is traditionally played with peach pits where one side is decorated and the other is blank. You may find different versions of this game online from other First Nations outside British Columbia. Winning the game takes skill and luck.

Activity 1: Playing Hubbub

Play the game with the Okanagan point system using BLM 7 – Hubbub Rules.

Resources and Materials

- BLM 7 – Hubbub Rules

Activity 2: Devising a Different Point System

After playing the two versions of the game, have students develop their own point system or research another method online. Questions to consider:

- What would be the factors that influence the quantity of points per possible throw?
- How would the different rules affect the speed/momentum of the game?
- Do the new rules make the game easier to win? Harder? (Describe how.)
- With the new rules, would the game be fair to both sides? What is the new probability per throw?

Have students actually play the game, using the new scoring system. Afterward, have them reflect on the changes, asking, "Do you think the changes to the rules of the game 'improve' the game?" Introduce the concepts of independent events to calculate determine the probability of winning this game

Extension

Consider coding Hubbub to be played on a computer using programming software such as Scratch.

Sticks in Hand (Sto: lo Nation)

Another game of chance, Sticks in Hand, can be perceived as more difficult, because each turn changes the probability of subsequent events. Although what happens on each turn can be viewed as an independent event, the changing odds following each turn makes predicting a winning game quite complex and challenging. This game was used to develop a sense of intuition and observation, as players might come to learn the features of the sticks to increase their chances of winning. This game is often played at social events.

Activity 1: Playing Sticks in Hand

Play the game Sticks in Hand, using BLM 8 – Rules for Sticks in Hand. Allow the students time to play multiple rounds. Have students keep track of their points.

Resources and Materials
- BLM 8 – Rules for Sticks in Hand

Activity 2: Determining the Event

What is the probability of picking the marked stick on the first round? Have students write out the chances of choosing the marked stick for each round. With each iteration how does the probability change? What do you notice about choosing the marked stick as the game progresses?

Activity 3: Comparing Actual Results

Compare your results of a set number of games with another pair. What do you notice? How can you improve your results? Is there a "danger zone" to picking the marked sticks?

Activity 4: Predicting the Round

As a class, create a probability tree diagram for the game. What can the students predict as to when the game will end? Does the class data support this? Verify both mathematically and experimentally. Determine the odds, probability, and expected value.

Encourage students to play the game and
- identify independent and dependent events
- deconstruct the game to figure out the best strategy for winning

In follow-up (or concurrent) discussions, challenge students to support their decisions mathematically.

Formative Assessment

Pose questions such as
- How does the momentum of the game differ, if at all, when the point system changes?
- How are the two games of chance mathematically similar and mathematically different? (Justify your answer both mathematically and conceptually.)

BLM 1 – *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.			

BLM 2 – *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)

BLM 3 – *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

BLM 4 – *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

BLM 5 – *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: ____

BLM 6 – *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.)

BLM 7 – *Hubbub Rules*

Materials needed per pair: 5 peach pits (stones) one side coloured

bowl

50 sticks

- Hubbub was a game played with dice made from peach pits, one side of each seared black in the fire. Five peach pits are tossed in a bowl on the ground.
- The name Hubbub is from the cries chanted while the dice are uncertain. Traditionally the opponents would try to distract the other team by chanting or making noises such as "HUB HUB HUB".
- The person in control of the dice attains the number of points shown black. If the pits fall out of the bowl during the turn, start the turn again.
- Points are kept by taking sticks. Once the sticks are gone the game is over. Suggestion is to start with 50 sticks.
- Alternative points system from other locations:
    - 5 of the same colour = 3 sticks
    - 4 of the same colour = 1 stick
- Variations within the game include:
    - The individual with the most points at the end of a set number of rounds wins,
    - The individual with the most/least number of points is eliminated from each round until only one is left as winner.

BLM 8 – *Rules for Sticks in Hand*

Materials each: 9 sticks with no markings

1 stick with a marking close to the bottom

To be played with a partner.

Each participant holds the bundle of 10 sticks in one hand.

- One participant begins by drawing one stick from the bundle of the other person.
- If they draw a blank stick, they get 1 Point. The turn then goes to the other person to draw a stick from their participant's hand.
- The round ends when a participant draws the "marked" stick.
- The winner is the participant with the most points.
- Game can be repeated in hopes of participants improving their score.

Additional Resources

Classroom and Professional

Classroom Resources

Although there are many academic resources dealing with ethnomathematics and related education theory, the number of classroom support learning resources related to teaching mathematics from an Indigenous perspective is relatively limited. This brief list of Classroom Resources includes only items offering practical advice that can be immediately applied in a mathematics teaching situation (e.g., lesson planning ideas or math-related content accessible to middle-years students). 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 – http://acip.sd79.bc.ca/category/math/
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 focussed 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 — https://csdt.org/culture/legacy/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 colours. 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 — https://csdt.rpi.edu/culture/legacy/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 colours. 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) – https://paveonline.pwsd76.ab.ca/course/index.php?categoryid=13
This school district-designed site has some good Indigenous 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.

Aboriginal/Indigenous Access (Faculty of Engineering and Applied Science, Queen's University) – www.aboriginalaccess.ca
This award-winning website 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.

Deepening Knowledge (Oise) – https://www.oise.utoronto.ca/deepeningknowledge/Teacher_Resources/Curriculum_Resources_%28by_subjects%29/Math/index.html
Housed by the University of Toronto, OISE, this is a set of Indigenous teacher classroom resources with possible ideas to expand upon. Some of this collection can also be used for personal professional development.

Perspectives (Manitoba government) – http://www.edu.gov.mb.ca/k12/abedu/perspectives/resources.html
This site is a suggested lesson plan, ideas and resource compilation for the Aboriginal/Indigenous Education department of the Government of Manitoba. There are multiple grades and subject areas listed.

Aboriginal/Indigenous Perspectives (U Regina) – http://aboriginalperspectives.uregina.ca/workshops/workshop2010/
Housed by the University of Regina, this is a comprehensive site with multiple numeracy ideas, information and games. This information is easy to follow and offers multiple entry points.

Alaska Math Resources

Picking Berries – https://www.amazon.ca/Picking-Berries-Connections-Collection-Measuring/dp/1550592947/ref=sr_1_3?qid=1563565114&refinements=p_27%3AJerry+Lipka&s=books&sr=1-3

Salmon Fishing – https://www.amazon.ca/Salmon-Fishing-Investigations-into-Probability/dp/1550593056/ref=pd_sim_14_3/140-2541852-0670529?_encoding=UTF8&pd_rd_i=1550593056&pd_rd_r=20f46935-5abd-48fe-9cee-4d76a611a56e&pd_rd_w=giLwz&pd_rd_wg=8W3YS&pf_rd_p=29a85b27-a36a-4f8d-94ca-

61aa962c5f39&pf_rd_r=APH8NFNXNZWY9BGAB5AZ&psc=1&refRID=APH8NFNXNZWY9BGAB5AZ

Drying Salmon – https://www.amazon.ca/Drying-Salmon-Journeys-Proportional-Pre-Algebraic/dp/1550593307

Meta-resources: BC Websites that have Links to Additional Classroom Resources

BCAMT – https://www.bcamt.ca/first-peoples-resources/

BC Numeracy Network – https://sites.google.com/view/bc-numeracy-network/connections/how-do-i-weave-through-the-first-peoples-principles-of-learning?authuser=0

Indigenous Mathematics K-12 Network – http://blogs.ubc.ca/aboriginalmathnetwork/

BC Indigenous Education Resource Inventory – https://curriculum.gov.bc.ca/sites/curriculum.gov.bc.ca/files/pdf/indigenous-resources-inventory.pdf

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

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."

Nicol, C. & Yovanovich, J. (2011). *Tluuwaay 'Waadluxan': Mathematical adventures*. Skidegate, BC: Haida Gwaii School District 50.

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.

Professional Resources

Pedagogy Resources

The BC Graduation Numeracy Assessment

Recognizing that the BC Ministry of Education has recently (2017) introduced the BC Graduation Numeracy Assessment (GNA) as a new graduation requirement (i.e., not to replace a provincial mathematics exam, but to assess numeracy across disciplines) you may find it helpful to consult the BC Ministry of Education website for additional support (https://curriculum.gov.bc.ca/provincial-assessment). This contains current, updated information about design specifications for the assessment, sample assessment questions and information for teachers, students and families.

Barta, J., Eglash, R., & Barkley, C. A. (2014). *Math is a verb: Activities and lessons from cultures around the world*. National Council of Teachers of Mathematics, Incorporated.

Barton, B. (1996). Making sense of ethnomathematics: Ethnomathematics is making sense. *Educational Studies in Mathematics*, 31, 201-233.

Castango, A.E. & Brayboy, B.M.J. (2008). Culturally responsive schooling for Indigenous youth: A review of the literature. *Review of Educational Research*, 78 (4), 941-993.

Gear, Alison L. (2012). A cultural introduction to math. *Teaching Children Mathematics*, 18 (6) February 2012, 354-360. (available via www.nctm.org)

Greer, Brian; Mukhopadhyay, Swapna; Powell, Arthur B.; Nelson-Barber, Sharon – Editors (2009). *Culturally Responsive Mathematics Education*. Routledge (available via https://www.amazon.ca/Culturally-Responsive-Mathematics-Education-Brian/dp/0805862641)

Gutiérrez, R. (2018). Rehumanizing Mathematics for Black, Indigenous, and Latinx students. *Annual Perspectives in Mathematics Education.* Reston, VA: National Council of Teachers of Mathematics.

Gutstein, Eric (Rico) & Peterson, Bob – Editors (2nd ed., 2013). *Rethinking Social Justice: Teaching Mathematics by the Numbers*. A Rethinking Schools Publication (available via https://www.amazon.ca/Rethinking-Mathematics-Teaching-Justice-Numbers/dp/0942961552/ref=sr_1_1?keywords=rethinking+mathematics&qid=1563569789&s=gateway&sr=8-1)

Lipka, J., and Adams, B. (2004). Culturally based math education as a way to improve Alaska native students' math performance. ACCLAIM Research Initiative, Ohio University. (available via https://eric.ed.gov/?id=ED484849)

Lipka, J., Sharp, N., Adams, B., & Sharp, F. (2007). Creating a third space for authentic biculturalism: Examples from math in a cultural context. *Journal of American Indian Education*, 46(3), 94-115.

Lipka, J., Sharp, N., Brenner, B., Yanez, E., & Sharp, F. (2005). The relevance of culturally based curriculum and instruction: The case of Nancy Sharp. *Journal of American Indian Education*, 44(3), 31-54.

Nicol, C., Archibald, J., & Baker, J. (2010). Investigating culturally responsive mathematics education. Report to the Canadian Council on Learning. accepted April 2010. (available at https://www.researchgate.net/publication/267954541_Investigating_Culturally_Responsive_Mathematics_Education)

Nicol, C., Archibald, J.A., & Baker, J. (2013). Designing a model of culturally responsive mathematics education: place, relationships and storywork. *Mathematics Education Research Journal*, 1-17.

Stocker, David (2017). *Math that Matters*. Toronto (available via https://www.strongnations.com/store/item_display.php?i=6397&f)

Why We Need to Rehumanize Mathematics? https://www.researchgate.net/publication/325828845_Why_we_need_to_rehumanize_mathematics

Cultural Knowledge Resources

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