June 6, 2022

Haa Shuká Tundatáani: The Tlingit Canoe & the Story of Kaax'achgóok

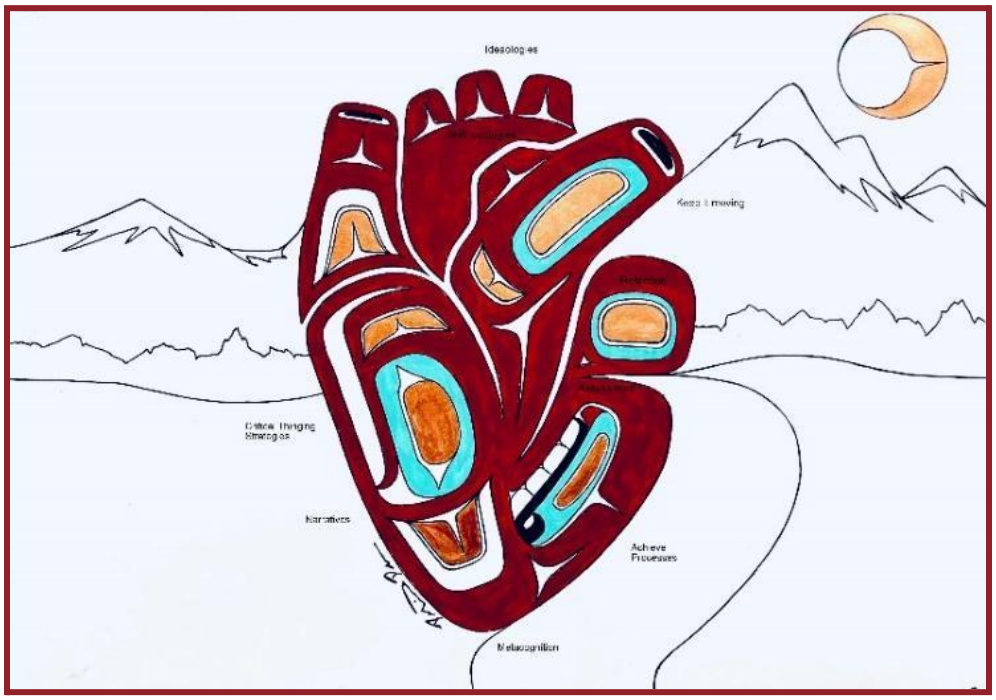

Figure 1: Design Attributions - Yanÿeidí, Design by Delfine Decker, Goldbelt Heritage Foundation

An Indigenous Framework for Learning

Haa Shuká Tundatáani represents a way of learning and understanding that connects us as people with the histories that have formed us, the knowledge we share today, and the world delivered by our future selves for future generations. This Indigenous framework seeks to heal.

This framework is designed around the heart at the center of existence, pumping what has existed before into what will exist in the future through the practice of listening, learning, and creation. This cycle of learning and belonging is in each of us and calls to be acknowledged and fostered by our surroundings and histories. Gunalchéesh, thank you to the Yanyeidi whose story guides the visual representation and philosophy behind the heart of our learning framework and its existence rooted in landscapes.

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UNIT PLAN
Ideologies
Haa Shuká Tundatáani: This unit seeks to blend the traditional canoe knowledge of the Tlingit people with modern mathematical concepts. Through connections with the oral narrative, Kaax'achgóok, students will expand mathematical understandings through an interdisciplinary, project-based approach. The history included in this unit is that of the Northwest canoe, one of the most enduring symbols associated with the Tlingit people of Southeast Alaska. The canoe, in its various forms, was the technological foundation of the Tlingit way of life. According to anthropologists, these wooden dugout vessels have been around for at least 10,000 years. Canoes provided access to the wealth of the ocean and allowed the Tlingit to overcome the geographical isolation created by the mountains, glaciers, and fjords of the northwest coast of North America. Construction of a canoe was a specialized skill, transmitted from generation to generation. The large Northwest canoe appears to have originated among the Haida, who had access to the large red cedar trees which grew in what today is British Columbia. As a result of the continuous contact brought about by trade and intermarriage, the Tlingit gradually adapted the Haida canoe designs to their own needs. Traditional carvers made use of stone adzes and fire to burn and hew out the center of a large spruce or cedar log. The Tlingit artisans then would shape the sides and ends of the canoe. Until the end of the 19th century, thousands of canoes of various sizes traversed the channels, inlets, and the open ocean along the northwest coast. However, during the 20th century, the traditional Tlingit canoe has been replaced by motorized skiffs and a variety of other vessels. But the traditional Tlingit canoe remains an important marine technological development which allowed the Native people of the northwest coast to survive and prosper, despite the challenges posed by climate and geography.
Unit Name & Level of Integration Required: • L1 - this unit is off-the-shelf with materials that can be found in most classrooms or schools.

Unit Author & Contact: Author: Paul Berg Photo Credits: Virginia Berg Editor: Tiffany La Rue	**Originating Source :**
Grade Range & Subject: Grade 7 -12: Math, History, Literature, and Writing	**Time and Timing:** 3-4 weeks
Materials:	

*Copies of the original student packet and teacher materials are included. In addition, Tlingit canoe vocabulary and boat design background information is provided.

Other Materials Needed:

- A copy of the oral narrative, Kaax'achgóok, as told by Andrew P. Johnson in Haa Shuka, Our Ancestors by Nora and Richard Dauenhauer (pgs. 83-107)
- 8x11 sheet of paper for each student
- Model Tlingit Canoe (a beautiful, mathematically accurate miniature canoe is held by GHF and available to loan out to classrooms for this unit)
- Accompanying student pages (provided in each lesson block in Atlas)

Essential Questions:

- What is the significance of Tlingit canoes?
- What mathematical connections exist between the Tlingit canoe design and other boat designs?

Student Skill Sets & Understandings to Be Developed:

- Students will be able to compare and contrast oral and written history.
- Students will be able to explain the significance of the canoe to the Tlingit people
- Students will be able to recognize and define nautical vocabulary terms.
- Students will be able to make a paper model canoe.
- Students will use mathematical expressions to calculate boat capacity, dimensions, and hull depth of Tlingit canoes.

Standards / Established Goals:

- *Ratios and Proportional Relationships 7.RP: Analyze proportional relationships and use them to solve real-world and mathematical problems.*
- *Geometry 7.D: Solve real-life and mathematical problems involving angle measure, area, surface area, and volume.*
- *HS N-Q.1. Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays*
- *HS A-SSE.1. Interpret expressions that represent a quantity in terms of its context.*

Methodologies

Methodologies

- Kinesthetic learning
- Project-based

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Subject / Course: Math, Literacy

Grade Range: 7th-12th

Time: 3-4 weeks

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Cultural Engagement: The oral narrative, Kaax'achgóok, is an exemplary piece of great literature due to it's timelessness, universal themes, communication across culture, the Hero's Journey, and instructive properties. The history and cultural lessons shared by the retelling of Kaax'achgóok creates a strong foundation for exploring the creative problem-solving methodologies of mathematics within the familiar setting of Tlingit Aani. Southeast Alaska way of life also promotes close interactions with waterways. By comparing and contrasting Tlingit canoe design with other contemporary boat designs, students will have opportunities to create connections to everyday tools.	**Elder / Culture Bearer Role:** ● As an alternative to reading a copy of the oral narrative, Kaax'achgóok, as told by Andrew P. Johnson. (Haa Shuka, Our Ancestors by Nora and Richard Dauenhauer), an elder can share the oral narrative with students. ● Tlingit canoe designers and carvers would be a welcomed guest for this unit ● Tlingit fishermen/fisherwomen with experience with various boats could speak to contemporary design challenges and opportunities
Integrated Media Element(s): Raven Spirit: A Native American Canoe's Journey	
Critical Thinking Strategies	
Home Connections: By making a model of a Tlingit canoe, students can bring home their models to share with families. Additional lesson extensions could include students helping a younger sibling, cousin, or community member make a similar model to explain the mathematical connections in their own words.	
Unit Progression & Lesson Descriptions 1. Unit Background Information 2. Lesson One: The Tlingit Canoe in Oral History 3. Lesson Two: Introduction to the Tlingit Canoe 4. Lesson Three: Canoe Math 5. Lesson Four: Canoe Math Continued 6. Assessment: Tlingit Canoe Unit Test	
Developing Critical Thinkers: ● Student-led discussions	

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- Problem-based learning

Tlingit Phrases:

- Toowú klagé haa t'aakx'í, ka haa naax sateeyí, ka haa kusteeyí: Pride in Family, Clan and Traditions is found in Love, Loyalty and Generosity (Pride in our family and our clan and our traditions)

Pinnacle Vocabulary:

- Tlingit Phrase: Kaax'achgóok át nakuxji yé áyá. English Translation: This is the place where Kaax'achgóok hunts.
- Tlingit Phrase: Tle a káa yan yasatán! English Translation: Set your bow on it!
- Tlingit Phrase: Yindei naytsóow yee axáayi. English Translation: Push your paddles way down.

Check for Understanding

Culminating Community Building Activity Project:

Formative Evaluation:	**Summative Evaluation:**
Checks for understanding of canoe math throughout unit.	Tlingit canoe unit test.

Reflections

Student Self-Reflection:
In learning about great literature and oral narratives, students will have an opportunity to self-reflect on the experience and learnings of Kaax'achgóok as it relates to their own lives.

Educator Notes & Reflections:

Acknowledgements:

scroll down for lesson template (copy and paste to duplicate the template for additional lessons).

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Learning Plan	
Lesson Number & Title: Unit Background Information	**Time & Timing:** For use throughout the unit
Materials Needed: • Canoe vocabulary • Tlingit Canoe facts • Hull Designs	

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Learning Plan	
Lesson Number & Title: Lesson One: The Tlingit Canoe in Oral History (3 Activities)	**Time & Timing:** For use throughout the unit ~3 class periods ● Session 1 – Engage, Explore and Explain 40-60 minutes ● Session 2 – Elaborate 40 to 60 minutes (could be expanded into 2 class sessions if so desired) ● Session 3 – Evaluate 30 minutes
Vocabulary: ● *Tlingit Phrase:* Kaax'achgóok át nakuxji yé áyá. *English Translation:* This is the place where Kaax'achgóok hunts. ● Oral narrative ● Hero's Journey ● Sea anchor	
Objectives: ● Students will be able to compare and contrast oral and written history. ● Students will be able to define the vocabulary words and use correctly in sentences. ● Students will be able to explain the significance of the canoe to the Tlingit people. ● Students will list and describe five characteristics of great literature.	
Materials: ● Book: Haa Shuka, Our Ancestors by Nora and Richard Dauenhauer, (Kaax'achgóok, pgs. 83-107) ● Digital PDF available here: https://tlingitlanguage.com/wp-content/uploads/2015/01/Dauenhauer-1987-Haa-Shuk%c3%a1.pdf ● Tlingit Canoe Teacher Packet: "Lesson One" ● Tlingit Canoe Student Packet: "Lesson One"	
Lesson Progression: Hook The history included in this unit is that of the Northwest canoe, one of the most enduring symbols associated with the Tlingit people of Southeast Alaska. The canoe, in its various forms, was the	

technological foundation of the Tlingit way of life. According to anthropologists, these wooden dugout vessels have been around for at least 10,000 years. Canoes provided access to the wealth of the ocean and allowed the Tlingit to overcome the geographical isolation created by the mountains, glaciers, and fjords of the northwest coast of North America. Construction of a canoe was a specialized skill, transmitted from generation to generation. The large Northwest canoe appears to have originated among the Haida, who had access to the large red cedar trees which grew in what today is British Columbia. As a result of the continuous contact brought about by trade and intermarriage, the Tlingit gradually adapted the Haida canoe designs to their own needs. Traditional carvers made use of stone adzes and fire to burn and hew out the center of a large spruce or cedar log. The Tlingit artisans then would shape the sides and ends of the canoe. Until the end of the 19th century, thousands of canoes of various sizes traversed the channels, inlets, and the open ocean along the northwest coast. However, during the 20th century, the traditional Tlingit canoe has been replaced by motorized skiffs and a variety of other vessels. But the traditional Tlingit canoe remains an important marine technological development which allowed the Native people of the northwest coast to survive and prosper, despite the challenges posed by climate and geography.

Building Understanding

Session #1: Engage

1. Begin this lesson by asking your students if any of them have ever been lost. What were the circumstances? How long were they lost? How did they feel when they were lost? Allow time for two or three students to respond with their experiences.

2. Next, tell the class that they are going to hear a Tlingit oral narrative account of group of hunters who became lost. Explain that this is not a fictional story but rather an actual historical account of events which took place among a group of Tlingit people near modern day Sitka.

Session #1: Explain

Before reading the oral narrative, explain the following to your students:

1. The most ancient historical records are not found among Egyptian hieroglyphics or Sumerian cuneiform script. Oral historical narratives, passed down from generation to generation, are the oldest historical accounts. Oral historical narratives predate written history by thousands of years.

2. The Tlingit people did not have a written language. Like most people in oral cultures, the Tlingit had well developed visual and oral memories. The history, the stories, and the culture were transmitted from one generation to the next through oral narratives. The Tlingit recorded their history in their memories.

3. Many Tlingit historical narratives are very ancient. Several of the Tlingit oral narratives describe historical events which took place the end of the last ice age.

4. The Tlingit language is a very sophisticated and complex language. Tlingit speakers use many metaphors to express ideas and shades of meaning. The language is highly visual and especially adept at expressing locational orientation—an important adaptation for a people living among mountains and near beaches. While the English language developed over the past 800 years, linguists estimate that the Tlingit language may date back as far as 10,000 years.

5. The narrative you are about to hear relates the adventures of a Tlingit hunter named, Kaax'achgóok. He and his nephews encounter a terrific storm while out hunting in their canoe.

Session #1: Explore

1. Introduce the Tlingit Oral Narrative, Kaax'achgóok, as told by Andrew P. Johnson. (Haa Shuka, Our Ancestors by Nora and Richard Dauenhauer.) Before reading the selection, you may want to share additional information about oral narratives.

2. Distribute the Kaax'achgóok Oral Narrative note sheet to each student. Direct them to take notes as the narrative is read.

3. Either read Kaax'achgóok to students or have student readers take turns reading the oral narrative to the class. At the end of the reading, allow time for your students to complete the Kaax'achgóok Notes sheet. If the period is ending before this is completed, have your students complete Kaax'achgóok Notes as their homework.

4. Class Discussion: After students have listened to the reading of the Kaax'achgóok oral narrative and completed the Kaax'achgóok Notes, conduct a class discussion. Use the Teacher Copy of the Kaax'achgóok Notes as a guide for the discussion.

Several additional discussion questions to expand the discussion:

• What caused the hunting party to get lost?

• How long were the men away from home? (Approximately a year)

• How did Kaax'achgóok and his nephews survive?

5. Lesson 1 Vocabulary: Hand out a copy of the Canoe Unit Vocabulary sheet to each student. Define the Lesson 1 Vocabulary Words on the board together as a class. Many of students may not be

familiar with nautical terms such as sea anchor and classmates can assist with colorful definitions based on the narrative or their own experience. Have student write down the meaning of each of the six vocabulary terms in Lesson 1.

Concluding Activity

Session #2: Lesson Extension Option One

Organize the class into five groups. Assign each group one of the following challenges to consider:

1. It is estimated that Kaax'achgóok's hunting party consisted of up to nine men in a cedar canoe. They returned home with supplies and many furs. What does this tell us about their canoe in terms of size, sturdiness, and seaworthiness? What would you estimate the dimensions of a craft large enough for nine men and their supplies? Be as specific as you can. (Do some calculations and estimate dimensions.)

2. Based on the information in the narrative, identify at least two possibilities for the place where the hunting party made landfall. Make a case for one of these as the most likely. Calculate the round trip distance for the voyage.

3. What does the oral narrative tell us about Kaax'achgóok's character? How does the narrative document changes in his character? Is he a heroic figure? Give examples and support your position.

4. Explain how the themes of this oral narrative are universal (applicable to situations and people today). Identify the themes and give examples.

5. Identify and describe several of the scientific, historical, cultural insights, or the moral lessons included in this narrative? (Possibilities: The narrative begins with a narrative frame—the line of inheritance through the maternal line. Oral literature contains detailed information about traditional technology and hunting skills. Species of hunted animals are identified. The use of the stars for navigation documents a sophisticated scientific knowledge of celestial navigation. On the voyage home the hunters made use of a sea anchor (line 295) to control their drifting at night. The narrative is also a psychological drama which reveals exemplary character and the ability to overcome major challenges.) Inform each group that they have 20 minutes to consider their issue related to the oral narrative. Give each group a copy of the oral narrative (if available) and their topic to analyze. Have each group select a moderator to lead the group discussion and a recorder to record the group's ideas. Each group selects two or three people to present their analysis and conclusions to the class (or if you prefer, have the whole group present to the class). Encourage the presenters to use the white board, graphics, or visual media for their presentations. After the presentations, have your students do a five minute fast-write in their journals summarizing the most

important insight/s they have gained from hearing and analyzing the oral narrative, Kaax̲'achgóok.

Session #2: Lesson Extension Option Two

Share this with your students: Great literature, whether fiction or non-fiction, generally includes several of the following characteristics:

-Timelessness: Great literature is understood and appreciated across time and across generations. Although the characters may have lived at a different time and in a different culture, their actions speak to us today.

-Universal Themes: The theme is the underlying meaning of a piece of literature. A literary selection may present more than one theme. Good literature does not actually tell you what the theme is—you determine the theme from the characters' actions.

-Communicates Across Cultures: Great literature communicates ideas and useful information across cultures.

-The Hero's Journey: The main character begins a long journey and overcomes major obstacles and challenges. The main character is transformed by the experience in a way that benefits not only him, but his community.

-Teaches the Reader: Great literature is instructive. It teaches us about human behavior, motivation, weakness and strength. We can learn about human nature, history, ethics and a host of other topics from great literature.

Ask your students the following question: Based on these five criteria, how would you rate Kaax̲'achgóok? Does this oral narrative qualify as great literature? (Note—you may need to clarify for some students that you are not asking them for their personal opinion as to whether Kaax̲'achgóok is great literature. Rather, you are asking them to evaluate the piece based on the presence or absence of any of the above five criteria. This may be a new experience for many of your students and they may have difficulty grasping the concept of evaluation based on criteria.) A lively discussion should ensue.

Session #2: Lesson Extension Option Three

Have your students write responses to the following in their journals. Suggestions — allow five minutes for students to write their response to each of the writing prompts. Call on students to share their responses with the class.

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Questions:

• What themes or ideas in this oral narrative are timeless, that is, meaningful across the gulfs of time, distance, and culture?

• What challenges did Kaax'achgóok have to overcome?

• In what ways is Kaax'achgóok a hero?

• In your opinion, what is the most important lesson that this narrative teaches?

• Why is it important?

• Describe the insights into Tlingit culture that you gained from this historical narrative.

• Describe how Kaax'achgóok's character changes and grows in the narrative. Does he undergo character development? If so, in what ways?

• Contrast the character of Kaax'achgóok's two wives.

(Response to Questions # 6-- Kaax'achgóok is originally too fearful to hunt. He even breaks all his hunting tools. His young wife is reduced to begging. He is humiliated by this and begins hunting. He succeeds in overcoming his fears by successfully leading his lost hunting party on long voyage home. He navigates by the stars successfully. He forgives his young wife and shares the riches from his voyage with his village.)

Session #3: Evaluate

Ask students to respond to one or more of the following questions. You may choose to do this as a class discussion, have students write responses in their notebooks, or assign this as a formal writing activity.

Writing: What did you learn from this this oral narrative? Describe several insights which you have gained.

Writing: In your journal, describe how Kaax'achgóok's character changed throughout the narrative.

Art/Writing: Draw a scene from the narrative. Write one or two paragraphs to describe what is happening in the scene.

Tlingit Science: The Tlingit were sophisticated hunters, fishers, navigators, and boat builders.

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Support this statement based on information from the narrative.

Written Response or Class Discussion: How we make more effective use of oral narratives as we live in a world flooded with electronic media and superficial entertainment.

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Learning Plan	
Lesson Number & Title: Lesson Two: Introduction to the Tlingit Canoe (3 Activities)	**Time & Timing:** ~1-2 class periods

Vocabulary:

- *Tlingit Phrase:* Tle a káa yan yasatán! *English Translation:* Set your bow on it!
- bow
- stern
- beam
- freeboard
- buoyancy
- gunwale
- tracking
- port
- starboard

Objectives:

- Understand the importance of the Tlingit Canoe as a tool and cultural symbol
- Make a paper model canoe
- Learn canoe nomenclature
- Learn nautical vocabulary terms

Materials:

- Canoe Journey Video: https://ocean.si.edu/human-con...
- 8x11 sheet of paper for each student
- Model Tlingit Canoe (available on loan by GHF)
- Tlingit Canoe Vocabulary and Boat Design Facts
- Tlingit Canoe Teacher Packet: "Lesson Two" - link in lesson one block
- Tlingit Canoe Student Packet: "Lesson Two" - link in lesson one block
- Paper Canoe Folding Directions

Lesson Progression:

Hook

Ask students:

1. What technological knowledge and devices did Kaax̲'achgóok and his crew rely on to return to Alaska? (knowledge of celestial navigation, sea-going canoe, paddles, sea anchor, etc.)

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2. What did Kaax̲'achgóok warn his crew to take good care of? (the canoe)

3. Canoes today are used in lakes and small streams. Kaax̲'achgóok's canoe allowed his hunting party to survive an open ocean voyage over large distances. How might Kaax'achgóok's vessel have differed from modern canoes?

Building Understanding

The Tlingit canoe was the primary mode of transportation in Southeast Alaska. The canoe was the most important tool which allowed the Tlingit to survive and prosper. Canoes were used for hunting, fishing, traveling, trading, social gatherings, ceremonial events, and war. Even today, our modern canoes (from small boats to Alaska State Ferries), along with airplanes, are the primary mode of transportation in Southeast.

Activity #1

View the "YouTube" video, Launching the Raven Canoe at the Museum of Natural History. On June 19, 2008, The Smithsonian's National Museum of Natural History (NMNH) and the Sealaska Heritage Institute held a formal naming and welcoming celebration for a new ocean-going cedar log canoe that has been especially carved for inclusion in the Sant Ocean Hall at the National Museum of Natural History.

The Raven Canoe, a 26 foot long Tlingit dugout canoe was carved by Tlingit artist, Douglas "Kevin" Chilton (Deisheetaan Clan) and his team. Over the course of a year, Tlingit Master Carver Douglas Chilton shipped away at a cedar log with traditional tools, gradually transforming a 26 foot long log into a traditional ocean going canoe. For additional information and pictures of the canoe, go to http://ocean.si.edu/ocean-stor...

Activity #2

Distribute a copy of the Tlingit Canoe Fact Sheet to students. As you and your students discuss the main points of the fact sheet, displacement the wooden Tlingit Canoe Model from the materials kit. The model is an accurate hand-made replica of a Tlingit canoe. (Note--please do not hand this around the room as it will be dropped and broken.)

Concluding Activity

Activity #3

1. Enquire is students are familiar with Origami? Then tell your students that they are going to do an origami paper activity to make a simple model canoe out of paper. Distribute the paper and instructions provided. Have students work together and help each other as they make a paper model of a Tlingit canoe. 8.5 X 11 inch paper will work fine for this activity. Another option is to use larger sheets of paper, even poster board, to make a larger model.

2. Ask your students to imagine how big their canoe would be in the real world. (The maximum size of a Tlingit canoe was about 70 feet long.) Tell your students to assign a scale to their paper model using inches and feet. For example: one inch = three feet, or a ratio of one to thirty-six. Have your students write the scale on the paper canoe. This information will be used in a later lesson in this unit. (Tell your students to keep their paper model in their notebooks at the end of this lesson, as they will be using the paper model again in Lesson 4.)

3. Have students open their notebooks to the Canoe Vocabulary page. Define/demonstrate/discuss Lesson #2 vocabulary terms. Use the paper models to illustrate the terms: bow, stern, beam, freeboard, buoyancy, displacement, gunwale, tracking, port, and starboard. Have students write the definitions.

Discussion points to add during these presentations:

-Why is a double ended canoe a practical design for SE Alaska?

-In what ways was a large canoe a cultural symbol for a community?

-Can we identify cultural symbols which communities make use of today?

Students respond to these open ended questions either in whole class discussion or as a writing activity in their notebooks:

1. What is the Tlingit word for canoe? *Yaakw*

2. Define/discuss several of the vocabulary terms. Use the model canoe to illustrate several of the vocabulary words.

3. Describe the importance of the Tlingit canoe:

a) Used as a tool,

b) Used as a symbol,

c) Used as a means of fostering and sustaining community pride.

4. Describe several of the design adaptations of the Tlingit canoes for Southeast Alaska coastal waters.

5. Western Red Cedar was a favored wood for canoe making. Why? The wood is strong and light. It

has a straight grain and few knots.

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Learning Plan	
Lesson Number & Title: Lesson Three: Canoe Math (4 Activities)	**Time & Timing:** ~1-2 class periods

Vocabulary:

- *Tlingit Phrase*: Aadéi yanal.á! *English Translation:* Steer toward it!
- following sea
- boat capacity
- capacity plate
- ratio
- freeboard

Objectives:

- Students will determine Maximum Boat Capacity based on dimensions of a canoe
- Students will calculate canoe dimensions by using the Length to Width Ratio
- Students will calculate hull depth based on the Length and Width of a canoe

Materials:

- Model Tlingit Canoe (available on loan by GHF)
- Tlingit Canoe Vocabulary and Boat Design Facts
- Tlingit Canoe Teacher Packet: "Lesson Three" - link in lesson one block
- Tlingit Canoe Student Packet: "Lesson Three" - link in lesson one block

Lesson Progression:

Hook

1. Introduce the idea of Boat Capacity to your students by describing the following nautical events: A ferry boat designed to carry no more that 350 passengers sinks while carrying over 500 people between two islands in the Philippine archipelago.

- A 32 foot tour boat on an Illinois lake capsizes when the 28 tourists gather at one side of the boat watch a water skier pass by.
- In 1945 the German cruise liner, Willhelm Gustloff, sinks in frigid Baltic Sea waters with 10,600 people aboard, resulting in the largest loss of life (over 9,000) ever recorded in a single maritime disaster. (Note:
  Google Wilhelm Gustloff. There are several excellent web sites about this greatest of all maritime tragedies.)

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2. Ask the question: “What did all these incidents have in common?” (Answer: The boats were all unsafely overloaded.)

3. Enquire if students have observed small skiffs or boats which have been overloaded in the waters near Juneau. Allow time for student responses. (Overloading a small skiff, especially during rough weather, is especially dangerous.) Small overloaded skiffs with square sterns are susceptible to being swamped by waves from a following sea breaking over the stern.)

Building Understanding

4. Explain to your students that most modern boats, from Lund skiffs to large vessels like the Malaspina, all have either a small metal capacity plate or a large sign which indicates the vessels maximum capacity. The Tlingit didn’t have a capacity plate on their canoes, but through hundreds of years of trial and error, they developed a sophisticated understanding of the capacity limitations of various sizes and types of canoes.

From years of experience, the Tlingit adapted the canoe to the sea conditions of the northern west coast of North America. Modern pleasure boats generally have a square stern which makes them unstable in a following sea. The Tlingit Canoe was double-ended which made them much more stable in a following sea. They were capable of cutting through and riding over a following sea, with much less danger of being swamped by a wave over the stern.

The Tlingit designed their canoes from a building tradition thousands of years old. Canoe building skills were passed down from generation to generation. Canoes were built without the aid of higher mathematics, complex drawings or metal tools. Yet the vessels were well adapted to the rapidly changing currents and coastal weather conditions of Alaska.

Activity #1: Vocabulary

Have students open their notebooks to the Canoe Vocabulary page. Define/demonstrate/discuss the Lesson 3 vocabulary terms.

Activity #2: Boat Capacity

Tell students that modern boat builders use mathematics in the process of designing and construction boats. One of the mathematical aids is a simple formula for calculating the potential capacity of small boat or canoe.

(Remind students that overloading small boats is one of the major causes of boat accidents and fatalities in Alaska.) The formula for calculating boat capacity is: Length x Width/15 = Capacity. Capacity is expressed as the number of adults who can safely be accommodated aboard the vessel. The formula assumes that the average person weighs about 150 pounds. Demonstrate this formula

for on the board with the following example:

A Red Cedar canoe has a length of 20 feet and a width of:

3 feet. (Length) 20 feet x (Width) 3 feet = 60 feet / 15 = 4 person capacity.

Hand out the Lesson 3, Activity 1, Boat Capacity to students. Allow students to work individually or in pairs. Go over the results in class. (See Lesson 3, Math Activity 1 KEY.) At the end of this activity remind students that the concept of boat capacity is very important. One of the most hazardous activities in Southeast waters is to go out on a small boat which is overloaded.

Activity #3: Beam to Length Ratio
Have copies of Lesson 3, Math Activity 2: Beam to Length Ratio available for your student. Before distributing this assignment to the class, present the following information to your students:

1. Tlingit canoe builders designed their canoes to be very seaworthy. Since they were dugout canoes from a single log, they were long and thin. Consequently, one of the distinguishing features of the Tlingit canoe hull was the distinctive beam to length ratio.

2. Modern powerboats usually have a beam to length ratio between 1 to 3 and 1 to 4. Consider a power boat with a length to beam to length ratio of 1 to 3. If the beam (the maximum width of the boat at the widest part) were 6 feet, the length would be 18 feet. Ask your students to consider what the length of a power boat would be with a beam to length ratio of 1 to 4 if the beam were 8 feet. (32 feet)

3. The Tlingit canoe usually had a beam to length ratio somewhere in the neighborhood of 1 to 7. (This ratio varied from a low of 1 to 6 to as high as 1 to 8.) This ratio was one of the reasons for the seaworthiness of the Tlingit canoe. The long, thin shape gave the Tlingit canoe remarkable seaworthy characteristics. The larger canoes could cut through waves, yet were long enough to rock over ocean swells. The design proved seaworthy enough to take Kaax'achgook and his nephews on a long voyage on the open ocean.

4. Assume that the ideal Tlingit canoe of any length has a 1 to 7 beam to length ratio. Given the beam, calculate the length of several canoes. (Do the following calculations on the board with your students.)

Canoe #1 – The beam is 3 feet. What is the length?

1/7 = 3/X Where x is the unknown factor. Explain to your students that we cross multiply to find the

unknown (X) in a proportion.

1/7 = 3/X

1X = 3 x 7

X = 21 feet

Canoe #2 – The beam is 4 feet. What is the length?

1/7 = 4/X

1X = 4 x 7

X = 28 feet

Canoe #3 – The beam is 6.5 feet. What is the length?

1/7 = 6.5/X

1X = 6.5 X 7

X = 45.5 feet

5. Now—Distribute Lesson 3, Activity 2, Beam to Length Ratio. Have student do this short activity in class. Go over the calculations in class using the KEY (Teacher Copy) of Lesson 3, Activity 2.

Concluding Activity

Activity #4: Tlingit Canoe Hull Dimensions and Capacity

1. Introduce the relationship between hull width and depth to your students: The Tlingit canoes were approximately twice as wide as they were deep, a 2 to 1 ratio. A canoe with a maximum outside width of six feet would be approximately three feet deep.

Another Example:
maximum Hull Width of a large canoe is 7 feet Hull Depth is ½ of 7 feet (3.5 feet)

2. Hand out Lesson 3 Activity 3, Tlingit Canoe Hull Dimensions and Capacity to the students. In this activity, the students calculate Beam Width, Hull Depth, and Capacity based on the length of a canoe hull

and the ratios that have been introduced. Allow time for students to do these calculations in class.

Using the KEY, Go over and Lesson 3, Activity 3 and correct in class. Discuss the unique design features of the Tlingit canoe. Review the Vocabulary terms.

Learning Plan	
Lesson Number & Title: Lesson Four: Canoe Math Continued (2 Activities)	**Time & Timing:** ~1-2 class periods

Vocabulary:

- *Tlingit Phrase:* Yindei naytsóow yee axáayi. *English Translation:* Push your paddles way down.
- stability
- proportion
- hull speed
- waterline length
- bow wave
- stern wave
- displacement
- displacement hull
- knot
- chine
- thwart
- tender

Objectives:

- Students will be able to describe the characteristics of displacement, semi-displacement, and planing hulls
- Students will understand the relationship between canoe hull length and potential speed
- Students will compute the theoretical maximum of speed of displacement hulls of given lengths
- Students will define and use appropriately ten new nautical terms

Materials:

- Tlingit Canoe Teacher Packet: "Lesson Four"
- Tlingit Canoe Student Packet: "Lesson Four"
- Monograph

Lesson Progression:

Hook

Unit Title: The Tlingit Canoe & the Story of Kaax'achgóok

Subject / Course: Math, Literacy

Grade Range: 7th-12th

Time: 3-4 weeks

Goldbelt Heritage

Distribute the Displacement, Semi-displacement, and Planing Hulls information sheet. Inform students of the following: Watercraft have hulls which can be classified as one of three basic types. (Displacement, Semi-displacement, and Planing hulls) Using the information sheet, explain the basic characteristics of the three types of hull design:

1. Planing Hull: Skims the surface of the water. Many small power boats have planing hulls.

2. Displacement Hull: This hull goes through the water rather than skimming over the surface. A displacement hull displaces the water.

3. Demi-displacement Hull: At high speed, this type of hull will partially life out of the water. Many cabin cruisers have semi-displacement hulls. Ask students if they can identify which of these three types of hull types a Tlingit canoe would be classified as. (Displacement) Tell students that the displacement hull creates a moving hole in the water. The maximum speed of a displacement hull can be calculated from the known waterline length of the hull.

Building Understanding

Hand out the monograph Displacement Hull Speed to the students. Use this monograph as a teaching aid as you present the mathematical analysis of the potential hull speed of a Tlingit canoe. Here is the basic idea. For years, boat designers have used a simple formula for determining the potential speed, HS (hull speed), for a displacement hull (a hull which plows through the water in contrast to a planing hull, as in small skiffs and speed boats, which plane on top of the water). The formula is HS = 1.34 x the square root of LWL (Length of the boat at the Waterline). The length at waterline must be expressed in feet and the resulting Hull Speed will be in knots.

Example: A Tlingit canoe has a LWL of 24 feet.

HS = 1.34 x the square root of 24

HS = 1.34 x 4.9 (rounded to the nearest tenth)

HS = 6.5 knots

The speed of 6.5 knots is achievable by strong rowers. For a 24 ft. long canoe to achieve a greater speed would require an enormous amount of energy, well beyond the rowing capacity of the crew. The monograph, Displacement Hull Speed, includes a presentation of the theory behind the hull speed and boat length computations. Use this document as a teaching tool when presenting displacement hull speed to the class.

Concluding Activity

Activity #1: Displacement Hull Speed

Hand out the Determining Displacement Hull Speed assignment to students. Questions 1 through 4 are computation questions. Questions 5 and 6 require a written response. (See KEY Lesson 4, Activity 1)

Activity #2: Paper Canoe Calculations

Give the students a copy of the student handout, Lesson 4, Math Activity 2 Paper Canoe Calculations. Students should use the paper model canoe they have made and the scale they have assigned to their canoe to make these calculations. This assignment may be given as homework or as a classroom activity. Note: The mathematical calculations for this activity will differ depending on the scale each student assigns to their paper canoe.

Go over the assignment/s in class with the students and evaluate their responses. For Activity 2, the Paper Canoe Calculations have the student's pair up and spot check the accuracy of their partner's calculations.

Learning Plan	
Lesson Number & Title: Assessment: Canoe Unit Test	**Time & Timing:** For use throughout the unit
Materials Needed: • Canoe Unit Test	